**5:15 PM**
**[120] ASSESSMENT OF FINGER TAPPING TEST FOR HUMAN FATIGUE AND EFFECTIVENESS OF GLUTAMIC ACID SUPPLEMENTATION AT HIGH ALTITUDE**
M. Khan[1], A.K. Salhan[2] and S.K. Sharma[2]
[1]*Electrical Engineering, Jamia Millia Islamia, New Delhi, India;* [2]*Defence Institute of Physiology and Allied Sciences, Defence Research and Development Organisation, Timarpur, India*

*(ORIGINAL RESEARCH)*

**BACKGROUND:** Finger Tapping Test (FTT) has a long history in the field of neuropsychology and called as a standalone test. Aim of the study is to see how a short duration finger tapping test is affected (i) at high altitude and (ii) with supplementation of glutamic acid. **METHODS:** Data was acquired from 30 healthy young volunteers aged between 24 to 28 years on sea level (SL) and high altitude (HA) of 10700 feet. All subjects were right hand dominant. The signal was acquired for movement of index finger tapping for 30 seconds of all the subjects. 30 subjects were randomly divided into two groups. 15 subjects were administered oral glutamic acid as supplementation group (SG) and rest was designated as the control group (CG). Tapping was recorded for 30 seconds on ppg probe of Biopac System and time noted for first 10 taps and last 10 taps from the recordings. At SL, the CG took 1.99 secs for first 10 taps and 2.27 secs for last 10 taps. The corresponding values for SG were 2.13 and 2.37 secs respectively. At HA, average δT for start and end taps was 2.12 and 2.49 secs for CG and 2.31 and 2.63 secs for SG. Corresponding average area was 66.15 and 77.87 for CG and 81.27 and 93.69 for SG. Tap Index for start was 31.28 for CG and 30.38 for last 10 taps. Corresponding values for SG were 34.60 and 35.38. **RESULTS:** Area under curve signifying extent of up-down movement of the finger found as 67.51 for start and 87.34 for end taps for CG and 77.48 for start and 95.85 for CG. The δT for start and end 10 taps for both groups was highly significantly increased in 30 secs ($p<0.00001$) signifying slowing of finger taps. Tap Index was created by dividing the area by δT and found significantly different ($p<0.05$) in both groups at SL. **DISCUSSION:** Comparing SL and HA values shown significant increase in δT in both CG ($p<0.05$) and SG ($p<0.005$) for first 10 taps however δT for end taps was significantly increased ($p<0.005$) for CG but a non-significant increase was seen in SG ($p=0.476$). There is a highly significant slowing of tapping speed by 30 seconds in both the groups ($p<0.00001$). The significance of slowing was more at HA ($p<0.000001$) in both the groups. **CONCLUSION:** Short time FTT for 30 secs may be effectively used as a simple and quick test for assessment of effect of HA on neuromuscular performance and also to study effect of supplements.

**Learning Objectives:**
1. How supplementation of glutamic acid affects small muscle performances?
2. How supplementation of glutamic acid affects small muscle performances at high altitude?
3. How short duration Finger Tapping Test can be utilized at high altitude?

## TUESDAY, MAY 8, 2018

***Tuesday, May 08*** ***8:30 AM***
***Chantilly East***

## 5th MEMORIAL REINARTZ LECTURE

*Ronald Przygodzki, M.D.*
**"Genomic Medicine: What, How and Where?"**

***Tuesday, May 08*** ***10:30 AM***
***Ballroom D***

## S-026: SLIDE: GZ ACCELERATION

**Chair: Alden Hilton**
*Dayton, OH*

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

**10:30 AM**
**[121] CUMULATIVE +GZ EXPOSURE AND ITS EFFECT ON ACCELERATION ATELECTASIS**
R.D. Pollock, H.D. Tank, F.L. Edwards and A.T. Stevenson
*QinetiQ, Farnborough, United Kingdom*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Recently there has been an increased reporting of acceleration atelectasis by fast jet aircrew. In the majority of individuals >60s exposure to +Gz is required for its development while it is believed that breathing gas mixtures containing <60% $O_2$ prevent it. However, the effects of cumulative exposure to +Gz acceleration have not been investigated and, given reports of acceleration atelectasis, the assumed protection from breathing <60% $O_2$ may no longer be valid. **METHODS:** Fifteen subjects, wearing full coverage anti-G trousers, completed four centrifuge exposures to 1, 2, 3 or 4 peaks of +5Gz, lasting 30s, separated by 15s nadirs at +1.4Gz. Exposures were performed twice with subjects breathing gas mixtures containing either 94% or 60% $O_2$ under Gz. Acceleration atelectasis was assessed after each exposure by measurement of forced inspiratory vital capacity (FIVC) and regional lung (basal) FIVC (rFIVC - by electrical impedance tomography). Pulmonary shunt was estimated from breath-by-breath measures of end-tidal $O_2$ concentration and peripheral oxygen saturation ($SpO_2$) obtained during a switch of the breathing gas to one containing 14% $O_2$. The minimum $SpO_2$ during this period was also recorded. **RESULTS:** Compared to baseline FIVC and rFIVC were significantly lower after all peaks in Gz breathing 94% $O_2$ ($P=0.012$). FIVC significantly declined after 4 peaks of Gz while breathing 60% $O_2$ ($P=0.015$) while there was a tendency for rFIVC to be lower after all Gz exposures when breathing 60 % $O_2$. There was a tendency for a greater number of peaks in Gz to cause a larger pulmonary shunt ($P=0.125$) which was more exaggerated when breathing 94% $O_2$ ($P=0.087$). The hypoxaemia during a hypoxic exposure post Gz was significantly lower after breathing 94% $O_2$ ($P=0.007$) and when a greater number of Gz peaks were performed ($P=0.003$). **DISCUSSION:** This is the first study to show that cumulative exposure to +Gz is capable of eliciting increasing levels of acceleration atelectasis, with >30s cumulative exposure sufficient to cause this when breathing high $O_2$ concentrations. With sufficient cumulative +Gz exposure, 60% $O_2$ is not capable of preventing acceleration atelectasis indicating a lower inspired $O_2$ concentration may be required to prevent acceleration atelectasis. The increased reporting of acceleration atelectasis may be due to the inspired $O_2$ concentrations not being sufficiently low to prevent it along with its gradual development over an entire sortie.

**Learning Objectives:**
1. To understand how cumulative exposure to +Gz acceleration influences acceleration atelectasis.
2. Recognize the importance of inspired O2 concentration on the development of acceleration atelectasis.

**10:45 AM**
**[122] VARIATION OF CARDIAC PARAMETERS BEFORE THE TERMINATION OF G FORCE DURING OPERATING ANTI-G STRAINING MANEUVER**
C. Lai[1], H. Chu[2], C. Liu[3] and M. Tu[1]
[1]*Aviation Physiology Research Laboratory, Kaohsiung Armed Force General Hospital Gangshan Branch, Kaohsiung City, Taiwan;* [2]*Institute of Aerospace and Undersea Medicine, National Defense Medical Center, Taipei City, Taiwan;* [3]*Kaohsiung Armed Force General Hospital Gangshan Branch, Kaohsiung City, Taiwan*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** When pilots are exposed to high G environment, blood will be impelled toward the lower body. Without proper protection, visual disturbance such as grayout, blackout, tunnel vision and G force induced loss of consciousness (G-LOC) may ensue. Anti-G straining maneuver (AGSM), which increases preload of the heart, is the most important guard against acceleration force and prevent fighter pilots from G-LOC. An objective evaluation of cardiac performance during AGSM would provide insight into acceleration training effectiveness. **AIMS:** To describe the cardiac indices characteristics of subjects while performing AGSM in the centrifuge and to compare these data between

non-G-LOC and G-LOC group. **METHODS:** We conducted this longitudinal study in 2017 and randomly recruited undergraduate student pilots of Air Force Academy as participants. By using a non-invasive hemodynamic monitor (PhysioFlow®Enduro™Manatec Biomedical, Paris, France), three main cardiovascular variables (cardiac output, CO; stroke volume, SV and heart rate, HR) were recorded before and after performing AGSM during high G endurance training (onset rate: 0.1G/second) in a human centrifuge (Latécoère, France). Endpoint of data extraction were the termination of G Force in the centrifuge due to (1) acceleration up to 9G, or (2) subjects suffered from loss of 100% peripheral vision or G-LOC. Data were analyzed by SPSS 20.0 software. **RESULTS AND CONCLUSIONS:** Totally, 37 subjects (age, 23.9±1.2 years) participated in the study. Their mean relaxed and straining G tolerance were 5.2 G and 8.4 G, respectively. AGSM effectiveness was 3.3 G. Nearly one-third of them were attacked by G-LOC (n=12). Ratios of SV, HR, and CO after and before performing AGSM were 0.99, 1.11, and 1.11, respectively. Only ratios of HR and CO were significantly elevated above value of 1.0. However, 5 seconds before the termination of G force, ratios of SV were significantly different between non-G-LOC and G-LOC group (1.06 and 0.86, respectively; *p* value=0.038). Our results indicated that cardiac parameters such as HR and CO would significantly increase during AGSM in high G endurance training. Compared with non-G-LOC group, G-LOC group couldn't effectively maintain SV during AGSM. In the future, we will apply this result to improve trainee's AGSM skill during high G endurance training.

**Learning Objectives:**

1. To evaluate the cardiovascular performance during AGSM in high G endurance training by using non-invasive equipment.
2. To compare physiological variations between non-GLOC and GLOC groups and further use this results to improve pilot's AGSM skill.

### 11:00 AM
### [123] IS KOREAN PILOTS(F-15/16)' G-TOLERANCE RELATED WITH ACTN-3 GENOTYPE OR OTHER FACTORS?

S. Shin
*Aerofitness, Korean Air Force Academy, Cheongju, Rep. of Korea*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Korea is divided country, North Korea's Kim raises conflict. So, Korean Air Force Pilots' physical aptitude is very important for preparing long-term period's operations. Hi-G tolerance could be measured from breath interval, is related with lower body's high intensity muscle endurance. In muscle type-2, ACTN-3 genotype (RR, RX, XX) was known as related with performance, especially 'R' is related with high muscle function. So, it's very interesting for inspecting pilots' Hi-G tolerance whether related with ACTN-3 genotype or other factors like body composition and flight time, etc. **METHODS:** 40 male pilots (age 25-40/IRB:ASMC-17-009) performed actual 9G-test (15sec) voluntarily in Korea Air Force Aeromedical Center with G-suit, L-1 AGSM (Anti-G Straining Maneuver). Breath interval was measured using stopwatch (CASIO) by researcher and body compositions(height(cm), weight(kg), muscle mass (kg), fat (%), BMI (kg/m2)) were measured by BIA device (Inbody720, Biospace, Korea) by professional. ACTN-3 Genotype was analyzed by GreenCross Laboratory, authorized by national organization. G-tolerance(breath interval) by Genotype (RR, RX, XX) was analyzed by One-Way ANOVA. Correlations between breathing interval, genotype and body compositions' was analyzed by SPSS 19.0 (for Windows). **RESULTS:** Among 40, RR & XX are each 13, RX is 18. First, RR's breath interval (G-tolerance) is longest (1.97sec/XX 1.94sec), but not significant by genotype. Second, no significance was showed in body compositions by genotype and G-tolerance. But, XX (174.47cm) shows similar heights with RR (174.58cm), but heavy weight (80.41kg vs. RR:78.61kg), muscle mass (35.59kg vs. RR:35.22kg) and fatty (17.77kg vs. RR:16.67kg). Third, breath interval was related with flight time (r=.323, α=.033). **DISCUSSION:** There is no research performed about G-tolerance and genetic factor. In Korean Pilots(F-15, 16), G-tolerance, Genotype(a=.741) and body compositions (muscle mass' a=.195) are not related with each other. G-tolerance is related with just flight time (a=.033). But, XX is relatively heavy, much muscle mass and fatty. This study is pilot study, for more explanation, more studies are needed. If participants' groups are divided by narrow age range, genetic relations about G-tolerance maybe.

**Learning Objectives:**

1. Is Hi-G tolerance related with genetic factor?

### 11:15 AM
### [124] THE EFFECTS OF AN AIRCREW CONDITIONING PROGRAMME ON PERFORMANCE DURING HIGH +GZ

E. Slungaard[2,3], N.D. Green[2], R.D. Pollock[1], A.T. Stevenson[1], D.J. Newham[4] and S. Harridge[3]
*[1]QinetiQ, Farnborough, United Kingdom; [2]RAF Centre of Aviation Medicine, Henlow, United Kingdom; [3]Centre of Human and Aerospace Physiological Sciences, King's College London, London, United Kingdom*

*(ORIGINAL RESEARCH)*

**INTRODUCTION**: There remains concern over the ability of aviators to tolerate the considerable +Gz stressors of the modern high performance aviation environment. The Aircrew Conditioning Programme (ACP) has been designed to improve +Gz tolerance and reduce neck injuries, and has been shown to have construct validity. The aim of the present study was to determine the efficacy of the ACP on +Gz performance in a controlled trial. The study protocol was approved in advance by the Ministry of Defence Research Ethics Committee. **METHODS:** Thirty-six male subjects (aged 24.6 ± 0.4 years) were recruited from the UK Royal Air Force and Royal Navy student aircrew. Subjects completed a series of runs on a man-carrying centrifuge (Farnborough, UK) pre and post completion of either 12 weeks of the ACP (exercise group (EG), n = 17) or no specific physical conditioning (control group (CG), n = 19). The centrifuge runs involved: (i) measurement of relaxed +Gz tolerance (RGT) via two gradual onset runs (0.1.G $s^{-1}$); (ii) straining +Gz tolerance (SGT) consisting of a stepped protocol from +3 Gz up to +7 Gz or when terminated by the subject; (iii) 4 simulated air combat maneuvers (SACMs) consisting of 4 cycles of 5s at +7 Gz followed by 15s at +5 Gz, separated by a 2-minute rest period. **RESULTS:** Thirty-five subjects completed the study (16 EG, 19 CG). RGT was unchanged in the EG (pre 4.2 ± 0.2, post 4.4 ± 0.2 Gz); as was SGT (pre 6.4 ± 0.1, post 6.5 ± 0.2 Gz). However, during the +5.5 Gz SGT step a lower physiological strain was indicated in the EG by a lower HR for the equivalent load (pre 146.0 ± 4.4, post 136.9 ± 5.6 beats.$min^{-1}$) compared to the CG (pre 148.0 ± 3.2, post 153.1 ± 3.3 beats.$min^{-1}$), while mean arterial blood pressure was unchanged. During the SACMs the number of +7 Gz peaks completed per subject (maximum of 16) had a tendency to increase in the EG only (pre 14.0 ± 1.2, post 15.4 ± 0.4 peaks per subject) whereas the CG had a tendency to reduce (pre 14.0 ± 0.9, post 13.6 ± 1.1 peaks per subject). **DISCUSSION:** The data show that the ACP did not negatively affect +Gz tolerance and may be effective in enhancing aircrew performance in a high +Gz environment by reducing physiological strain at given levels of +Gz.

**Learning Objectives:**

1. To demonstrate the effects of a conditioning program specifically designed to improve the performance of aircrew operating in a high +Gz environment.

### 11:30 AM
### [125] A COMPARISON OF NON-HUMAN PRIMATE INJURIES DOCUMENTED IN HORIZONTAL VERSUS VERTICAL SLED +GZ IMPACT ACCELERATIONS

A. Abraczinskas[1,2], A. Olszko[1,2], C.M. Beltran[1,2], J.S. McGhee[1], J. Baisden[3], K.B. Vasquez[1] and C. Chancey[1]
*[1]U.S. Army Aeromedical Research Laboratory, Ft. Rucker, AL; [2]Laulima Government Solutions, LLC, Orlando, FL; [3]Medical College of Wisconsin, Milwaukee, WI*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Human primates (NHP) were exposed to +Gz (head-to-toe) loading seated upright on a vertical track or supine on a horizontal track. A comparison of documented injuries between these loading modes may offer insight into effects of orientation during axial loading, which is important when considering occupant positioning both during testing scenarios as well as within aircraft and ground vehicles with supine or upright occupants. **METHODS:** NBDL NHP necropsy and pathology reports, now contained in the Biodynamics Data Resource (BDR) of U.S. Army Aeromedical Research Laboratory (USAARL), were reviewed by physicians to determine acceleration-related injuries. Runs with acceleration-related injuries were included for analysis and

categorized as related to the central nervous system (CNS), musculoskeletal system (MSK), or thoracic region (THR). The occurrence of injuries relative to the corresponding peak sled acceleration (PSA) and equipment, horizontal accelerator (HA) or vertical accelerator (VA), were compared. **RESULTS:** PSA ranged between 6 and 86G. Out of the 63 +Gz runs conducted, a total of 17 runs (6 HA, 11 VA) resulted in acceleration-related injury. For HA runs, the lowest PSA associated with injury was 70G. For all injuries from HA runs, CNS injuries (n=5), MSK injuries (n=6), and THR injuries (n=6) occurred at/above 75G, 70G, and 70G, respectively. For VA runs, the lowest PSA associated with injury was 40G. For all injuries from VA runs, CNS injuries (n=3), MSK injuries (n=9), and THR injuries (n=8) occurred at/above 60G, 40G, and 50G, respectively. **DISCUSSION:** Although loading in the same +Gz direction, subject and sled orientation may affect threshold levels and likelihood of certain injury types. In this analysis, axial loading to upright occupants produced more musculoskeletal and thoracic injuries. Loading to supine occupants produced more CNS injuries. Though additional analysis is necessary to translate these results to the human, this comparison highlights the effects gravity may have during axial loading and importance of orientation when considering next generation equipment design or occupant placement during testing scenarios and all modes of travel.

**Learning Objectives:**

1. The objective is to understand how injury type is affected by subject positioning relative to gravity when loading is applied in the same direction.

**11:45 AM**

### [126] INFLUENCE OF POSITIVE PRESSURE BREATHING FOR G-PROTECTION (PBG) ON LUNG FUNCTION IN HIGH PERFORMANCE FLYING

S. Barthelmann[1], F.M. Jakobs[2], C. Wonhas[2] and N.J. Guettler[2]
*[1]Tactical Air Force Wing 74, German Air Force, Neuburg a.d. Donau, Germany; [2]German Air Force Center of Aerospace Medicine, Fürstenfeldbruck, Germany*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Use of positive pressure breathing for g-protection (PBG), beside additional anti-g equipment, ensures increased g-tolerance in high performance aircraft pilots. Pilot exposure to these increased pressures is obviously quite short, but the given pressure is up to 60mmHg, e.g., in the Eurofighter typhoon. As a result, a potential decrease in lung function could be hypothesized. We aimed to investigate whether there is evidence of pathological values in the lung function tests as a consequence of PBG supporting this hypothesis in a defined collective of German Eurofighter pilots. **METHODS:** Spirometric and body-plethysmographic data of healthy pilots aged 19-52 (31.1 ± 8.3) years were retrospectively analyzed using standard statistical software. Spirometric data were available for n=169 pilots, while plethysmographic data were available for n=109 pilots. Input variables included date of examination, age, weight, height, flight hours and body mass as a calculated index. Data were analyzed for cross-sectional findings as well as for relative change over time, with respect to age- and gender-specific reference values as provided by the European Respiratory Society. Correlation of plethysmographic outcomes with the pilot's flight hours was approached using linear regression. **RESULTS:** Based on spirometric results, no pathological findings could be confirmed. This was true for cross-sectional data as well as for longitudinal data which, although decreasing over time, paralleled the respective reference values. In contrast, body-plethysmographic measurements reflected a selective increase of residual volume (RV) which slightly, but significantly outranged the respective reference values ($p<0.005$). Linear regression modelling confirmed a statistical correlation between RV and age ($R^2=0.374$) and flight hours and age ($R^2=0.493$), respectively not between RV and flight hours ($R^2=0.010$) indicating confounding introduced by age. **DISCUSSION:** At present, we conclude that there is no evidence for a harmful effect of PBG on lung function in high performance aircraft pilots. Our results indicate that body-plethysmography might be more sensitive towards the detection of minor, for instance age related changes as spirometric measurements. Furthermore body-plethysmography outbalances spirometry in the evaluation of pulmonary diseases like emphysema.

**Learning Objectives:**

1. Presently there is no evidence for a harmful effect of PBG on lung function in high performance aircraft pilots.
2. Body-plethysmography might be more sensitive towards the detection of minor, for instance age related changes as spirometric measurements.
3. Furthermore body-plethysmography outbalances spirometry in the evaluation of pulmonary diseases like emphysema.

***Tuesday, May 08*** ***10:30 AM***
***Ballroom E***

## S-027: PANEL: PROVOKED SEIZURES —"FIT" TO FLY?

**Chair: Roger Hesselbrock**
*Wright-Patterson AFB, OH*

**PANEL OVERVIEW:** Seizures are an uncommon occurrence in aviators, but have serious aeromedical implications due to sudden incapacitation that results in most instances. The future recurrence risk generally exceeds aeromedically acceptable standards, precluding return to fly in some cases permanently, and in other cases only after a long observation period. However, some cases of seizures provoked by external factors are amenable to a more expedient, safe return to flying recommendation following suitable evaluation with favorable results. This panel will focus on the broad topic of provoked seizures, with separate presentations covering the use of electroencephalogram and sleep monitoring protocols, ethanol-related seizures, discussion and debunking of some popularly held provocative factors for seizures, case examples of provoked seizures in aviators, and the determination process for returning to fly following a provoked seizure.

### [127] RETURN TO FLY DETERMINATION PROCESS FOR PROVOKED SEIZURES

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

*(EDUCATION - TUTORIAL)*

**PROBLEM STATEMENT:** Seizures, fortunately, occur uncommonly in aviators, but have important aeromedical implications due to the sudden, unpredictable occurrence and the incapacitation that is seen with most seizure types. The future recurrence of seizures generally exceeds aeromedically acceptable standards. This results in permanent flying disqualification for some cases, but even in cases with more favorable clinical circumstances, a safe return to flying recommendation is possible only after a long observation period. Some cases of seizures provoked by external factors are amenable to a more expedient, safe return to flying recommendation following suitable evaluation with favorable results. **TOPIC:** I will present and discuss the process for making a return to fly determination in aviators with provoked seizures, covering recommended assessment, future recurrence risks, suitable observation period before safely returning to fly, and any follow-up management. Applicable practice guideline/parameter guidance will be incorporated into the presentation. Data from the U.S. Air Force School of Aerospace Medicine and other sources will be used to illustrate the process and outcomes. **APPLICATIONS:** This presentation is applicable to all aviation medical examiners who evaluate aviators with provoked seizures.

**Learning Objectives:**

1. Review the basic process for aeromedical disposition in aviators with seizures.
2. Review current American Academy of Neurology practice guideline information for adults with unprovoked seizures.
3. Review current military and civilian agency guidance for returning to fly after seizures.

### [128] AN UPDATE ON THE USE OF EEG, MEEG AND FMRI IN THE RISK ASSESSMENT OF SEIZURES IN AVIATORS

C.R. Skinner
*Neurology, Ottawa Hospital, Ottawa, ON, Canada*

*(EDUCATION - CASE STUDY CLINICAL)*

This session will review the use of EEG, MEEG and fMRI in the assessment of aviators referred for determining a diagnosis of seizures in an individual with a first time seizure or unexplained loss of consciousness. The session will focus on the use of these techniques to support risk assessment of further events. The session will review the sensitivity and specificity of the various modalities and provocation procedures currently in use. These procedures include sleep deprivation, photic stimulation and hyperventilation. There will be a discussion of ethical considerations with respect to more aggressive forms of seizure provocation. There will also a brief review of newer techniques of detection of occult seizure activity such as analysis of high frequency oscillations (HFO), advanced signal analysis of the default mode network and analysis of polysomnographic EEG data. A diagnostic algorithm will be presented for discussion.

**Learning Objectives:**

1. To review the use of the different modalities of EEG, MEEG and fMRI in the risk assessment of seizures in aviators.
2. To review the techniques used to provoke EEG abnormalities and the ethical considerations.
3. To review advances techniques of analysis such as analysis of high frequency oscillations (HFO), advanced signal analysis of the default mode network and analysis of polysomnographic EEG data.

### [129] ALCOHOL RELATED SEIZURES

J.D. Hastings
*Aeromedical Neurology LLC, Tampa, FL*

*(EDUCATION - TUTORIAL)*

One or more seizures occurring in an aviator has widespread implications. If seizure etiology is apparent (e.g., neoplasm, stroke, traumatic brain injury), medical certification decisions relate to the underlying pathology. Etiology is unknown in over 50% of cases. In the U.S., a single seizure with normal studies and no risk factors will ground a pilot for four years, and multiple seizures will ground a pilot for at least ten years if not permanently. Accordingly, a diligent search for seizure etiology is paramount. In earlier years pilots with alcoholism lost their career. It was not rare for a pilot to have an alcohol withdrawal seizure in the cockpit, the pilot abstaining before work. Now that rehabilitation allows return to flying, identification of alcohol withdrawal seizure is critical. Alcohol withdrawal seizures do not indicate epilepsy, and if clearly identified return to flying may be possible in one year. The importance of identifying characteristics of alcohol withdrawal seizures (and other acute symptomatic seizures), as well as excluding other seizures masquerading as alcohol withdrawal seizures will be discussed. Aeromedical disposition and return to flying implications will be addressed.

**Learning Objectives:**

1. To identify alcohol related seizure characteristics.
2. To exclude other seizures masquerading as alcohol withdrawal seizures.
3. To discuss return to flying following alcohol rehabilitation.

### [130] PROVOKED AND ACUTE SYMPTOMATIC SEIZURES IN NAVAL AIRCREW: CASE STUDIES FROM NAMI

E.Y. Park
*Neurology, Naval Aerospace Medical Institute, Pensacola, FL*

*(EDUCATION - CASE STUDY CLINICAL)*

**PROBLEM STATEMENT:** Seizures in aircrew represent a distinct hazard to flight safety and a compromise to mission effectiveness in military operations are, therefore, considered disqualifying. In some cases of provoked or acute symptomatic seizure experienced aircrew may be deemed acceptable risk and returned to flight duties. **BACKGROUND / LITERATURE REVIEW:** Designated aviation personnel who experience a seizure are disqualified from aviation duty. Certain types of provoked or acute symptomatic seizures may be considered for a waiver if causal factors can be identified, treated, avoided, or sufficiently mitigated, and expected flight conditions are unlikely to exacerbate future seizure risk. **CASE PRESENTATION:** The Naval Aerospace Medical Institute (NAMI) has entertained waiver requests for a variety of provoked and acute symptomatic seizures, including seizures in the setting of recent heavy alcohol consumption, local anesthetic administration, meningioencephalitis, hyponatremia, photic stimulation, and stimulant use, and combinations of the above. Aeromedical disposition of aircrew that experience these seizures can be challenging due to the difficulty in determining the risk of a future unprovoked seizure. Several cases will be presented along with their suspected mechanisms and the rationale for the aeromedical disposition decisions. **OPERATIONAL / CLINICAL RELEVANCE:** These cases are a cross section of provoked and acute symptomatic seizures deliberated at NAMI in the past 10 years. They illustrate the challenges in developing aeromedical disposition recommendations for aircrew members who have experienced seizures.

**Learning Objectives:**

1. Understand the difference between cryptogenic and symptomatic seizures.
2. Know some common causes of provoked seizures.

***Tuesday, May 08*** ***10:30 AM***
***Wedgewood***

## S-028: PANEL: COMPLEXITIES AND EVOLVING TECHNOLOGIES FOR HUMAN MISSIONS TO MOON/MARS: ORGANIZATIONAL, HUMAN-SYSTEMS AND MEDICAL CHALLENGES

**Chair: Ilaria Cinelli**
*Galway, Co. Galway, Ireland*

**Chair: Dwight Holland**
*Roanoke, VA*

**PANEL OVERVIEW:** Human settlements on the Moon and on Mars could be considered the next largest interdisciplinary and international challenge of humanity, starting from about 2020's. In an endeavor where failure is not an option, preparation and execution are crucial ensuing mission success. Simulated missions in analogue environments replicates part of the complexity of the real missions to test and to assess emerging technology and some countermeasures, to improve design, user-experience and efficiency. From crew selection to permanent human settlements, there is a need to look at the larger picture of mission management and structure regarding specific ergonomic, medical and psychological factors - both in the astronaut crew and ground support (GS), which includes Mission Support, technical facilities and resources. Besides the functionality of the human body, we must investigate and presume the interdependence between the astronaut mental wellness, team cohesion and the quality of communication with the GS. The panel aims at highlighting the ensuing gaps: in space life-sciences, in space-related multidisciplinary research fields, and to provide examples of challenges in analogue missions, built on collaborative interdisciplinary and international efforts. The panel will start discussing the implications of medical and psychological factors and their future role in shaping the processes of structure of ground control and communication methodologies. Then, consideration is given to on-going practical challenges and corresponding solutions behind Moon/Mars analogue missions, as a first step towards real interplanetary human missions. The discussion will include the problems already detected in analogue missions and proposed countermeasures in the context of potential solutions, as well as emerging medical technologies and protocols for in-flight medical emergencies and long-haul flights. Time delayed communications will be reviewed both for medical evaluation purposes and crew-to-ground intercommunication. The need of new medical technology for time delayed surveillance become evident to overcome the practical difficulties of remote medical assistance and patient monitoring system. Thus, future medical training should conform to delayed preparedness for medical intervention. The panel will conclude tying together these topics, with a few lessons learned/not learned from limited lunar and orbital operations, with several areas of concern for the earliest Mars missions.

## [131] OPERATING AN INTERNATIONAL MARS ANALOGUE SIMULATION WITH TIME DELAY

S. Hettrich[2], T. Lucic[3] and I. Cinelli[1]
*[1]Biomedical Engineering, NUIG, Galway, Ireland; [2]Space Generation Advisory Council, Hamburg, Germany; [3]Space Generation Advisory Council, Porto, Portugal*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Future human space exploration to the Moon and destinations beyond, e.g. Mars, will bear huge efforts financially and technologically. Currently, no single nation can undertake such an expedition on its own. Another huge challenge for operating a Mars mission lies in the time-delayed communication due to the long distance. Impatience, irritability and stress arise both in the crew and Mission Control (MC) for the lack of real-time communication affecting team cohesion in both groups. Analogue missions help to study and improve current mission operations to cope with these factors. This work reports operational challenges for an international mission, including an international crew, international MC and time-delayed communications, based on the Poland Mars Analogue Simulation (PMAS) 2017, conducted by the Space Exploration Project Group of the Space Generation Advisory Council. **METHODS:** PMAS was a two-week simulation, which was divided into a Lunar and a Martian part. Difference here was a 15 minute time delay. The mission was run by over 40 students and young professionals from different disciplines; over 30 countries were participating directly, and more were supporting and contributing remotely. **RESULTS:** Using qualitative methods and frequency analysis on post-mission reports of different MC teams (medical team, records team,...) the key problems and solutions for effective time-delayed communication, with a heterogeneous MC, were discussed. **DISCUSSION:** High-fidelity analogue simulations on Earth can help to establish operational procedures and guidelines, by developing effective communication methods which optimizes performance. Problems and solutions will be discussed for both for crew and MC training, and Moon-Mars simulation cases.

**Learning Objectives:**

1. Mission control/support and communication methodologies have connections to the astronaut's mental wellness.
2. Mission management should contribute to the development of new type of remote medical assistance under time-delayed conditions.
3. Only high-fidelity missions can show up the links between operations, scientific efficiency and medical and psychological factors.

## [132] THE DARK SIDE OF ANALOGUE ASTRONAUTS–THE ROLE OF PSYCHOPATHY IN RISK TAKING AND PERCEPTION OF STRESS, ANXIETY, AND DEPRESSION

T. Lucic
*Space Generation Advisory Council (SGAC), Lisbon, Portugal*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Recruitment of analogue astronauts is a challenging and crucial task in order to guarantee the success of any mission. One of the most important things to assess is emotional stability and the ability to make optimal decisions even under conditions of isolation. Previous findings have suggested that different factors of psychopathy (Fearless Dominance and Impulsive Antisociality) are connected to both of these outcomes. However, to the extent of our knowledge, this connection has never been explored in the context of analogue astronaut selection. The aim of this study was to determine the relationship across time between the above mentioned psychopathic factors with stress, anxiety and depression, and optimal risk decision making and risky behavior measured on the Balloon Analogue Risk Task (BART). **METHOD:** The results were collected on a total of 12 participants during the PMAS 2017 analogue mission duration and preparation period. The selected 12 participants assessed their daily depression, stress and anxiety levels during the one-week preparation period and 6 analogue astronauts performed BART testing during the isolation period of 2 weeks. **RESULTS:** Using hierarchical linear modeling (HLM) we investigated the relationship of psychopathic factors and BART results across time. No significant relationship was found. In parallel HLM was also used to investigate the relationship of depression, anxiety and stress with different psychopathic factors. The positive relationship between Impulsive Antisociality with depression, anxiety and stress was found across time, as well as a negative relationship of Fearless Dominance with depression and stress. **DISCUSSION:** These results suggest possible advantages on considering a high "Fearless Dominant" and low "Impulsive antisociality" profile when considering candidates for highly emotionally demanding analogue missions as a simple, quick and economical addition to the existing selection process. Nevertheless, a more detailed overview of psychopathic factors in the selection of analogous astronauts is needed to show how differentiating factors of psychopathy can be of use in the present context.

**Learning Objectives:**

1. Understand the additional value of screening for psychopathy factor profile (moderate to high "Fearless Dominance" and low "Impulsive Antisociality") in civilian and volunteer based analogue astronaut selection.

## [133] TELESURGERY-TELEANESTHESIA, 3D PRINTING & VR TECHNOLOGIES TO TRAIN NON-MEDICAL ANALOG ASTRONAUTS DURING MOON-MARS SIMS

S.I. Jewell[1,2], E. Jewell[2,1], M. Borri[2,3], N. Jewell[1,2], M. Koromorowski[2] and K. Mall[1,2]
*[1]Mars Academy USA, LLC, Van Nuys, CA; [2]Mars Desert Research Station, Utah, CA; [3]Robots Everywhere LLC, San Raphael, CA*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** To-date, there has been little study in the use of telesurgery and innovative technologies, such as, 3D printed medical tools in an integrated approach to Search and Rescue (SAR) and onsite emergency medical tele-triage operational procedures. Additionally, there has been minimal research in using virtual-, and augmented reality technology in telemedicine for training non-medical personnel or analog astronaut crews living in remote, isolated extreme environments. **METHOD:** To-date, pre-pilot and pilot studies have been conducted with analog crews at Mars Desert Research Station (MDRS) to address this problem. The study utilized real-time communication protocols between several remote medical teams and on-site non-medical trained crews to demonstrate the potential of integrating VR, 3D printing, and telesurgery-teleanesthesia protocols in a remote or extreme environment as a promising solutions. An IRB ethics approval was obtained to conduct the pilot studies. **RESULTS:** Thus far, results obtained has shown promising outcomes. The study looked at certain parameters utilizing "tele-mentoring" and "simulation-based learning" concepts for teaching participants in acquiring specific skill sets, for example, time to attain knowledge acquisition, number of times or repetition of specific tasks to attain accuracy and autonomy to perform the tasks/skill sets, and retention time of skills sets. The results showed each participant required 2-3 training sessions to attain accuracy and confidence to perform the tasks without expert guidance. **DISCUSSION:** Medical challenges facing short or long duration space missions for future human settlements on Moon or Mars can be tested and simulated on Earth's analog environments, i.e., during high fidelity analog missions to Antarctic or Everest, and might incorporate a time lag delay which will necessitate simulation training and medical guidance through systems that do not rely on synchronous real-time communication. Analog sims demonstrates the potential for developing tele-mentoring training protocols and integrating exponential technologies as viable possibilities for training non-medical analog astronaut crews during isolation and confinement in extreme environments.

**Learning Objectives:**

1. Participants will be able to learn about new innovative, novel technologies, such as, virtual reality and 3D printing of medical tools, can be used to support future crews living in isolation, extreme environments, and during long duration space missions.
2. Participants will learn how "simulation-based learning" and "just-in-time based learning" concepts can be used to teach new medical skills and knowledge to non-medical personnel and crews living in remote, isolated environments.
3. Participants will learn how telesurgery-teleanesthesia acquisition skills can play an integral part of remote missions, in Space and remote regions on Earth, where medical intervention is required when limited or no medically trained personnel is available.

### [134] MEDICINE AND SURGERY FOR MOON/MARS OPERATIONS

C. Salicrup[1,2]
*[1]Mission Doctor, Medical Team Leader, Analogue Astronaut (B Crew), PMAS, SGAC-SPEG, Alexandria, VA; [2]Boeing 787 Senior First Officer, Aeromexico, Mexico City, Mexico*

*(ORIGINAL RESEARCH)*

Space medical logistics have developed experience in orbital and ISS operational situations, where in case of a life-threatening situation the astronaut may be sent in a capsule back to earth, making a ballistic reentry and getting in to a hospital in less than 6 hours after his travel back to earth begins. In a Moon mission or in the path to Mars there will be a point of no return and coming back to Earth for definitive medical care will be unfeasible, therefore many medical situations, medical emergency management and training should be considered. Moon/Mars analogue missions are being used as a platform for medical preparedness, not only including how to manage a medical emergency on board or in the red planet, but also, we are covering the medical/psychological selection of the analogue astronauts that will be held in confinement, their nutrition and hydration, survival and medical training, non-medical officers training, medical kits equipment, medical drugs, medical situations during EVAs and how to maintain MOC and current training for mission doctors/surgeons during a long term mission. So far, the surgical management of a medical-trauma situation has not been necessary in Earth orbit, but it will be for interplanetary missions, then space anesthesia devices are being developed as well as space surgery devices and techniques, who will perform them and with which type of training, advice or mentoring will depend on the distance of the ship or settlement, to Earth. Since telemedicine, telesurgery and telementoring will depend on the communications time gap that is distance related. Recently we participated in the Poland Mars Analogue mission, organized by the Space Exploration Group of the SGAC, medical controls were taken very seriously, as well as the mission realism, it is the first know analogue mission that involves a full Mission Control/Support Center and a gap in communication time that simulated the Mars situation. These challenges made the medical team to develop techniques for medical surveillance and management, also for the major time of the mission there was not a medical officer on board, situation that the medical team had to deal with. Also the mission doctor and medical team leader was designated as one of the analogue astronauts, having the same training and experiencing the same situations with the other analogues. This situation helped him to get closely to them favoring medical care as happens with a flight surgeon-pilot program.

**Learning Objectives:**

1. The attendant will learn about the importance of logistics and developing of medical preparedness for a Moon/Mars mission.

### [135] HIGHLIGHTING SPACE LESSONS LEARNED - CAN WE EXTRAPOLATE THESE WITH TECHNOLOGY IMPROVEMENTS TO GO DIRECT TO MARS SAFELY?

D.A. Holland
*Human Factors Associates, Roanoke, VA*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** With planners looking at future architectures for human mission(s) to the surface of Mars, debate is ensuing on the safest pathway with the most efficient use of resources. A direct to Mars approach with only a cis-lunar (not surface return) stay, seems reasonably efficient. But, if past space history of systems evolution to date holds true - this might be a risky proposition. **METHODS:** This presentation opens with remarks tying some notions contained in the other presentations here. And, from the experience of this author in Antarctica on a remote scientific field expedition in dangerous areas as applied to studying modern space systems evolution and future plans. Freedom of Information Act request information on some Moonwalkers by William Rowe in various years was provided to the author help to frame some matters relating to Lunar surface operations fatigue, etc., issues. A review of several different eras of spaceflight shows that human-centered medical or Human Factors problems more generally were often not-well-understood cropped up at nearly every major technology new-demonstration point, or fairly soon thereafter. This occurred during the Russian program to a similar extent as well. **DISCUSSION:** Aside from Space Shuttle losses, which were macro-systems/organizational losses in nature - Phase 1 of ISS resulted in two close calls (Progress 233/234 spacecraft) - with 234 colliding with Mir due to a host of Human Systems Integration issues from Ground Control pressure, to poor controls and displays, fatigue, etc. It is the "perfect storm" case study highlighting the need for listening to the crew on board, and improving controls and displays to keep workloads reasonable during critical times. Interestingly, 2 other mishaps show that nascent space systems with poor human factors design can fail during high workload periods (e.g., X-15 and SpaceShip 2 mishaps). Other examples exist during the early space era of problems with EVA, egress, biomechanics, etc. **CONCLUSIONS:** These mishaps and others serve as sentinel warnings about the dangers of going too far, too fast and not fully testing technology-human capacities during novel operations methodically in a flight test fashion with buildup. History and Operational Risk Management imply that a return to the Moon surface first before risking Martian surface operations will reduce risk, if the costs and various pressures can be tolerated, with appropriate lessons learned along the journey.

**Learning Objectives:**

1. Going to Mars directly is fraught with peril based upon past history of human spaceflight at critical turning points in operations or technology.
2. Understand there are many precedents in the history of spaceflight where effective Human-System Integration has been ill-considered, leading to mishaps.
3. New space tasks unless very routine should be considered almost in a flight test like fashion with interactive buildup and study.

***Tuesday, May 08*** ***10:30 AM***
***Ballroom B***

## S-029: PANEL: AEROSPACE SAFETY CENTERS YEAR-IN-REVIEW: 2017

*Sponsored by AsMA Aerospace Safety Committee*

**Chair: Tyler Brooks**
*Ottawa, ON, Canada*

**Chair: Brian Musselman**
*Albuquerque, NM*

**PANEL OVERVIEW:** This panel presents the results of a review of 2017 aerospace safety data. Representatives from military and civil aerospace organizations will present summaries and analyses of their safety data collected in 2017. Cause factors including mechanical and human factors will be explored, identifiable trends will be highlighted, and updates on risk mitigation strategies will be discussed. With certain types of accidents increasingly becoming rare events, the panel discussion is a unique opportunity to review the collective experiences of multiple safety programs and consider a variety of risk mitigation solutions.

### [136] ROYAL CANADIAN AIR FORCE FLIGHT SAFETY: YEAR-IN-REVIEW 2017

T. Brooks
*Director of Flight Safety, Canadian Armed Forces, Ottawa, ON, Canada*

*(EDUCATION - PROCESS)*

**MOTIVATION:** The Royal Canadian Air Force (RCAF) operates all Army, Navy and Air Force aircraft in the Canadian Armed Forces. The Director of Flight Safety (DFS) investigates aviation occurrences with the goal of preventing accidental loss of aircraft and personnel. Contributory or causal human factors are identified using the Canadian Forces Human Factors Analysis and Classification System (CF- HFACS). Statistics and analysis from 2017 are discussed. **OVERVIEW:** Accidents and incidents in 2017 were reviewed to identify factors which may have caused or contributed to these occurrences. These factors were reviewed in the context of previously identified hazards which have been prioritized by DFS, such as fatigue, culture, and substances hazardous to aviation. **SIGNIFICANCE:** Fatigue, culture and substances hazardous to aviation

continue to be relevant hazards in the RCAF. DFS has helped to propel several risk mitigation initiatives specifically aimed these factors, including the implementation of the RCAF Fatigue Risk Management System.

**Learning Objectives:**

1. Understand the overall trends in RCAF flight occurrences in 2017.
2. Understand the factors identified as contributing to flight occurrences and the mitigating initiatives being undertaken by DFS.

### [137] U.S. CIVIL AVIATION IN 2017

C.A. DeJohn and W.D. Mills
*Aerospace Medical Research Division, FAA Civil Aerospace Medical Institute, Oklahoma City, OK*

*(EDUCATION - PROCESS)*

**MOTIVATION:** Trends in accident rates and performance data were analyzed for all types of civil aviation operations with emphasis on 2017 data. U.S. civil aviation accident data was analyzed to determine trends from 1990 to 2017; whereas, safety performance measures were analyzed for various time periods depending on available data. **OVERVIEW:** Fatal accident rates for all types of operations, except commuter airlines, significantly decreased for the period 1990 to 2017 ($p < 0.05$). During the same period air taxi and general aviation non-fatal accident rates decreased more rapidly than their respective fatal accident rates ($p < 0.01$). The general aviation fatal accident rate was below the target rate for 2015 and 2016. Actual safety performance measure rates for commercial air carrier fatality, serious runway incursion, serious loss of aircraft separation, and general aviation fatal accidents were all below their respective target rates for 2016. **SIGNIFICANCE:** An analysis of accident rates between 1990 and 2017 and trends in safety performance measures for all types of operations indicated steady improvements in civil aviation safety.

**Learning Objectives:**

1. Become familiar with the recent trends in aircraft accident rates for different types of operations.
2. Become familiar with the recent trends in aviation safety performance measures for different types of operations.
3. Become familiar with the differences between actual and predicted accident rates and performance measures for 2017.

### [138] NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) 2017 YEAR IN REVIEW.

T.G. Dillinger
*Office of Safety and Mission Assurance, NASA Headquarters, Washington, DC*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** This presentation provides information regarding NASA reportable mishaps, close calls, and hi-visibility events during the year 2017. In addition to occurrence data, human factors and mishap prevention information is also provided. The focus will be on current data, analysis, and trends based on 2017 data. **METHODS:** NASA collects Class A, B, C, and D mishap information as well as close calls and hi-visibility events in an investigation data-base called NMIS – NASA Mishap Investigation System. NMIS data, along with human factors (HF) data from the NASA Safety Center (NSC) database is annually analyzed and reported. This includes analysis and trending by year, aircraft, and other various factors. Data from 2017 will be used to show current events and trending, including HFACS analysis of human factors data. **RESULTS:** NASA continues to experience low occurrences of reportable events including low aviation mishap rates. Efforts to maintain vigilance and instill a strong prevention-focused safety culture are an important part of NASA Safety program. **DISCUSSION:** Analysis of NMIS data and safety prevention efforts indicates steady improvements in all safety -- including aviation. Efforts to delve further in human factors seek to maintain advancements, continually improve future mishap reduction efforts, and see further decline in preventable mishaps.

**Learning Objectives:**

1. Understand current mishap trends at NASA.
2. Review relevant historical mishap trends and events at NASA.
3. Understand current human factors identified within the 2017 NASA mishap database.

### [139] U.S. ARMY COMBAT READINESS CENTER: ARMY AVIATION ACCIDENTS 2017 YEAR-IN-REVIEW

D.C. Romine
*Command Group, U.S. Army Combat Readiness Center / HQ Dept of the Army Safety, Ft. Rucker, AL*

*(EDUCATION - PROCESS)*

For the period, 1 OCT 2016 thru 30 SEP 2017, U.S. Army Aviation accidents are presented to international community of aerospace medicine and physiology specialists. Particular attention is given to pertinent human factors, causation, and, lessons-learned for cultural and engineering improvements in safety with the goal of decreased loss of life and materiel across the U.S. Army Enterprise and by extension, the wider, international aerospace and military communities. Presentation method is to be given live, in-person, as part of a panel of other Canadian and U.S. aerospace medicine safety professionals, with PowerPoint slides, at the 2018 International Scientific Symposium of the Aerospace Medical Association in Dallas, Texas, USA.

**Learning Objectives:**

1. To present U.S. Army Aviation accident data for mishaps that occurred during Fiscal Year 2017.
2. To present causal human factors elements of U.S. Army Aviation accidents that occurred during Fiscal Year 2017.
3. To present responses from the U.S. Army Aviation and Safety communities for ways to mitigate futures losses based on lessons-learned from U.S. Army Aviation accidents that occurred during Fiscal Year 2017.

### [140] U.S. AIR FORCE AVIATION SAFETY: FY 2017 YEAR IN REVIEW

C.R. Pack, H. Tevebaugh, S. Stouder and B. Musselman
*Human Factors Safety Division, U.S. Air Force Safety Center, Albuquerque, NM*

*(EDUCATION - PROCESS)*

**MOTIVATION:** This panel will provide a review of fiscal year (FY) 2017 statistics and analysis for USAF Class A Aviation mishaps including classification with DoD Human Factors Analysis and Classification System (DoD HFACS). **OVERVIEW:** FY17 data was obtained from the USAF Safety Center database for Aviation mishaps and reviewed for human factors as determined by the Safety Investigation Boards (SIB). The human factors present were categorized for the present year and the preceding 9 years. The U.S. Air Force experienced 11 Class A Aviation mishaps during FY17 (a rate of 0.69 per 100,000 flight hours) with 7 destroyed aircraft and 5 fatalities. The review of Class A aviation mishaps over the past year demonstrated that most are attributed to human factors. The use and analysis of DoD HFACS will be discussed. **SIGNIFICANCE:** The total number of Class A aviation mishaps and the overall Class A mishap rate decreased slightly from FY16, and the number of fatalities decreased significantly. Human factors analysis reveals patterns of factors that appear to be amenable to organizational influence.

**Learning Objectives:**

1. The audience will know the overall trend in USAF mishaps and human factors contributing to current year mishaps in comparison with data from previous years.

### [141] NAVAL AVIATION SAFETY: 2017 YEAR IN REVEW

L.A. Vitatoe and P. DeMieri
*USN, Naval Safety Center, Norfolk, VA*

*(EDUCATION - PROCESS)*

**INTRODUCTION:** The Naval Safety Center analyzes Navy and Marine Corps aviation safety investigation reports in order to identify mishap causal factors. **METHODS:** All Class A flight mishaps involving U.S. Navy and Marine Corps aircraft during fiscal year 2017 (FY17) were reviewed using the Human Factors Analysis and Classification System (HFACS). **RESULTS:** During FY17 there were X Class A mishaps in the U. S. Navy (x.xx per 100,000 flight hours) and x Class A mishaps in the U.S. Marine Corps (x.xx per 100,000 flight hours). A review of Class A flight mishaps over the past 10 years demonstrated that human factors were the predominant causal factors. A review of current Physiological

Episodes in Naval Aviation will also be presented. **DISCUSSION:** HFACS is a useful tool in safety investigation analysis and assists in identifying causal factors to focus mitigation strategies to prevent future mishaps. Its standardization across the Department of Defense facilitates cross-analysis and shared efforts to prevent future mishaps.
**Learning Objectives:**
1. Review the overall trend in U.S. Navy and Marine Corps flight mishaps and the most common human factors identified as causal factors.
2. Identify the most common Human Factors Analysis and Classification System (HFACS) categories for Naval Aviation mishaps.
3. Review the trends in Naval Aviation mishap HFACS causal factors over the last decade.

***Tuesday, May 08*** ***10:30 AM***
***Topaz***

## S-030: PANEL: #BARFINGSTINKS: CROWDSOURCING GLOBAL SOLUTIONS FOR AIRSICKNESS

*Sponsored by Aerospace Physiology Society*

**Chair: Glen Harmon**
*Daytona, FL*

**Chair: Jaime Harvey**
*Alexandria, VA*

**PANEL OVERVIEW:** Airsickness as a human performance issue in flight is best treated by a multi-disciplined solution. The increasingly demanding flight environment continues to cause sensory conflict leading to a range of performance-degrading symptoms from nausea to total incapacitation—a serious safety of flight issue. Aerospace medical professionals have worked together using a trifecta of pharmacological, behavioral, and physiological protocols—but how do you figure out which formula works best? In today's connected world—you crowd-source it. This panel has globally crowdsourced the age-old airsickness problem by engaging multi-national aerospace medical professionals from a variety of military organizations and civilian institutions to share their best practices and training guidelines used to treat and manage the symptoms of airsickness. This collaborative effort will use a micro-level analysis toward a macro-level solution.

### [142] RNZAF: PREVALENCE, PREVENTION AND MANAGEMENT OF AIRSICKNESS

D. Bonetti
*AMU, RNZAF, Auckland, New Zealand*

*(EDUCATION - CASE STUDY HUMAN PERFORMANCE)*

Airsickness is a human performance issue that can cause Aircrew significant problems and affect operational effectiveness. Historically there are low reported rates of Air sickness within the RNZAF. However, it is also possible that the incidence of Airsickness has been underreported. The reported frequency and severity of sickness is greater on flights involving large quantities of multi-axial accelerations, especially in non-piloting roles and can affected career aspirations. Data will be presented demonstrating the rate of Airsickness per Aircraft type. To mitigate Airsickness, the RNZAF employs a multidisciplinary approach, consisting of the following components: Education, Medical consultation and pharmacological intervention, desensitization training, relaxation, health and wellbeing advice. These components are delivered by Medical Officers Physiologists and Psychologists. Whilst the reported rates of Airsickness are low, Effective management and prevention of Airsickness remains an important Aviation Medicine requirement for the RNZAF.
**Learning Objectives:**
1. Learn about the frequency and severity of Airsickness within the RNZAF and the migration strategies that are employed.

### [143] SO YOU'RE AIRSICK, SO WHAT?

A. Moerman
*Aerospace Physiology, Center for Man in Aviation, Zeewolde, Netherlands*

*(EDUCATION - TUTORIAL)*

The Royal Netherlands Air Force (RNLAF) promotes an airsickness program that encourages and optimizes a multi-discipline approach to resolving airsickness. At the "Center for Man in Aviation" (Soesterberg, NL) the program is continuously evolving to meet the individual needs with its core focus being retaining qualified pilot candidates. This presentation will cover the overall program: prevention methods given to aircrew, identification from Flight Surgeons, behavioral intervention with a Psychologist and finally, treatment with an Aerospace Physiologist. The treatment protocol combines Barany Chair use with mental exercises and relaxation techniques that may last up to 10 days. During this treatment protocol, the Aerospace Physiologist and Psychologist work together perfecting stress-responding behaviors for the individual's needs both in and out of the Barany Chair. This presentation will focus on the RNLAF philosophy of airsickness treatment and will also cover the overall RNLAF population, airsickness rates among aircrew and treatment success rates.
**Learning Objectives:**
1. To learn and understand the RNLAF Air Sickness Management Program.

### [144] AN OVERVIEW OF THE RAF MOTION SICKNESS DESENSITISATION PROGRAMME

P.D. Hodkinson[1,2], B. Posselt[1] and J.S. Woolford[3]
*[1]RAF Centre of Aviation Medicine, Hitchin, United Kingdom; [2]Division of Anaesthesia, Addenbrookes Hospital, University of Cambridge, Cambridge, United Kingdom; [3]Aerospace Medicine, U.S. Air Force, Sykesville, MD*

*(EDUCATION - PROCESS)*

**MOTIVATION:** Motion sickness is considered a normal response to an abnormal environment but it can impair aircrew progress through flying training or affect their operational effectiveness. There is marked inter-individual variability in both susceptibility and rate of adaptation, giving rise to motion sickness desensitization programs. This talk contributes to the panel and discussion by providing an overview of the RAF program, its content and outcomes. **OVERVIEW:** The RAF desensitization program is targeted at pilots who fail to progress through flying training or have impaired performance due to motion sickness. Trainee aircrew are initially managed at local station level to permit extra time for adaptation to the motion of flight. If they continue to fail sorties due to motion sickness they are referred to the station medical officer to exclude underlying medical causes and then the RAF Centre of Aviation Medicine for the desensitization program. This comprises a four-week ground phase followed by a four-week flying phase (fixed-wing aircrew only). The ground phase involves twice daily sessions in the disorientation trainer (at gradually increasing speeds of rotation, starting at 10-20 deg/s and building up to potential maximum of 120 deg/s by the end of the program. Whilst rotating they undertake 10 sets of controlled head movements in each direction in an attempt to give a controlled dose of motion and vestibular stimulus (Coriolis cross-coupling). Speed changes within a session are sub-threshold (0.16 deg/s/s) and may be increased if symptoms are minimal/steady or decreased if symptoms are too great e.g., nausea. The flying phase consists of 20 sorties, each structured to again gradually increase sensory provocation based on trainee symptoms. The intention of the program is to build physiological tolerance to increasing motion stimulus at a rate that does not induce nausea and vomiting and in doing so also address, to a degree, elements of the psychological component of motion sickness. Future areas of interest include more formal psychology components (e.g., mindfulness or Cognitive Behavioral Therapy) or use of video based visual desensitization as a prelude or adjunct to the program. **SIGNIFICANCE:** The RAF motion sickness desensitization program has a high success rate ~85-95%) of returning individuals to complete flying training or return to operational flying, preventing the potential loss of trained or partially trained aircrew.
**Learning Objectives:**
1. To understand the structure of the RAF motion sickness desensitization program including gradual progression and components of both the ground and flying phases.

### [145] SPIN, DON'T PUKE. AIRSICKNESS MANAGEMENT AT U.S. NAVAL AIR TRAINING COMMANDS

L. Immeker and L. Meeker
*Chief of Naval Air Training, Corpus Christi, TX*

*(EDUCATION - PROCESS)*

**MOTIVATION:** As technology continues to advance, the human in the loop often remains the limiting factor of the weapons system. Airsickness is a common human factors problem for students in primary flight training. Airsickness interferes with safety of flight, progression through flight training, and accession of strike fighter aircrew to the operational fleet. Symptoms may recur after long periods of non-flying or transition to more challenging flight maneuvers or aircraft with enhanced flight characteristics. Most students adapt to the flying environment quickly while others may require additional assistance for aeronautical adaptability via an airsickness management program. This program has been historically effective, but can be time consuming with significant delays in student progression through pipeline training. A comprehensive review and discussion of airsickness management program elements is essential to streamline efforts. **OVERVIEW:** Chief of Naval Air Training commands utilize a multi-modal approach on airsickness management. Program success in helping flight students prevent and mitigate airsickness depends heavily on early intervention with education and training. Traditionally, the airsickness management program has relied on aircrew rotational training to promote desensitization and biofeedback training. Overall the program is highly effective with less than 1% airsickness attrition through flight training for Pilots and Naval Flight Officers. Nonetheless, this process is time consuming with limited empirical evidence to support overall effectiveness. Focus is likely needed on earlier phases of the airsickness program related to behavioral training to reduce anxiety and build confidence. **SIGNIFICANCE:** Approximately 45% of primary, student military aviators experience at least one significant airsickness event, resulting in a flight safety concern or change to the mission profile at Training Air Wings. Of that subset, 16% endure significant symptoms and require aircrew rotational and biofeedback training. This places a substantial burden on airsickness program trainers and delays a significant number of primary flight students through pipeline training for weeks to months at a time. Although overall attrition is low, there is a need to reduce the time removed from the training pipeline and identify which program elements provide the most significant airsickness desensitization for this population.

**Learning Objectives:**

1. Understand the USNs primary methods and limitations in managing/mitigating airsickness in Naval Air Training.

### [146] UNITED STATES AIR FORCE AIRSICKNESS MANAGEMENT PROGRAM

M.A. Sinagra
*Aerospace & Operational Physiology, U.S. Air Force, Universal City, TX*

*(EDUCATION - PROCESS)*

The United States Air Force (USAF) utilizes a multi-faceted approach to airsickness management otherwise known as the formal Airsickness Management Program (AMP). Aircrew Rotational Training (ART) may be provided in conjunction with or separate from the AMP. This presentation will discuss the differences in the design of the AMP, and ART in addition to: the lifecycle of a trainee from enrollment to completion, the etiology of the airsickness experienced, and the prevalence of influencing stressors on the trainee (e.g., physiological, psychological). Contributing factors or root causes identified in the AMP/ART allow USAF practitioners to develop a tiered solution that meets the trainee's individual circumstances. Program efficacy, treatment success, and airsickness desensitization rates will also be addressed.

**Learning Objectives:**

1. Understand the participant intake, and treatment process for the USAF AMP.
2. Understand the power in utilizing individualized, and customer centric training.

***Tuesday, May 08*** ***10:30 AM***
***Sapphire***

## S-031: PANEL: A FULL PANEL REVIEW OF AMCS VITALS AND PLANS FOR THE FUTURE

**Chair: Katrina Avers**
*Yukon, OK*

**PANEL OVERVIEW:** This panel presents the results of the most recent Federal Aviation Administration (FAA) Aerospace Medicine Certification Services (AMCS) service quality surveys. These surveys were administered by the Civil Aerospace Medical Institute (CAMI) to Aviation Medical Examiners (AMEs) and pilots to assess their satisfaction with the quality of services provided to support pilot medical certification and satisfaction with the certification process. The first presentation will provide an overview of the AMCS surveys and the methods by which these surveys were administered. The presentations will contain detailed discussions of the data collected in the surveys by topic area. The second presentation will discuss results specific to Aerospace Education provided to AMEs. These educational services are frequently updated based on new communication methods, training requirements, and AME feedback. The next presentation will discuss services related to certification and AME satisfaction with the certification process. The fourth presentation will discuss results specific to perceptions of the Regional Flight Surgeon Office. The final presentation will cover AME satisfaction with the new online systems that were implemented after the previous survey administration in 2014. Conclusions and implications for AMCS services will be discussed.

### [147] METHODS FOR ASSESSING AME AND PILOT SATISFACTION WITH FAA AEROSPACE MEDICAL CERTIFICATION SERVICES

J. Barrett[1], M. Bryant[1], S. Thomas[2] and K. Avers[1]
*[1]CAMI, FAA, Oklahoma City, OK; [2]Cherokee CRC, LLC, Oklahoma City, OK*

*(EDUCATION - PROCESS)*

**MOTIVATION:** The Federal Aviation Administration's (FAA's) Civil Aerospace Medical Institute (CAMI) regulates pilot medical certifications, which are conducted by Aviation Medical Examiners (AMEs). The FAA began surveying AMEs in 2000 to assess AME perceptions on the quality of support services provided by the FAA. To ensure that pilots are satisfied with the certification process, stakeholder service surveys were introduced in 2004. Both surveys have been re-administered approximately every 2 years with the most recent surveys administered in 2016. Survey results are used by the Office of Aerospace Medicine (OAM) and the Aerospace Medical Education Division (AAM-300) to improve FAA Aerospace Medical Certification Services (AMCS) provided to AMEs and airmen. This presentation will discuss the methods and provide an overview of the most recent administration of these two surveys. **OVERVIEW:** CAMI's Aerospace Human Factors Research Division (AAM-500) is tasked with conducting both the AME and Airman surveys. The AME and Airman surveys have been developed through years of collaboration between AAM-300, AAM-400, AAM-500, and OAM. In survey development, items are added or modified to obtain feedback on OAM innovations based on previous results. In 2016, invitations containing a link or web address to complete the survey were sent to 2,970 AMEs and to 14,039 Airman, with an approximate response rate of 63% and 55%, respectively. Of those invited to participate, 1,801 AMEs and 7,777 pilots met criteria for inclusion in the final reports. Specifically, respondents must have been an AME for at least 12 months and conducted an applicant exam for an airman medical certificate in the 12 months prior to the survey. For airman, respondents must have recently sought Class I, Class II, or Class III medical certification from an AME within the previous 24 months. Results from the surveys indicated overall positive trends regarding the certification process and services available for AMEs. **SIGNIFICANCE:** Federal requirements dictate that feedback processes must be in place to assess the quality of services provided to regulated populations. These surveys allow AMEs and airmen to provide feedback on services involved with medical certifications, and they allow the FAA to utilize this feedback when reviewing policy recommendations. This presentation is of interest to medical and aviation professionals.

**Learning Objectives:**
1. To understand the methodological considerations for assessing feedback on aviation medical certification from Aviation Medical Examiners and pilots.
2. To understand the methods used to improve efficiency in a complex aerospace medical certification system.

## [148] FAA AEROSPACE MEDICAL EDUCATION DIVISION

S.J. Veronneau, W.S. Silberman and D.M. King
*Aerospace Medical Education Division, FAA CAMI, Oklahoma City, OK*

*(EDUCATION - PROCESS)*

**MOTIVATION:** The Federal Aviation Administration (FAA) is tasked with regulating pilot medical certifications, which are performed by designated Aviation Medical Examiners (AMEs). The Civil Aerospace Medical Institute (CAMI) biennial surveys are administered to collect feedback from AMEs on issues they face, problems that need resolving, and potential changes that could improve the effectiveness and efficiency of airmen medical certification. CAMI also surveys pilots for feedback on their exam experiences. This presentation will discuss the survey findings and how the Aerospace Medical Education Division (AMED) benefits from the information. **OVERVIEW:** AMEs must undergo initial aviation medicine training to be designated as an AME, and they must continue to keep their knowledge of certification requirements up to date by taking part in refresher training and reviewing updates to requirements for pilot certification. AMED is responsible for providing these support services to AMEs. These services include certification support, in-person seminars, online training courses, videos and materials, office inspections, AME-related office supplies, and teaching how to search the *Guide for Aviation Medical Examiners* and publishing the *Federal Air Surgeon's Medical Bulletin*. The 2016 survey found that although AMEs were highly satisfied with AMED services and felt that these services met or exceeded their expectations, there is some room for improvement. They rank ordered their preferences for improvements which were captured in the survey instrument. **SIGNIFICANCE:** Findings from this survey illustrate the current ways in which the FAA supports its AMEs by ensuring quality services are provided and educating AMSs in obtaining appropriate aeromedical certification dispositions. This presentation also describes the systems-based approach to aerospace medical certification. Furthermore, methods to improve efficiency in a complex aerospace medical certification system are provided. This work is of interest to AMEs, Civil Aviation Authorities, Personnel Licensing specialists, or professionals involved in aviation medical research.

**Learning Objectives:**
1. The participant will learn how the results of the biennial survey are used to improve the Federal Aviation Administration (FAA) Aviation Medical Examiner (AME) designee management processes.
2. The participant will learn about the services and safety products that are produced and managed by the Aerospace Medical Education Division at the FAA Civil Aerospace Medical Institute.
3. The participant will learn about the initial and refresher AME training requirements required to maintain an FAA AME designation.

## [149] AEROSPACE MEDICAL CERTIFICATION DIVISION SERVICES SURVEY UPDATE 2018

D.M. O'Brien
*Civil Aerospace Medical Institute, FAA, Oklahoma City, OK*

*(EDUCATION - PROCESS)*

**OVERVIEW:** The FAA is dedicated to improving the medical certification process for both AMEs and pilots. Over time, technological advancements have streamlined the certification process, allowing for increased use of online resources to transmit and archive information regarding pilot medical certifications. To better support AMEs conducting medical certifications, AMCD in Oklahoma City, OK provides the following services: information systems including MedXPress and the Aerospace Medicine Certification Subsystem, professional advice on aeromedical and administrative topics; labelling, scanning and archiving of all medical certification applications and supporting clinical data; and risk based aeromedical certificate dispositioning. The FAA also reviews and updates aeromedical standards (published in the AME Guide) and revises Conditions AMEs Can Issue (CACI). The 2016 AMCS survey found AME feedback as overwhelmingly positive regarding these services, however, there are opportunities for improvement regarding communication and awareness of specific services and capabilities. The FAA Office of Aerospace Medicine (OAM) will continue to monitor AME and pilot satisfaction and changing expectations.

**Learning Objectives:**
1. This presentation will convey a greater understanding of AME concerns and benefits relating to Medical Certification and CACI protocols. Methods used to improve Aerospace Medicine Certification Services (AMCS) are also described. This work is of interest to AMEs, pilots, and all other individuals involved in medical certification.

## [150] REGIONAL FLIGHT SURGEON'S OFFICE

S.E. Northrup
*Aerospace Medicine, FAA, Peachtree City, GA*

*(EDUCATION - PROCESS)*

**MOTIVATION:** The Federal Aviation Administration (FAA) is tasked with regulating pilot medical certifications, which are performed by Aviation Medical Examiners (AMEs). A goal of the Civil Aerospace Medical Institute (CAMI) biennially surveying AMEs regarding their interactions and experiences with their respective Regional Flight Surgeon offices. **OVERVIEW:** The Regional Flight Surgeon office provides the following support and services to AMEs: aeromedical consultation and information, interpretation of pertinent policy, rules, and regulations, answers regarding medications and airmen medical certification decisions, and performance evaluations and quality assurance, including site visits. Overall, AMEs were satisfied with their interactions and experiences with their Regional Flight Surgeon office, although there remains room for improvement. The FAA will continue to monitor AME satisfaction and changing expectations. Implications for Regional Flight Surgeon office changes will be discussed. **SIGNIFICANCE:** These findings involving the Regional Flight Surgeon office will increase understanding of AME perceptions of Regional Flight Surgeon office services and efforts by the FAA to continually see improvements to these services. Potential changes to Regional Flight Surgeon office operations will also be identified. AMEs or other medical professionals with an who interact with Regional Flight Surgeon offices or have an interest in pilot medical certification would benefit from this presentation.

**Learning Objectives:**
1. Increase awareness of FAA Regional Flight Surgeon Office activities.
2. Understand existing feedback mechanisms within the Office of Aerospace Medicine.

## [151] FEEDBACK AND FUTURE DIRECTIONS FOR AEROSPACE MEDICAL CERTIFICATION

S. Goodman
*Federal Aviation Administration, Washington, DC*

*(EDUCATION - PROCESS)*

**MOTIVATION:** The Office of Aerospace Medicine (OAM) is responsible for pilot medical certification to ensure pilots are medically qualified to operate aircraft and perform their duties safely. To accomplish this task, the FAA has designated a network of trained Aviation Medical Examiners (AMEs) to support conduct medical certifications. The Civil Aerospace Medical Institute (CAMI) periodically administers surveys to AMEs and pilots to evaluate the quality of services. This presentation will discuss satisfaction with these services and opportunities for improvement. **OVERVIEW:** The OAM is continually looking for methods to improve aerospace medical certification. The surveys administered to AMEs and pilots assessed perceptions of services including but not limited to online resources, training and seminars, the Designee Management System (DMS), and the *Federal Air Surgeon Bulletin*. The data from the surveys were analyzed and provided to the Federal Air Surgeon's Management team for review. Some recommendations by AMEs and pilots are not feasible due to organizational or regulatory constraints, while other suggestions are carefully considered and implemented. Findings from the survey and implications

for future directions will be discussed. **SIGNIFICANCE:** Practical considerations resulting from the findings of the survey will help increase understanding of what types of information is collected from the biennial AME and pilot surveys and of how this data is utilized in improving services. A broader perspective in the aviation certification process will be of interest for both practitioners and researchers who specialize in aviation medicine.

**Learning Objectives:**

1. To learn how feedback from the OAM surveys is considered and implemented.

***Tuesday, May 08*** ***10:30 AM***
***Ballroom A***

## S-032: PANEL: AEROMEDICAL RESEARCH LABORATORIES: CAPABILITIES AND OPPORTUNITIES FOR COLLABORATION – PART 1

*Sponsored by AsMA Science & Technology Committee*

**Chair: Estrella Forster**
*Mustang, OK*

**Chair: William Fraser**
*Toronto, ON, Canada*

**PANEL OVERVIEW:** This panel, organized and sponsored by the Science and Technology Committee of the Aerospace Medical Association (AsMA), is one of two educational panels that aim to introduce aeromedical research organizations (military, government, industry, or academia) to discuss their capabilities and potential opportunities for collaboration with other scientists across the world. The contributors to part 2 of the panel are: (1) Dr. (Col. Ret.) John Crowley of the U.S. Army Aeromedical Research Laboratory in Fort Rucker, Alabama, U.S.; (2) Dr. (Col. Ret.) Francisco Rios of the Spanish Aviation Safety Agency, Madrid, Spain; (3) Dr. David Newman of the Monash University Aviation Medicine Unit, Melbourne, Australia; (4) Dr. Richard Arnold, of the U.S. Navy Medical Research Unit, Dayton, OH, U.S.; and (5) Dr. Barry Shender, of the U.S. Navy NAVAIR Human Systems Department, Patuxent River, MD, U.S. Limitations in the program did not allow us to include other aeromedical research organizations in U.S. and abroad – we hope to do so in future AsMA meetings. The panel will include a discussion of topics that the participant organizations consider amenable to the potential formulation of collaborative research efforts. It also offers an opportunity to leverage scarce resources and encourages an internationally united approach towards enhancing world aviation safety.

### [152] AEROMEDICAL RESEARCH IN THE U.S. ARMY – USAARL UPDATE AND OPPORTUNITIES FOR COLLABORATION

J. Crowley
*U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL*

*(EDUCATION - TUTORIAL)*

The U.S. Army Aeromedical Research Laboratory (USAARL), located at Fort Rucker, Alabama—the Home of Army Aviation—is the Department of Defense's premier laboratory focusing on problems and solutions for military helicopter pilots and crew. The modern U.S. Army Aviator is challenged by the most demanding missions, high operational tempo, and austere conditions--against a backdrop of ever-increasing aircraft technology and complexity. It is the mission of USAARL to characterize these threats and develop countermeasures across the spectrum of aeromedical hazards. In a resource-constrained research environment, it is essential to coordinate research objectives, programs, and projects, to maximize return-on-investment and deliver solutions to our aviation warfighters and customers. Current research programs at USAARL can be divided into three categories: 1) General Operational Medicine: Focusing on protection from blast-related injury and the return-to-duty after neurosensory injury (e.g., TBI), this research has broad applicability beyond the aviation population to larger at-risk military populations. 2) Traditional Aeromedical Research: The performance of aircrew under degraded psychological, medical, and physiological conditions is a long-standing focus of USAARL research. Hazards of noise, vibration, disorientation, crash, and disease, present long-standing challenges to aircrew health and aviation safety. 3) Emerging Aeromedical Research Topics: "New" sources of aeromedical risk include operations in degraded visual environments (DVE), increasing cockpit technologies (e.g., automation, high definition displays), as well as the aviation medicine-related issues in manned-unmanned teaming (MUM-T). This presentation will outline the major USAARL research programs, the drivers and planned products, and highlight areas in which synergy and collaboration will enhance the quality of science and our research products. A focus on human factors and human systems integration problems signals a return to a broader definition of aeromedical research that will improve efficiency and deliver actionable solutions to real safety problems of modern military rotary-wing aviation.

**Learning Objectives:**

1. To understand current aeromedical problems facing the modern military helicopter pilot, and the resulting research programs at the U.S. Army Aeromedical Research Laboratory, with an emphasis on opportunities for collaborative research in rotary-wing aviation medicine.

### [153] SPANISH AVIATION SAFETY AGENCY (AESA): RESEARCH & COLLABORATION OPPORTUNITIES

F. Rios-Tejada, P. Guillen, F. Torrero, A. Rodriguez and D. Perez-Chao
*AESA, Madrid, Spain*

*(EDUCATION - TUTORIAL)*

The Spanish Aviation Safety Agency (AESA) is the major civilian Institution in Spain who provides guidelines in terms of aviation medicine safety issues. It assures the fulfillment of European Aviation Safety Agency (EASA) rules and requirements, promotes instruction, identifies gaps, and provides coordination of aviation research that might be considered of benefit to flight safety. AESA is organized into four major departments: The Medical Division, under the umbrella of the Licensing Division, addresses human factors, human performance, aeromedical risk analysis, and other aeromedical issues that may arise. Under the umbrella of AESA, we have 14 Aeromedical Centers and 98 Aviation Medical Examiners (AMEs). All physicals are handled by a common computerized system which centralizes, in the medical division, the entire application management process. It also enables the archiving of a huge amount of clinical and medical data for analyses and for the benefit of rulemaking and aeromedical management. In addition, under the leadership of AESA, it is achievable to develop appropriate tools, information, and procurement of resources to develop research plans or securing collaborators. Current emerging topics are discussed and promoted with Institutions, centers of aviation medicine, universities, and technological or research establishments. Several activities and shared initiatives will be described, including: working groups formed with the International Civil Aviation Organization (ICAO) and cooperative initiatives, such as color vision standards, drugs and alcohol management, and mental health issues. The latter involves the development of a full training program in mental health for AMEs and the final establishment of psychometric testing for initial exams in class 1 and 3 certificates. Cooperative studies include topics such as aircrew health and safety measures in collaboration with aviation stakeholders. Other research efforts have been established with the University of Granada, University San Pablo (Madrid), Carlos III, and the Polytechnic University of Madrid. AESA also promotes the development of Centers of Excellence in areas related to aviation and the environment, remotely piloted aircraft development, and human factors initiatives. Civil Aviation Authorities play a key role in the knowledge base of research lines of study that must be managed, coordinated, and propagated by adequate instruction and education on behalf of flight safety.

**Learning Objectives:**

1. To review the overall structure and objectives of AESA.
2. To become familiar with the lines of research that AESA promotes and supports on behalf of Aviation Safety.

**[154] MONASH UNIVERSITY AVIATION MEDICINE UNIT**

D.G. Newman
*Aviation Medicine Unit, Monash University, Point Cook, Australia*

*(EDUCATION - TUTORIAL)*

Monash University's Aviation Medicine Unit is part of the School of Public Health and Preventive Medicine, and conducts a range of training and research activities in aviation medicine. Located in Melbourne, Australia, the main emphasis of the Aviation Medicine Unit is on understanding the implications of exposure to the flight environment on human performance. The purpose of this presentation is to highlight our activities, our areas of research interest, our research capabilities and potential opportunities for collaboration with like-minded institutions. The Aviation Medicine Unit is responsible for teaching a number of short courses in aviation medicine, at the basic and advanced level, including the highly successful 2-week Australian Certificate in Civil Aviation Medicine (ACCAM). This course is a prerequisite for medical practitioners who wish to register with the Civil Aviation Safety Authority of Australia (CASA) as Designated Aviation Medical Examiners. The Aviation Medicine Unit conducts a wide range of research activities in aviation medicine, aerospace physiology and human factors, with an emphasis on the effects of altitude, G force, spatial disorientation and motion sickness in both pilots and passengers. We have access to a range of fixed wing and rotary wing flight simulators and are currently looking at acquiring a twin-jet airline-style simulator for research and training. We also have access to aircraft as required for in-flight studies. Much of the Unit's research involves collaborations with national and international partners including Drexel University in Philadelphia, and in conjunction with the aviation industry. Current research areas of interest include neck injuries in pilots exposed to high G, cardiovascular regulation and control in the high G environment, spatial disorientation, and super-agile flight and its biodynamic implications. Our current research projects include a flight simulator-based study into spatial disorientation, and a study looking at the G force environment of advanced competition aerobatic aircraft via direct inflight measurement. The Aviation Medicine Unit at Monash University welcomes ideas for research collaboration from interested institutions and centres.

**Learning Objectives:**

1. Understand the current research capabilities and projects of the Aviation Medicine Unit at Monash University.

**[155] AEROMEDICAL RESEARCH AT NAVAL MEDICAL RESEARCH UNIT DAYTON**

R.D. Arnold and K. Mumy
[1]*NAMRU-D, Wright-Patterson AFB, OH*

*(EDUCATION - TUTORIAL)*

Naval Medical Research Unit Dayton (NAMRU-D) on Wright-Patterson AFB, Ohio conducts basic and applied research in support of operational requirements in the areas of aerospace medicine, human performance, and environmental health effects. The command is organized into two functional laboratories. The Naval Aerospace Medical Research Laboratory (NAMRL) predominantly conducts applied human-use research studies to understand and mitigate threats presented to aircrew by the aviation environment. The Environmental Health Effects Laboratory (EHEL) predominantly conducts basic research using non-human models to address environmental health threats presented by the full range of operational environments, including aviation. This panel presentation highlights NAMRL research capabilities and programs in the areas of high altitude effects, respiratory physiology, acceleration effects, vision sciences, fatigue, and aircrew health. EHEL research capabilities and programs that address aeromedical issues will also be highlighted. NAMRU-D actively collaborates with other U.S. Defense laboratories, academic, commercial, and international research partners. Past and current research collaborations will be highlighted and promising topics for future collaborations will be discussed.

**Learning Objectives:**

1. Understand the research mission, capabilities, and portfolio of Naval Medical Research Unit Dayton.

**[156] NAVAIR HUMAN SYSTEMS DEPARTMENT – CAPABILITIES AND RESEARCH PORTFOLIO**

B.S. Shender
*Human Systems, NAVAIR, Patuxent River, MD*

*(EDUCATION - TUTORIAL)*

**MOTIVATION:** The Naval Air Systems Command Human Systems Department (HSD) provides expertise, world-class facilities, products, and services to optimize human performance, protection, and survivability to support the Naval Aviation Enterprise. **OVERVIEW:** Warfighters endure a wide range of physical, cognitive, emotional, and physiological stressors during normal operations and combat. Stressors include long duration missions in extreme climates, hazardous noise, maneuvering and impact acceleration, vibration and shock forces, and frequent altitude changes. Historically, life support systems (LSS) development programs addressed these issues as largely independent challenges. When development was uncoordinated (lacking design agreement between supporting groups), the resulting LSS were often bulky, hot, and had adverse impacts on other human performance survivability factors, e.g., aircraft ejection. Poor LSS design encumbers aircrew, contributing to fatigue, distraction, and ultimately decreased mission performance/effectiveness. Furthermore, some LSS designs inflicted unintended adverse consequences, including digital night vision goggles and helmet mounted devices (HMD). These systems clearly enhance mission performance but can result in spinal pain, reduced cervical range of motion, and increased injury risk during aircraft ejection or crash. Modern seating systems were designed for impact protection but do not provide ergonomic support to warfighters for extended 5+ hour operations. By employing a systems of systems approach and advanced simulation tools (i.e., digital human modeling, spinal injury risk, kinematic modeling), the HSD is actively developing solutions to these challenges, including physiological monitoring and warning systems, oxygen systems surveillance and contaminant mitigation, crash recording, crashworthy helicopter seating, multi-environment stress (noise, altitude, thermal, directed energy) protection, advanced human-machine interfaces, maintainer tools and workplace protection, performance enhancement devices (e.g., digital HMD), and live, virtual, and constructive training. **SIGNIFICANCE:** While aviation environmental hazards haven't changed in 100 years, aircraft capabilities and mission requirements have magnified the risks. With budget pressures and human research challenges, the best way to tackle these problems is collaboratively. The HSD conducts and seeks to expand partnerships across services and internationally.

**Learning Objectives:**

1. Learn how NAVAIR is working to support aircrew performance, protection and survivability.

***Tuesday, May 08*** ***10:30 AM***
***Senators***

## S-033: PANEL: AEROSPACE MEDICINE BOARD REVIEW SERIES #1

*Sponsored by ASAMS*

**Chair: Timothy Burkhart**
*Annapolis, MD*

**PANEL OVERVIEW:** The Aerospace Medicine Board Review series will review core topics in Aerospace Medicine and is designed to prepare Aerospace Medicine specialists for the ABPM re-certification exam. Topics are presented in three sessions, adhere to the ABPM Study Guide Outline, and intended to cover its entirety over the course of three consecutive years. Combined with the annual RAM Bowl and Aerospace Medicine Grand Rounds sessions, these board review sessions will address preventive medicine core topics along with core knowledge areas of Aerospace Medicine. This panel will cover essential elements of Theory of Flight, Epidemiology & Biostatistics Review, and Spatial Orientation & Illusions/Aviation Vision.

### [157] AEROSPACE BOARD EXAM REVIEW: THEORY OF FLIGHT

J.A. Fulkerson
*Naval Aerospace Medical Institute, Navy Medicine Operational Training Center, Pensacola, FL*

*(EDUCATION - TUTORIAL)*

Topics to be covered in this board review lecture will include a review of the different altitudes and airspeeds, the forces of flight, the theory of lift, types of drag, stalls, and spins.

**Learning Objectives:**

1. Define density altitude.
2. Define true airspeed.
3. Differentiate between a stall and a spin.

***Tuesday, May 08*** ***2:00 PM***
***Ballroom D***

## S-034: PANEL: COMPLEX PROBLEMS, NOVEL SOLUTIONS: JUNIOR AND FUTURE FLIGHT SURGEONS LEADING INNOVATION ACROSS THE UNITED STATES MILITARY

**Chair: Paul Nelson**
*Maxwell AFB, AL*

**Chair: Kenneth Taylor**
*Columbus, MS*

**PANEL OVERVIEW:** The diverse missions of aviators, special duty operators, and trainees across the United States Air Force present complex operational medicine problems. This panel features junior Flight Surgeons from various installations across the Department of Defense who will discuss how their flight medicine program delivers innovative solutions to combat the diverse population of war fighters they care for. All solutions have one central theme: bringing medical services directly to their supported populations to increase the value of clinical services to both the patient and the mission they support. Our first presentation features a fatigue countermeasures presentation from the 432nd wing at Whiteman Air Force Base. Our presenters will discuss the Fatigue Avoidance Scheduling Tool (FAST) and their current efforts to implement the tool in the RPA community. Our second presentation continues the discussion of fatigue countermeasures, this time in the fighter pilot. The effectiveness of modafinil and zolpidem in combating fatigue in the deployed environment will be presented by a flight surgeon from Marine Corps Air Station Beaufort. This data was gathered during a 6 month deployment in a group of F-18 pilots and Weapons Systems operators. Our third presentation offers a unique perspective on osteopathic manipulation in the F-16 and F-35 community from a flight surgeon at Hill AFB. This presentation will discuss the background and evidence behind osteopathic manipulation and provide a description of its current use in high performance aircraft pilots at Hill. Our fourth presentation addresses supplement use in our pilots with a case report of a special operator who presented with multiple strokes after herbal therapy through an off-base provider. This presentation will examine the current United States Air Force guidance on acceptable supplements in our aircrew community. Our final presentation will be a case report from Columbus AFB of a first-assignment instructor pilot who was involved in a serious motor vehicle accident with multiple injuries. She was retained in the military and eventually returned to flying status after an extended period of time in a non-flying status. This presentation will focus on the holistic approach to returning an aviator to flying duties in the military.

### [158] PERCEIVED EFFECTIVENESS OF PERFORMANCE MAINTENANCE MEDICATIONS DURING COMBAT FLIGHT OPERATIONS

R. Filler and V.E.Bigornia
*Medical, MAG 31, Beaufort, SC*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Stimulant medications have long been recognized as a means to preserve performance in aviators subject to extended flight operations or circadian rhythm disruption. Recently hypnotic medications have proven efficacious in optimizing sleep onset and quality. The Navy's Performance Maintenance During Continuous Flight Operations manual recommended dextroamephetamine, zolpidem, and temazepam as first line medications. This guidance was amended in 2012 to recommend modafinil and eliminate temazepam as a drugs of choice based on current pharmacologic studies. A Marine Fighter Attack Squadron utilized these medication recommendations and retrospectively surveyed aircrew upon return from combat operations regarding perceptions of effectiveness. **METHODS:** An IRB approved retrospective anonymous survey invitation was sent by email to all aircrew that flew with the squadron during deployment. This included pilots and weapon system operators both from the squadron and augment aircrew. Data was collected regarding baseline stimulant usage and sleep, ground testing phase and operational phase. Effectiveness was measured as an ordinal value from 0 to 10 with 10 being most effective. **RESULTS:** Given a small sample size, results are reported as descriptive statistics. 12 Pilots and 11 Weapons System Operators mean age 34.72 (SD 3.92yrs), with mean 1372 flight hours (SD 696hrs). Modafinil was rated 7.35 on ground testing (SD1.80) and 7.17 (SD 2.99) in operation use. Zolpidem was rated as 8.29 (SD 1.83) on ground testing and 7.88 (SD 1.95) on operational usage. Stimulant usage was only reported on the midnight to noon shift. Zolpidem usage was greater on that shift as well. **DISCUSSION:** The author could find no recent operational usage data reported in the medical literature. This dataset, while limited by sample size, supports the current performance maintenance medication recommendations as being efficacious for performance maintenance consistent with data reported in the research setting. Additionally while perhaps not 'one-size fits all' the medications appear to be well tolerated and have minimal side effects in the majority of survey respondents.

**Learning Objectives:**

1. Analyze aircrew perceptions of the effectiveness of performance maintenance medications in an operational context.

### [159] PROCESS FOR APPLYING THE FATIGUE AVOIDANCE SCHEDULING TOOL TO THE CHALLENGES OF THE RPA ENVIRONMENT

K.D. Harencak and C. James
*Flight Medicine, 509MDG Whiteman AFB, MO*

*(EDUCATION - PROCESS)*

**MOTIVATION:** The remotely piloted aircraft (RPA) environment presents unique challenges in the context of sustained twenty-four hour operations. Due to the nature of these operations, RPA operators are shift workers with the associated circadian rhythm and fatigue challenges. This presentation seeks to inform other clinicians of one method used to assist RPA operators with fatigue avoidance and management techniques, and to contribute to a growing body of recommendations for fatigue management in human performance. **OVERVIEW:** Flight surgeons at Whiteman Air Force Base, Missouri have the unique privilege of learning about and managing fatigue inherent to long-duration B-2 bomber operations. Clinical interactions with RPA pilots, sensor operators and intelligence coordinators repeatedly identified anecdotal evidence of similar fatigue complaints and somatic symptoms related to working in a twenty-four hour sustained operations environment. Using the tools and data typically compiled for long duration bomber sorties, along with MAJCOM guidance for fatigue management in RPA operations, team members developed an RPA-specific fatigue countermeasures program. The Fatigue Avoidance Scheduling Tool (FAST) was first used to highlight circadian rhythm and identify areas of greatest fatigue threat in each specific work shift. Operators were then briefed on fatigue mitigation strategies, to include sleep hygiene, dietary changes, eye rest, and judicious use of caffeine. Finally, operational use of pharmacologic sleep aids were added into the program as an adjunctive measure in accordance with MAJCOM policy guidance. This method, specifically relating to its development using the FAST, is presented as a method for combating fatigue in the RPA operating environment. **SIGNIFICANCE:** Developing a fatigue avoidance and management program specific to the RPA environment is expected to translate into both operational and clinical significance. Operationally, reduced fatigue levels are expected to lead to fewer errors and increased manpower. From a

medical standpoint, reduced fatigue translates into decreased utilization of medical resources and decreased care costs. This process is of interest to military physicians caring for any special duty operators participating in high operations-tempo mission sets.

**Learning Objectives:**

1. To inform providers about fatigue risks in shift work in the RPA environment.
2. To provide a method for teaching operators how to mitigate fatigue.

### [160] PAIN AND GAIN: AWARENESS OF THE SAFETY AND HEALTH CONSEQUENCES OF DIETARY AND PERFORMANCE SUPPLEMENT USE IN AIRCREW

B.E. Organ
*U.S. Air Force, Laughlin AFB, TX*

*(EDUCATION - CASE STUDY CLINICAL)*

**PROBLEM STATEMENT:** This case report describes an otherwise healthy Special Operations troop who presented with acute embolic stroke after using supplements supplied to him by a Functional Medicine provider. **BACKGROUND/LITERATURE REVIEW:** The use of unregulated dietary supplements to optimize physical performance is pervasive, particularly in the Special Operations community. In addition to those available for over-the-counter purchase, there is increasing access to functional and naturopathic medical therapies. Due to such a wide array of available supplements and minimal FDA regulation, there is little evidence-based literature available on the safety or adverse effects of a given supplement. Further, there is no detailed guidance available to Flight Surgeons on supplements and treatments that are potentially hazardous to aircrew health or safety of flight. **CASE PRESENTATION:** A 39-year-old active duty Special Operations troop with no significant past medical history presented with vision loss, confusion, mild dysarthria, and generalized weakness. He was admitted to the hospital and evaluated with extensive laboratory testing for possible neurological, autoimmune, and infectious causes of his symptoms, all of which returned normal. A non-contrast head CT showed no abnormality, but an MRI brain showed multiple acute ischemic strokes. On further questioning, he admitted to using dietary supplements and alternative medical therapy as prescribed to him by a functional medicine provider. His symptoms improved over his 4-day admission and he was discharged to close follow-up. **OPERATIONAL/CLINICAL RELEVANCE:** The safety and adverse effects of dietary supplements are not well described in any official capacity for Flight Surgeons to implement when advising aircrew on their use. While little evidence-based literature exists on the multitude of supplements on the market, adverse health events related to supplement use are well-documented in case reports. Due to the sheer number of available supplements, it is perhaps unrealistic to think we will ever have clinical studies to rely on, but there should be better guidance for Flight Surgeons regarding their use in aircrew. We might start with an available database on adverse events related to supplement use and move toward creating a supplement guide similar to our current approved aircrew medication list.

**Learning Objectives:**

1. Identify the risks to aircrew of dietary supplement use.
2. Identify ways to track adverse effects of supplements and make guidance on use in aircrew readily available to Flight Surgeons for reference.

### [161] A PROPOSED OSTEOPATHIC MANIPULATIVE TREATMENT (OMT) PLAN TO EFFICIENTLY EVALUATE AND TREAT PILOTS

B. Hanshaw
*Flight Medicine, U.S. Air Force, Hill AFB, UT*

*(EDUCATION - TUTORIAL)*

**PROBLEM STATEMENT:** How to utilize a proposed dedicated Osteopathic Manipulative Treatment (OMT) plan to prevent and treat common injuries associated with flying. **TOPIC:** Musculoskeletal complaints are not unique to military aviators. However, they are common and may be treated and perhaps prevented with a dedicated Osteopathic approach. Performing OMT regularly can keep our pilots flying and in many cases, expedite the return to flying status for those grounded. Applying Osteopathic principles to this population may improve adherence to treatment plans and invite a culture of trust between the aviator and their provider. In a busy clinic, or even in a deployed setting, there can be many barriers to devoting enough time to adequately evaluate and treat our pilots with OMT. Having a standardized approach to diagnosing and treating with Osteopathic techniques can prove invaluable. In this discussion, a specific method of how to expedite the evaluation as well as perform the proposed OMT techniques will be reviewed. **APPLICATIONS:** Acute pain associated with flying may vary in the degree of pain and duration, however it can be detrimental to the progression of the pilot's abilities and be unfavorable to the mission. The goal is to reduce the member's pain and return them to fly status expeditiously. The approach will be to evaluate quickly and perform treatment while gauging the comfort level of the patient. For the pilots in undergraduate pilot training (UPT) or those starting their career in their assigned airframe, setting up regular (i.e., every 2 weeks) OMT appointments may improve mobility and help prevent neck and back injuries. An approach to treatment should include targeting myofascial restrictions and improving mobility and flexibility.In the group of pilots with chronic musculoskeletal conditions, treatment frequency is more patient specific. However, adhering to a regular and frequent OMT regimen may reduce acute flares of pain and conceivably limit progression of disease. An approach for these patients should be to decrease pain as well as improve mobility.

**Learning Objectives:**

1. The participant will have an understanding on how to efficiently and effectively evaluate and treat musculoskeletal pain in pilots using the proposed OMT protocol.

### [162] OPEN COMMINUTED TIB/FIB FRACTURE AFTER DRUNK DRIVER HITS A FIGHTER PILOT: A CASE REPORT

Z. Powers
*U.S. Air Force, Columbus AFB, MS*

*(EDUCATION - CASE STUDY CLINICAL)*

**PROBLEM STATEMENT:** This case report describes a pilot's complicated recovery after an MVA with a drunk driver. **BACKGROUND/LITERATURE REVIEWS:** The United States is facing a significant pilot shortage, with effects being felt in the military as we compete with our civilian counterparts for trained assets. The pipeline for military pilots is currently over 12 months, and costing hundreds of thousands of dollars. As in years past we have no shortage of pilot applicants, but a limited supply of costly trained or partially trained assets, so pilot retention is an important component of meeting the pilot shortage. While we have been instructed by senior line Air Force leaders to assume more risk, in reality this is difficult to do with our current aeromedical standards system. **CASE PRESENTATION:** This case report will focus on the retention considerations of a first assignment instructor pilot (FAIP) who was injured in a motor vehicle accident when the car she was traveling in was hit by a drunk driver. She remained in duties not to include flying status (DNIF) for an extended period of time while local flight surgeons worked with specialists and line leadership to retain her in some aviation related capacity. This case report will detail both the clinical and operational medical considerations as well as the administrative concerns of trying to provide the best medical care for the member while maintaining her in the highest capacity available for military service. **OPERATIONAL/CLINICAL RELEVANCE:** Complex Aerospace Medicine cases are best handled in a cross functional multidisciplinary manner with the patient/aviator at the center of the team, and with clear communication between the aviator, clinical team, and line leadership. These relationships become even more important when non-standard recommendations are made to preserve assets in the highest level of ability while still mitigating safety and mission concerns.

***Tuesday, May 08*** ***2:00 PM***
***Ballroom E***

## S-035: PANEL: VENOUS THROMBOEMBOLIC DISEASE AND AIRCREW: WHAT IS THE PROBLEM? PANEL OF THE FRENCH SOCIETY OF AEROSPACE MEDICINE (IN ENGLISH)

*Sponsored by French Society of Aerospace Medicine (SOFRAMAS)*

**Chair: Sébastien Bisconte**
*Villenave-d'Ornon, Aquitaine, France*

**Chair: Olivier Manen**
*Clamart, Ile-de-France, France*

**PANEL OVERVIEW:** Many studies have been carried out about venous thromboembolic disease among travellers, particularly flying all around the world. However, the relation between aircrew members and pulmonary embolism or deep venous thrombosis has not led to so many papers. Consequently, the French Society of Aerospace Medicine (SOFRAMAS) decided to present an updated position on the remaining questions that should cover most aspects of this topic. What is the risk for aircrew members to present such events? An occupational practitioner of the Air France company will talk about epidemiology with the results of a recent survey. After one episode in aircrew, the aeromedical experts are used to assessing the risk with certain investigations. Is this attitude always supported by evidence-based medicine? One author will detail what a thrombophilia testing consists of and its expected place nowadays in the therapeutic and recurrence risk management. A third author will develop the current role of Doppler ultrasound in aeromedical expertise as far as it is commonly used in care medicine for initial diagnosis and regular follow-up. With a literature study about this topic in intertropical countries, a fourth author will bring original data and show us how some factors of Virchow's triad may be favoured by local conditions. A fifth author will eventually extend the discussion to the final decision by presenting the experience of the French aircrew members suffering from this disease and examined in the Aeromedical Center of Percy Military Hospital in the last decade.

### [163] VENOUS THROMBO-EMBOLISM: A 10-YEAR RETROSPECTIVE STUDY AMONG CIVILIAN AIRCREW MEMBERS

C. Cardines and M. Klerlein
*Occupational Medicine, Air France, Roissy Charles De Gaulle, France*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Following a pilot study presented in 2012, an ongoing survey about VTE (thrombosis and pulmonary embolism) incidence among the civilian aircrew members of a major European airline is reported here, during a 10-year period. **METHODS:** Through exhaustive analysis of each VTE record in our internal data base of occupational health service, we estimated incidence and prevalence of these diseases. All the calculations were done, according to various demographic and occupational factors (gender, age, position). **RESULTS:** There were 137 aircrew who suffered from VTE, which represent 150 VTE, i.e., an average of 15 cases per year for 15 000 aircrew on long and medium hauls. We did not notice any in-flight incapacity, and only few stopover incapacity. Concerning fitness, we didn't notice any unfitness decision after diagnosis, treatment and medical assessment. Neither any sequel, nor post-thrombotic syndrome was highlighted. The distribution of the VTE cases observed is: 78.6% phlebitis - 21.4% pulmonary embolism; distributed such 40% of women and 60% of men. The mean age of aircrew who suffered from VTE is 53.4 years old for pilots, 42.9 years old for cabin crew**.** Concerning VTE, most of them appear once, more particularly concerning cabin crew, in contrary among pilots: 37.5% twice or thrice. Most of the risk factors are not professional: traumatism / orthopedic surgery / venous insufficiency or post venous surgery/ blood disorders/ post immobilization. Regarding occupational risk factor, being a pilot male and working on long haul flight seems to be associated with VTE. **CONCLUSION:** Despite better information and prophylactic recommendation about wearing G.C.S., this pathology is still observed, but remain an uncommon occurrence. We must continue to inform our aircrew and the physicians to not ignore and underestimate it. Preventive measures are still necessary.

**Learning Objectives:**
1. Gaining knowledge on prevalence of VTE in aircrew members.

### [164] IS THE RISK MANAGEMENT ACCESSIBLE BY A LABORATORY TEST ?

N. Huiban[6], J. Monin[2], G. Guiu[2], F. Brocq[6], M. Monteil[6], S. Bisconte[5], C. Cardines[7], M. Zerrik[1], E. Perrier[4] and O. Manen[3]
*[1]Aeromedical Center, Instruction Military Hospital Mohammed V, Rabat, Morocco; [2]Aeromedical Center - Percy Military Hospital, Clamart, France; [3]Aeromedical Expertise, French Military Health Service Academy, Clamart, France; [4]HIA Percy, Clamart, France; [5]HIA Robert Picqué, Villenave d'Ornon, France; [6]Aeromedical Center, Sainte Anne Military Hospital, Toulon, France; [7]Air France, Paris, France*

*(EDUCATION - TUTORIAL)*

**PROBLEM STATEMENT:** Venous thromboembolic (VTE) disease is a chronic, multifactor and recurrent disease. Its frequency and seriousness related to pulmonary embolism, more than the role of aeronautical factors, is an essential matter of concern for prevention and flight safety. After a first clinical event, aeromedical strategy is focused on the recurrence risk estimation. As such, identification of biological predisposing factors proves a legitimate interest. **TOPIC:** According to recent data, we propose a review of thrombophilia tests including prevalences and relative risks for each inherited or acquired factor. The implication in common practice will be illustrated by case-reports issued from the French military aeromedical centers, before discussing updated strategies in the use of these tests. **APPLICATIONS:** Thrombophilia testing after an acute VTE event can match the period of medical expertise but its relevance should be considered through a current vision: the interest of these tools, easy to prescribe but of uncertain meaning, is controversial while simple clinical and anamnestic criteria seem to be better indicated in the appreciation of the recurrence risk. Various predictive models of VTE recurrence have recently been developed without any thrombophilia test. In addition, the involvement of these markers in an extended anticoagulation duration has been evoked but not confirmed in recent recommendations. The role of thrombophilia in the decision-making process for aircrews seems to be limited except for the distinction between provoked or unprovoked VTE event. A consensus is organized around limited tests in the individuals presenting with suggestive anamnesis or clinical data. **CONCLUSION :** The usefulness of thrombophilia testing in the recurrence risk and therapeutic management is called into question. Thus, their use should be adapted to the clinical context to support situations where the return to flying duties will be conditioned by safety limitations.

**Learning Objectives:**
1. To know the contents of thrombophilia tests.
2. To learn current strategies of using thrombophilia tests.
3. To discuss their interests applied to aircrew members.

### [165] WHAT IS THE REAL PLACE OF VENOUS ECHO DOPPLER IN FLYING REHABILITATION AFTER A THROMBOEMBOLIC EVENT?

S. Bisconte[4], V. Maricourt[5], A. Diard[5], N. Huiban[2], J. Monin[1], S. Nguyen[4] and O. Manen[3]
*[1]Aeromedical Center - Percy Military Hospital, Clamart, France; [2]French Military Health Service, Toulon Cedex 9, France; [3]Aeromedical Expertise, French Military Health Service Academy, Clamart, France; [4]Gironde, Aeromedical Center - Robert Picqué Hospital, Bordeaux, France; [5]Gironde, Angiology, Langon, France*

*(EDUCATION - CASE STUDY CLINICAL)*

**BACKGROUND:** Venous thromboembolism (VTE) and its risk of pulmonary embolism can directly impact the flight safety (pain, swelling, dyspnea, hypoxia, chest pain and even death). After a first episode, the aeromedical concern revolves around the presence of sequelae and the

risk of recurrence. For this, flight surgeon should perform investigations, including ultrasound imaging. Elements to be taken into account by this imaging are not clearly defined. **OBJECTIVES:** To review the medical literature to discuss the real place of venous ultrasound in aircrew members flying rehabilitation. **DISCUSSION:** Venous Echo Doppler is essential for the VTE diagnosis (incompressibility of the vein, localization, complications). Elements of the first imaging are very important for aeromedical rehabilitation. Because of imaging characteristics like noninvasive, excellent diagnostic performance and low cost, its place in the follow-up is often discussed as a routine screening. However, there is no place to repeat it during treatment except in case of clinical symptoms. For rehabilitation, a venous echo Doppler can be performed at the end of the anticoagulation therapy. There is no link between ultrasound sequel, treatment prolongation, recurrent risk and thrombotic syndrome. Venous echo Doppler can even so help in diagnosis of TVE recurrent by comparing post-treatment ultrasonic imaging and in damaged valves and abnormal blood flow identification. **CONCLUSION:** Compared to medical history, biological markers of thrombophilia (Factor V Leiden, protein S and C, antithrombin III …) and occult malignancy, the venous Doppler echo has only a limited place in the evaluation of thromboembolism recurrent risk.

**Learning Objectives:**

1. Define the place of venous echo Doppler in aircrew member flying rehabilitation.

### [166] CHARACTERISTICS OF VTE IN INTERTROPICAL ZONE

M. Zerrik[1], H. Echchachoui[1], M. El Ghazi[1], Z. Iloughmane[1], F. Bennani[1], O. Manen[3], M. Rabhi[4] and M. Chemsi[1]

*[1]Aeromedical Expertise Center, Military Teaching Hospital mohamed V, Rabat, Morocco; [3]Aeromedical Expertise, French Military Health Service Academy, Clamart, France; [4]Internal Medicine, Military Teaching Hospital mohamed V, Rabat, Morocco*

*(ORIGINAL RESEARCH)*

**BACKGROUND:** Venous thromboembolism (VTE) is among the three leading causes of cardiovascular disease worldwide, several factors may explain the considerable variation of VTE incidence and severity reported from various parts of the world. The aim of this presentation is to describe some characteristics of this disease in intertropical zone. **METHODS:** We searched PubMed database to identify articles published on VTE epidemiology and risk in intertropical zone, without language restriction. **RESULTS:** Human exposure to a tropical climate causes a procoagulant state due to diverse hemostasis disturbance. Snake bites are also an environmental risk in intertropical zone, and snake venom contains a toxin which has a potential to initiate several stages of coagulation pathway or platelet aggregation. Infections are an emergent thromboembolism risk factor, through several mechanisms (venous stasis, hypercoagulability…), especially tropical infections like severe malaria, other parasitosis, dengue fever and tuberculosis. Many studies have reported cases of VTE in tourists returning from an intertropical country. Finally, ethnicity appears to be associated with the development of VTE. Black people are more likely to present VTE in comparison to White, Asian or Hispanic individuals. Susceptibility of a population to VTE events is related to pro-thrombotic conditions and sickle cell disease/trait. **CONCLUSION:** Flight surgeons should be aware of these environmental and ethnic factors that may lead to prevention, and in case of an event in aircrew: a look for predisposing factors, a specific duration of anticoagulant treatment and a case-by-case final decision.

**Learning Objectives:**

1. risk factors for venous thromboembolism in intertropical zone.

### [167] VENOUS THROMBOEMBOLIC DISEASE IN AIRCREW MEMBERS: THE FITNESS ASSESSMENT

J. Monin[1,3], G. Guiu[1,3], N. Huiban[4,3], A. Hornez[1], S. Bisconte[2], S. Coste[3], V. Beylot[1], J. Oliviez[1], J. Deroche[1], E. Perrier[1,3] and O. Manen[1,3]

*[1]Aeromedical Center - Percy Military Hospital, Clamart, France; [2]HIA Robert Picqué, Villenave d'Ornon, France; [3]French Military Health Service Academy, Paris, France; [4]Aeromedical Center, Toulon, France*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Venous thromboembolic disease (VTED) is a rare cause of unfitness in aircrew members (AM), firstly because infrequent in this population. After a pulmonary embolism (PE) or a deep venous thrombosis (DVT), the fitness decision depends on the need for anticoagulation, the presence of sequelae, the chance of recurrence and the aircrew duty. **METHODS:** The aims of this study were to describe the population of AM with a diagnosis of VTED, and to analyze the arguments that led to the fitness decision. All the medical files of AM suffering from VTED referred to the licensing authority were extracted from the AM examined in the Aeromedical Center of Percy Military Hospital from 01/01/2006 to 12/31/2016. **RESULTS:** Our population was composed of 33 AM with VTED (mean age: 45.6 +/- 12 yo, 87.9% males, 75.8% civilians, 56.6% pilots). The thromboembolic event was PE in 75.8% of cases, DVT in 81.8%, and 56.6% with both events. A genetic thrombophilia was found in 30.3% of the patients, and an acquired risk factor in 36.4% (circumstantial predisposing factor 15.1%, acquired disease 21.2%). The anticoagulant treatment was mostly vitamin K antagonist (78.8%), followed by direct oral anticoagulants (15.2%) and low molecular weight heparin (6.1%), with mean treatment duration of 8.5 +/- 7.1 mo (excluding 5 patients with a long-term treatment). After a complete assessment, 84.8% of AM were declared fit to fly (with time limitation 96.4%, multi-pilot limitation 52.6% of pilots. **DISCUSSION:** After a diagnosis of VTED in aircrews, a period of grounding is necessary to allow a curative treatment and to look for a predisposing factor. In the fitness discussion, the presence of a circumstantial factor should allow a quick return to flight after the end of the treatment whereas a thrombophilia should require a specific risk assessment. However, the diagnosis of VTED rarely leads to unfitness decision nowadays in both civilian and military aircrews. Initial close follow-up is justified particularly in case of idiopathic episodes.

**Learning Objectives:**

1. to analyze the arguments that led to the fitness decision in AM with VTED.

***Tuesday, May 08*** ***2:00 PM***
***Wedgewood***

## S-036: PANEL: BEHAVIORAL HEALTH AND PERFORMANCE IN HUMAN SPACEFLIGHT

*Sponsored by Space Medicine Association*

**Chair: Gary Beven**
*Houston, TX*

**Chair: Steve Vander Ark**
*Houston, TX*

**PANEL OVERVIEW:** There are two distinct functions of the Behavioral Health and Performance (BHP) specialists at NASA Johnson Space Center, with a shared goal of ensuring optimal performance during spaceflight missions. The BHP Operations team is active in many areas, including the psychological and psychiatric screening of astronaut applicants, as well as monitoring and support for astronauts during International Space Station (ISS) missions. The BHP Laboratory is engaged in research in space and analog platforms to address the gaps in knowledge and inform the risks and other challenges associated with future spaceflight exploration missions. Their research is focused on topics that align with the Human Research Program's Human Factors Behavioral Performance Element goals, including Behavioral Medicine, Team and Sleep/Fatigue. This panel will provide details of recent work by BHP Operations and the BHP Laboratory at NASA JSC, and will demonstrate their shared goals of achieving optimal performance for astronauts during all mission phases. In 2016-17 NASA was engaged with selecting the next Astronaut Candidate class, which reported for duty in August 2017. The first two presentations will detail the work conducted by the BHP Operations team for the two rounds of screening activities, with a more in-depth look at their approach for the suitability criteria developed for applicant screening. The third presentation will apply the results of a cognitive assessment study, recently completed by the BHP Laboratory

with U.S. Army War College participants, discussing the findings in the context of ensuring optimal performance in space under various demands in extreme, hostile environments. The fourth presentation will provide an overview of development work that is ongoing to develop a Standard Measures suite to effectively measure aspects of behavioral health and performance that are useful for research, and eventually can be considered for implemented within operations. The final presentation will describe results obtained in a spaceflight analog study during which behavioral health effects were assessed for crewmembers when some of their meals were replaced with a nutrient-rich food bar, which are being considered for exploration missions that have limited mass and volume for supplies.

## [168] BEHAVIORAL COMPONENTS OF NASA'S 2017 ASTRONAUT SELECTION CYCLE

G. Beven[3], A. Holland[3], J.J. Picano[2], R.C. Moomaw[2], K. Slack[1] and S. Vander Ark[1]
*[1]KBRwyle, Houston, TX; [2]UTMB, Houston, TX; [3]Space Medicine Operations Division, NASA Johnson Space Center, Houston, TX*

*(EDUCATION - TUTORIAL)*

**PROBLEM STATEMENT:** In order to successfully implement the behavioral aspects of an astronaut selection and screening process geared toward long-duration and deep space missions, a multi-phase process combining best practice elements from the fields of industrial-organizational psychology, operational psychology, aerospace psychology and aerospace psychiatry, are needed. Furthermore, this process should be implemented by professionals with broad, in depth, and direct spaceflight operations experience. **TOPIC:** In 2017 NASA completed the selection process for its 22nd class of astronaut candidates. NASA's multi-phase U.S. astronaut selection process seeks to identify the most qualified astronaut candidates from a very large number of applicants. With the approaching end of the International Space Station program in 2024 and the advent of missions beyond low earth orbit, NASA focused on selecting those individuals who were most suited to the unique demands of long-duration spaceflight as well as future deep space missions. In total, NASA received 18,357 applications for the 2017 astronaut selection cycle. Of these, 120 were invited to NASA Johnson Space Center (JSC) for Round 1 initial screening and interviews, which consisted of an Astronaut Selection Board (ASB) preliminary interview, medical examinations, and psychological testing. Of these, 50 individuals were invited to return for Round 2. This round consisted of further medical testing, comprehensive behavioral assessments, psychiatric examination, and a second ASB interview. Following this, 12 astronaut candidates (ASCANs) were ultimately chosen to go forward to basic training in Houston. The contents, benefits, and lessons learned from implementing this phased astronaut selection process will be discussed. The lessons learned can benefit the future selection of space flyers, whether they are for NASA or commercial spaceflight missions. **APPLICATIONS:** The need for a structured, multi-phase behavioral selection process that utilizes best practices from the fields operational psychology and aerospace psychiatry, preferably planned and implemented by personnel with extensive spaceflight operations experience, is required to ensure that this aspect of the astronaut candidate selection and screening process is successful.

**Learning Objectives:**

1. Understand the historical context of 2017 NASA astronaut candidate selection cycle as well as the primary steps and processes NASA uses to implement behavioral components of the astronaut candidate screening and selection process.
2. Understand the importance of the need for selection team personnel to have direct operational spaceflight operations experience as well as in-depth exposure to astronauts over the course of their careers in order to achieve a successful outcome.

## [169] AN HISTORICAL REVIEW OF THE ASSESSMENT OF PSYCHOLOGICAL SUITABILITY FOR LONG DURATION SPACE MISSIONS

J.J. Picano[1] and A. Holland[2]
*[1]UTMB/NASA JSC, Houston, TX; [2]NASA JSC, Houston, TX*

*(EDUCATION - PROCESS)*

**MOTIVATION:** NASA's growing focus on long-duration spaceflight missions increases the need for selecting astronauts with the psychological competencies necessary to adapt to living and working in space for long periods. Behavioral Health and Performance (BHP) group at NASA has been evaluating suitability for Long Duration Missions (LDM) in astronaut applicants since 1998 in conjunction with International Space Station (ISS) missions. In this presentation, we review the development of suitability ratings for LDM in the BHP astronaut selection process, and examine the trends in selection outcomes since their introduction in 1998 to 2013. **OVERVIEW:** Astronaut applicants in the final phase of NASA's Astronaut selection process (N= 434) were rated for suitability for LDM after an extensive interview (1998-2009) and simulations (after 2009) on 10 broad factors (e.g., performance under stressful conditions, judgment/decision making, and teamwork skills) deemed important for long duration missions by job analysis methods. An Overall Suitability for LDM rating from 1 (low) to 5 (high) was given for each applicant. Overall Suitability for LDM was not related to age or gender. Applicants rated higher in Overall Suitability for LDM were significantly more likely to be selected ($r$ = .24). Over the last three selection cycles, no applicants were selected who were rated low (ratings of 1 or 2) in suitability for LDM; whereas the percentage of applicants selected who were rated high (ratings of 4 or 5) in suitability for LDM equals or exceeds 75% over the last 3 cycles. **SIGNIFICANCE:** With NASA's increasing focus on longer duration spaceflight missions on the ISS over the past two decades, there has been a significant tendency to select astronauts with greater psychological competencies for long-duration missions. It is important to understand the psychological competencies that contribute to suitability for LDM as we move to selecting astronauts for longer duration space exploration missions.

**Learning Objectives:**

1. Participants will understand the psychological competencies that contribute to suitability for long duration space missions.
2. Participants will understand the role of psychological suitability assessment in the astronaut selection process.
3. Participants will understand the relationship between suitability for long duration space missions and selection as an astronaut over the course of NASA's experience with ISS missions.

## [170] COGNITIVE PERFORMANCE IN MILITARY SENIOR LEADERS: ANALYSIS & IMPLICATIONS

T. Williams[1], L.B. Landon[3], J. Schneiderman[3], K. Seaton[2], W.B. Vessey[1], R. Stanley[4], C. Kusmiesz[4], J. Tisson[4], D. Arias[3], S. Stranges[3] and J. Dunn[3]
*[1]NASA JSC, Houston, TX; [2]UTMB/KBRwyle, Houston, TX; [3]KBRwyle, Houston, TX; [4]U.S. Army War College, Carlisle, PA*

*(EDUCATION - TUTORIAL)*

**PROBLEM STATEMENT:** The demands on senior leaders in the military are well-known. They operate in issues and confront problems that are volatile, uncertain, complex and ambiguous. Their ability to sift through the vast amounts of information, to achieve the coup d'oeil, or glance that allows for a comprehensive appreciation of the demands, helps distinguish the good leaders from the great ones. **TOPIC:** Cognitive processes that allow for reactions to cognitive efficiency, attention and vigilance, and information processing combined with relevant experience to give what they see *context*. This presentation reports on the use of two measures used by NASA, the Cognition Battery and WinSCAT, to develop norms using 50 senior military officers attending a senior service college. Using the newly developed Cognition Battery and the more familiar, WinSCAT, we will describe the tests, the norms developed, and place these results within the context of the high levels of autonomy along with the necessity to engage creative problem-solving, mental agility, and critical thinking required of senior leaders. **APPLICATIONS:** This presentation will place these findings into the context of ensuring optimal performance in space under various demands in extreme, hostile environments.

**Learning Objectives:**

1. Understand the significance of neurobehavioral screening of senior leaders using the recently developed and NASA-funded, Cognition Battery, and compared to the WinSCAT, a cognitive assessment tool currently used on the International Space Station (ISS).

### [171] OVERVIEW OF NASA BEHAVIORAL HEALTH & PERFORMANCE STANDARD MEASURES

P.G. Roma[1], J. Schneiderman[1], L.B. Landon[1], A. Whitmire[1] and T. Williams[2]
*[1]NASA Behavioral Health & Performance Laboratory, KBRwyle, Houston, TX; [2]Human Factors & Behavioral Performance Element, NASA Johnson Space Center, Houston, TX*

*(EDUCATION - TUTORIAL)*

**PROBLEM STATEMENT:** Future deep space exploration missions will present challenges to crew behavioral health and performance greater than those currently faced by astronauts working and living in low-Earth orbit on the International Space Station (ISS), including unprecedented duration and distance, isolation, and confinement under increasingly autonomous operations. Over the years, studies in spaceflight and space analog environments, such as remote Antarctic stations, have provided valuable insight on the behavioral health and performance risks facing individuals and teams in extended isolation and confinement. However, a limitation of this research and applications to future exploration missions is a lack of standardized measures to enable insights, comparisons, and countermeasure development relative to behavioral health and performance across laboratory, field, operational, and spaceflight settings. **TOPIC:** NASA's Human Research Program (HRP) is developing a set of "Standard Measures" for use in spaceflight and spaceflight analog environments to monitor the risks of long-duration missions on human health and performance, including behavioral health, individual and team performance, and social processes. Based on measures selected, developed, and tested under the NASA-funded Behavioral Core Measures project (PI: D.F. Dinges) as well as other projects from NASA's Human Factors & Behavioral Performance research portfolio, NASA's Behavioral Health & Performance (BHP) Laboratory is further evaluating the operational feasibility, acceptability, and validity of a multidisciplinary suite of objective, subjective, behavioral, and biological measures for monitoring behavioral health, individual and team performance, and social processes over time. The inaugural generation of the NASA BHP Standard Measures includes a neurocognitive test battery, actigraphy, physical proximity sensors, cardiovascular monitors, and subjective self-reports of mood, depression, and various team and social processes and performance outcomes. **APPLICATIONS:** The NASA BHP Standard Measures suite and components thereof may be used to inform and monitor behavioral health, individual and team performance, and social processes in research and operations across laboratory, spaceflight, defense, aviation, maritime, energy, business, and other high-performance teams and 24/7 operational environments.

**Learning Objectives:**

1. The participant will learn how the NASA BHP Standard Measures suite may be used to inform and monitor behavioral health, individual and team performance, and social processes in research and operations across laboratory, spaceflight, defense, aviation, maritime, energy, business, and other high-performance teams and 24/7 operational environments.

### [172] PSYCHOLOGICAL ASPECTS OF FOOD BARS AS MEAL REPLACEMENT IN SPACEFLIGHT

A. Whitmire[1], T. Sirmons[2], M. Young[3], J. Schneiderman[1], K. Slack[1], T. Williams[3] and G. Douglas[3]
*[1]Behavioral Health and Performance, NASA/KBRwyle, Houston, TX; [2]KBRwyle, Houston, TX; [3]NASA Johnson Space Center, Houston, TX*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Currently on the International Space Station (ISS), a robust food system provides astronauts with over 200 processed and prepackaged standard menu items over the course of their mission. In addition, the Behavioral Health and Performance Group (BHP) at NASA Johnson Space Center offers crew members special foods such as candies and fresh fruits, as care packages are periodically delivered via re-supply vehicles. Even with such a relatively wide selection, anecdotal reports indicate fatigue with the existing food system. This is especially concerning for future missions, where exploration mission vehicles will not have the mass or volume needed to provide similar options. Efforts are underway to reduce mass and volume of nutritious and acceptable foods for deep space missions. Nutrient-dense meal replacement bars have been developed and tested, and are expected to provide a portion of the food supply in future missions. To characterize acceptability and psychological responses to food bars in isolation and confinement, we tested four flavor varieties in four 30-day missions in the Human Exploration Research Analog (HERA) Campaign 3. **METHODS:** Crewmembers (n=16) were asked to consume meal bars every morning for breakfast for the first 15 days of the mission, and once every 3 days for the second half of the mission-- with the ability to choose breakfast from menu items on the other 2 days. Daily surveys assessed responses to the meal options, as well as mood, perceived stress, and other behavioral outcomes. **RESULTS:** Preliminary results indicate that daily consumption of meal replacement bars positively correlated with stress and sleepiness. Crewmembers also provided qualitative feedback relative to the food bars to provide additional context about the eating experience in HERA. Analysis is still ongoing, but current trends suggest that daily involuntary meal replacement is related to a negative psychological response, while meal replacement on a more limited basis may be acceptable to most crew for missions up to 30 days. **DISCUSSION:** Refining our understanding of responses to forced food options during long-duration missions will help to inform the food system and behavioral health countermeasures adopted in future spaceflight vehicles for long duration exploration missions.

**Learning Objectives:**

1. The participant will be able to recognize the critical issues surrounding food systems for spaceflight.
2. The participant will be able to understand the results of a Food Bars study at the NASA Johnson Space Center, and the implications of that study for future spaceflight missions.
3. The participant will be able to relate psychological well being to the food system requirements for future spaceflight.

***Tuesday, May 08*** ***2:00 PM***
***Ballroom B***

## S-037: PANEL: FAA EXPERIENCE WITH "BASICMED" – AN ALTERNATIVE PROCESS TO THE THIRD CLASS MEDICAL CERTIFICATION OF U.S. GENERAL AVIATION PILOTS

**Chair: Michael Berry**
*Washington, DC*

**PANEL OVERVIEW:** In the United States, the Federal Aviation Administration (FAA) Extension, Safety, and Security Act of 2016 was enacted on July 15, 2016. Section 2307 of this Act, Medical Certification of Certain Small Aircraft Pilots, directed the FAA to "issue or revise regulations to ensure that an individual may operate as pilot in command of a covered aircraft" without having to undergo the medical certification process under 14 CFR part 67, if the pilot and aircraft meet certain prescribed conditions as outlined in the Act, and to do so within 180 days. The FAA amended two and created one new federal regulation in order to comply with the law. This was accomplished on January 11, 2017, with an effective date of May 1, 2017. The final rule, Alternative Pilot Physical Examination and Education Requirements, implemented, without interpretation, the requirements of Section 2307 and described how the FAA will implement those provisions. This program has been named "BasicMed". This panel presents the Federal Aviation Administration experience with BasicMed at the one-year point. Presentations in this Panel will describe the rule making development of BasicMed in compliance with the law, the impact of this new program on Aviation Medical Examiners, a description of the demographics and statistics of the BasicMed pilot population, and the safety record over the first year, the legal aspects and experience during the first year, and finally an overview of the continuing challenges of implementing these new BasicMed rules, the future implications for aeromedical certification, and Office of Aerospace Medicine collaboration with the FAA Flight Standards Service to accomplish the implementation.

## [173] FEDERAL AVIATION ADMINISTRATION EXPERIENCE WITH "BASICMED" – RULE-MAKING DEVELOPMENT

J.R. DeVoll
*Office of Aerospace Medicine, FAA, Washington, DC*

*(EDUCATION - PROCESS)*

Section 2307 of the Federal Aviation Administration (FAA) Extension, Safety, and Security Act of 2016 tasked the FAA with publishing a new regulation ("rule") to allow pilots of certain small aircraft to fly using an alternative to third-class airman medical certification. The rule had to be published within 180 days and implemented within one year. This presentation addresses complexities of creating regulations and related challenges to aerospace medicine and aviation safety. In July 2016, a rule-writing team assembled from representatives from FAA stakeholders including Flight Standards, Aerospace Medicine, General Counsel, budget, public affairs, security, and others. The new rule needed to implement wording from the law virtually verbatim, but the published notice of rule-making needed to address the numerous other questions and issues arising as a consequence of the legislation. Major issues addressed included: operational limitations; pilot privileges (e.g., student pilot, flight instruction); definition of a valid drivers' license; medical certificate requirements; applications for airman medical certificates; completion of the medical education course; care and treatment by a physician; medical education course requirements and availability; documentation requirements; authority to require additional information; and regulatory notices and cost analyses. The rule was published January 11, 2017, titled the "Alternative Pilot Physical Examination and Education Requirements." Overall, the rule included amendments to 14 CFR parts 61 and 91, and a new part 68. Concurrently, the team addressed action items required for implementation. Key issues included: cooperative development of the medical education course; engaging with stakeholder organizations to develop the necessary informatics and data capabilities; developing the Comprehensive Medical Examination Checklist; messaging and public affairs issues; and approval of forms by the Office of Management and Budget. All required elements were in place for implementation on May 1, 2017. The BasicMed implementation process shows that legislation affecting safety issues is not straightforward and can have unintended consequences. International civil aviation authorities should be aware of external forces that may impose change, and develop strategies to stay ahead of advances in medicine and the sociopolitical currents affecting the aviation stakeholders and pilot populations.

**Learning Objectives:**

1. Understand the complexities facing aeromedical certification authorities in developing safety regulations in the context of national laws and statutes.
2. Understand the related complexities of actual implementation of new rules or regulations.
3. Understand the importance of staying abreast of not only current evidence-based medicine, but also the sociopolitical currents demanding change amongst aviation stakeholders, commercial pilots, and general aviation pilots.

## [174] BASICMED AND THE IMPLICATIONS FOR U.S. AVIATION MEDICAL EXAMINERS

G.A. Pinnell
*Flight Medicine, Airdocs Aeromedical Support Services, Freeland, MI*

*(EDUCATION - PROCESS)*

The Federal Aviation Administration (FAA) Extension, Safety, and Security Act of 2016 was enacted on July 15, 2016 which gave rise to an alternative to traditional 3rd Class medical certification for pilots operating certain aircraft under 6000 pounds. This regulation, which is known as BasicMed raises questions, which to date are unanswered, regarding aviation safety, but may also have a significant impact on the aviation medical examiner community. The majority of the Aviation Medical Examiner (AME) corps, which has been declining in numbers for years, will be facing reduced demand for third-class FAA medical exams. This raises questions regarding future availability and quality of AME services due to reduced opportunity to gain experience with FAA medical certification and Aerospace Medicine. Many AMEs will likely not offer the BasicMed Exams due to legal issues, which leaves this aeromedical surveillance to physicians without any aeromedical certification training. The aircraft insurance industry who is a major stakeholder in aviation safety appears not to have reacted to date in any dramatic manner to BasicMed other than to, in some instances, require an FAA Third Class Medical for pilots over a certain age. This presentation will address these issues.

**Learning Objectives:**

1. Understand the potential legal ramifications of performing BasicMed exams by physicians.
2. Understand the potential impact of BasicMed on availability of Aviation Medical Examiner (AME) Services.
3. Understand the current and potential impact of BasicMed to the National Airspace System.

## [175] THE U.S. EXPERIENCE WITH BASICMED DURING THE FIRST YEAR – DEMOGRAPHICS AND SAFETY OUTCOMES

W.D. Mills and R. Greenhaw
*Medical Research Division, FAA Civil Aerospace Medical Institute, Oklahoma City, OK*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** BasicMed, a new class of U.S. flight operations (FAR Part 68) which took effect on May 1, 2017, eliminates the requirement to possess an FAA medical certificate for personal flying for hundreds of thousands of U.S. pilots. There are modest limitations on these flight operations and some medical oversight consisting of online medical education every two years, and evaluation by any community physician every four years. A previous FAA medical certificate issued after July 14, 2006 is also required. **METHOD:** A list of pilots approved for BasicMed was obtained from the FAA Airman Registry. This was matched with the FAA medical database and the National Transportation Safety Board's accident database. Variables of interest were extracted. **RESULTS:** In the first 3 months of this program, 14,356 pilots had met the criteria for BasicMed and new pilots were being added at about 100 per day. The average age of these pilots was substantially older than medically certified pilots and two-thirds held a private pilot's certificate. Their median total flight time was 870 hours with median past six-month flight time of 12 hours as reported on their last FAA physical exam. The proportion of BasicMed pilots who required a special issuance waiver at the time of their last FAA medical exam was 5 times higher than medically certified pilots. BasicMed pilots were involved in 16 accidents over the first two months of the program, which is 0.14% of those pilots compared to an estimated 0.019% for pilots holding a 3rd-class medical certificate. **DISCUSSION:** The BasicMed rule is a very popular option for U.S. pilots engaged in personal flying. However, there remains the question as to whether the lack of FAA medical oversight will be associated with unacceptably high accident rates.

**Learning Objectives:**

1. Understand the characteristics and safety experience of the current population of BasicMed pilots.

## [176] FEDERAL AVIATION ADMINISTRATION EXPERIENCE WITH "BASICMED" – LEGAL EXPERIENCE

M. Stuart[2], J. Vaughan[2] and J.R. DeVoll[1]
*[1]Office of Aerospace Medicine, Federal Aviation Administration, Washington, DC ; [2]Office of the General Counsel, FAA, Washington, DC*

*(EDUCATION - PROCESS)*

Section 2307 of the Federal Aviation Administration (FAA) Extension, Safety, and Security Act of 2016 (FESSA) mandated the FAA to publish and implement a new regulation ("rule") allowing pilots of certain small aircraft to fly using an alternative to third-class airman medical certification for general aviation specified in Part 67 of Title 14, Code of Federal Regulations (14 CFR Part 67). Though the wording of the bill appeared "straightforward," it actually presented numerous legal challenges for both rule-writing and implementation. During rule-writing, the key major challenge was to understand the legal implications without attempting to infer the intent of Congress. Legal questions included defining the meaning of "state licensed physician," legal basis for National Driver Registry (NDR) check, whether the medical education course

would be directly under FAA control or a stakeholder group, the legal basis for requiring and collecting pilot information, legal agreements with stakeholder groups, defining when the most recent medical certificate allows use of BasicMed, understanding the nuances of previously "suspended" certificates, driver's license issues, etc. Because BasicMed was implemented only recently on May 1, 2017, the FAA's experience with actual legal and enforcement issues in this area is developing. The FAA expects that additional legal and enforcement issues unanticipated by the BasicMed legislation will continue to arise. Lessons learned from the first 12 months of BasicMed will be discussed.

**Learning Objectives:**

1. Understand some of the legal issues faced during the rule writing for BasicMed.
2. Understand how the FAA is having to deal with legal enforcement issues for potential non-compliance with BasicMed.
3. Understand the implications of BasicMed on enforcement related to currently held medical certificates.

### [177] BASICMED ISSUES, FUTURE DIRECTIONS, AND AVIATION SAFETY

M.A. Berry
*Office of Aerospace Medicine, Federal Aviation Administration, Washington, DC*

*(EDUCATION - PROCESS)*

There are a number of possible individual BasicMed pilot applicant scenarios that are not addressed or described in this new BasicMed rule. Each situation requires a case by case resolution. The first of these unanticipated situations arose only 2 weeks after the May 1, 2017 implementation. This rule as published has a number of gaps and has required the FAA Office of Aerospace Medicine (AAM) to develop new standardized policies related to medical certification. This rule, which created a new 14 CFR Part 68, does not specifically address medical certification, which is the purview of AAM, but instead describes an alternative process which is the purview of the FAA Flight Standards Service (AFS). It has therefore required collaborative action between AAM and AFS to address the gaps in the rule. The results of this collaboration and specific actions taken will be described. The implications for Aviation Safety due to the BasicMed rule will also be presented.

**Learning Objectives:**

1. Understand the gaps in the BasicMed Rule as written, and the potential consequences.
2. Understand the actions taken by the FAA Office of Aerospace Medicine in order to mitigate the safety risks created by the gaps in the new BasicMed Rule.
3. Understand the aviation safety implications for those gaps that cannot be mitigated by a new process or procedure from the FAA Office of Aerospace Medicine or FAA Flight Standards Service.

***Tuesday, May 08*** ***2:00 PM***
***Topaz***

## S-038: PANEL: HUMAN PERFORMANCE AUGMENTATION WITH NON-INVASIVE BRAIN STIMULATION TECHNOLOGIES

*Sponsored by Life Sciences and Biomedical Engineering Branch*

**Chair: Lindsey McIntire**
*Dayton, OH*

**PANEL OVERVIEW:** This panel presents the results from the Air Force's Non-invasive Brain Stimulation Team research portfolio over the past year. The studies assessed the efficacy of techniques such as transcranial direct current stimulation (tDCS) and transdermal vagal nerve stimulation (tVNS) to enhance aspects of human cognition. The research spans from basic science to understand the mechanism of action to applied research to investigate optimal stimulation paradigms for the military. The first presentation explores the mechanism of tDCS using a variety of neuroimaging techniques. Understanding the mechanism will contribute to optimization of the stimulation paradigms. The second presentation covers the effects of tDCS on driving performance under sleep deprivation stress. The next presentation will describe the results of a head-to-head comparison between a laboratory-based tDCS system and a new commercial unit. Specifically, the study assessed the effects of stimulation on multitasking performance. The final presentation will discuss the effects of tVNS on learning to identify targets in radar imagery. The results of these studies provide promising evidence that non-invasive stimulation techniques can be used to enhance various aspects of cognition in military environments.

### [178] COGNITVE PERFORMANCE ENHANCEMENT OF CONSECUTIVE DAYS OF TRANSCRANIAL DIRECT CURRENT STIMULATION: AN FMRI INVESTIGATION

C. Whitehead[2], A. McKinley[1], L.K. McIntire[2], M. Sherwood[3] and C. Goodyear[2]
*[1]Applied Neuroscience, Air Force Research Laboratory, Wright-Patterson AFB, OH; [2]Infoscitex, Inc., Dayton, OH; [3]Wright State University, Dayton, OH*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Transcranial direct current stimulation (tDCS) is a noninvasive brain stimulation technique that uses a mild electrical current passed between electrodes on the scalp to modify neuronal membrane resting potential. Studies focusing on treating disorders of clinical patients commonly stimulate in several sessions over consecutive days or weeks to achieve a greater effect and extend effect duration. However these studies don't focus on enhancing cognitive performance (i.e. vigilance or skill learning) in healthy individuals, nor do they examine functional or metabolite changes. In this study, we propose to examine the additive effects of tDCS in a healthy military population with non-invasive neuroimaging and compare with the single session data. **METHODS:** Twenty-four participants completed 5 data collection sessions; the first 3 being on consecutive days. Twelve participants received 30 minutes of anodal tDCS stimulation (2mA) and twelve received 30 minutes of sham stimulation, with the electrode array placed over their dorsolateral prefrontal cortex (DLPFC). Neuroimaging was performed immediately prior to and following stimulation on all three days. Magnetic resonance imaging (MRI) baseline scans were compared to post-stimulation scans; including functional MRI (fMRI), diffusion tensor imaging (DTI), and aterial spin labeling (ASL). One week and two weeks following the final tDCS session, participants returned for follow-up testing where they received only neuroimaging and no stimulation. **RESULTS:** When analyzing fMRI and DRI, voxel-wise paired t-tests show differential increases in neural activation between real and sham stimulation when comparing Day 1 pre-stimulation and Day 3 post-stimulation. Voxel-wise paired t-tests also evaluated the effect of stimulation on blood perfusion, showing increased perfusion in both ventral and dorsal streams. Results were significant at $p<0.05$. **DISCUSSION:** Single session tDCS has been shown to provide effects lasting hours after the stimulation ceased. However, less is known about whether cognitive benefits found in single exposure tDCS would exhibit a similar extension (a greater effect and/or longer effect duration) when applied over consecutive days. Exploring the additive effects of tDCS through neuroimaging will potentially improve our understanding of the effectiveness and duration of tDCS effects and increase the feasibility of incorporating the technology into operational Air Force environments.

**Learning Objectives:**

1. The effects of transcranial direct current stimulation on attention and memory.
2. The effects of transcranial direct current stimulation on brain activity.
3. Possible transcranial direct current stimulation mechanisms of action that generate the observed behavioral effects.

### [179] THE EFFECTS OF TRANSCRANIAL DIRECT CURRENT STIMULATION (TDCS) ON DRIVING PERFORMANCE DURING 37 HOURS OF EXTENDED WAKEFULNESS

L. McIntire[2], A. McKinley[1] and C. Goodyear[2]
*[1]Applied Neuroscience, Air Force Research Laboratory, Wright-Patterson AFB, OH; [2]Infoscitex, Dayton, OH*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** It is well known that drowsy driving is a major factor in many traffic accidents. Studies have found that it is not the duration of driving but the amount of time spent awake that causes driving performance to decline. While it is best to abstain from driving drowsy, it is not realistically an option for some occupations such as transportation and medicine. Many people use caffeine or stimulates to help them sustain wakefulness. However, these interventions can have drawbacks. We are investigating another fatigue countermeasure that has potentially fewer side effects and longer lasting benefits. A form of non-invasive brain stimulation called transcranial direct current stimulation (tDCS) has been shown to improve sustained attention (6 hours post-stimulation) and reaction time (24 hours post stimulation) during sleep deprivation. We hypothesize tDCS can also benefit driving performance under sleep deprivation. **METHODS:** Three groups of 12 participants in each group participated in the study. One group received tDCS over the left dorsolateral prefrontal cortex (IDLPFC). Another received tDCS over the primary motor cortex (M1). The final received sham brain stimulation. Participants completed 37 hours of sustained wakefulness. They were tested every two hours on a monotonous 30 minute driving task from 1800 to 2000 the next day for a total of 9 sessions. **RESULTS:** Participants receiving stimulation, regardless of location, were able to better perform the driving simulation task in both distance from the lead car and deviation from center of the lane compared to the group receiving sham stimulation ($p \leq 0.05$). This improved performance lasted at least 9 hours post-stimulation ($p \leq 0.05$). **DISCUSSION:** Based on this research study and two more that looked at brain stimulation and driving performance without fatigue shows that brain stimulation aids in driving performance regardless of sleepiness levels and that benefit can last for several hours post stimulation.

**Learning Objectives:**

1. The effects of tDCS on driving performance.
2. The differences in location of tDCS stimulation on driving performance.
3. Driving performance and sleep deprivation.

## [180] COMPARING THE EFFECTS OF TRANSCRANIAL DIRECT CURRENT STIMULUATION WITH EEG ELECTRODES VERSUS THE HALO SPORT ON MULTITASKING

A. McKinley[1], J. Nelson[3] and L.K. McIntire[2]

*[1]Applied Neuroscience, Air Force Research Laboratory, Wright-Patterson AFB, OH; [2]Infoscitex, Inc., Dayton, OH; [3]Wright-Patterson AFB, Dayton, OH*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** The ability to monitor and respond to multiple events simultaneously can be extremely overwhelming on a human operator's cognitive state resulting in a decline in performance. However, within the past several years researchers have provided evidence that transcranial direct current stimulation (tDCS) can be used as a countermeasure to augment and enhance performance during multitasking environments. To date, there has been very little research conducted comparing different tDCS devices to improve cognition. This study examined the efficacy of tDCS using a 5 electroencephalographic (EEG) electrode array compared to the halo sport neuromodulation system over the motor cortex (M1) while multitasking. In addition, FaceLab (eye tracker) was incorporated to record the participants scanning pattern. **METHODS:** Forty-Five active duty military members participated in the two day study. The participants were randomly assigned to three groups, each group consisted of thirteen males and two females. On the first day, they performed a training session of the multi-attribute task battery (MATB) which consisted of five different difficulty levels each lasting four minutes. The difficultly levels were provided in sequential order. On the second day, the participants were either provided on-line anodal tDCS via 5 EEG electrodes, on-line anodal tDCS via halo sport or a null condition (no electrodes) while performing MATB. **RESULTS:** The findings indicate that on-line anodal tDCS via EEG electrodes and halo sport improved multitasking performance compared to the null condition at each of the five difficulty levels. Although the halo sport neuromodulation system displayed the greatest enhancement, there was not a significant difference between the halo sport neuromodulation system and the EEG electrodes. Eye scanning patterns displayed underlying evidence that administering on-line anodal tDCS during a multitasking environment accelerated information processing capabilities resulting in less fixation and higher performance. **DISCUSSION:** The results provided evidence that on-line tDCS can be used as a countermeasure to combat an operator's performance decrement during multitasking. Although the halo sport neuromodulation system displayed the greatest enhancement, both electrode conditions improved multitasking performance compared to the null condition. As well, eye scanning patterns provided underlying evidence that tDCS may enhance information processing efficiency.

**Learning Objectives:**

1. The effects of transcranial direct current stimulation (tDCS) on multitasking performance.
2. The effects of transcranial direct current stimulation (tDCS) on attention performance.
3. The effects of transcranial direct current stimulation (tDCS) on oculometrics.

## [181] ACCELERATING IMAGE ANALYST TRAINING WITH TRANSDERMAL VAGAL NERVE STIMULATION (TVNS)

A. McKinley[1], M. Paczynski[4], B. Minnery[4], L.K. McIntire[2] and J. Nelson[3]

*[1]Applied Neuroscience, Air Force Research Laboratory, Wright-Patterson AFB, OH; [2]Infoscitex, Inc., Dayton, OH; [3]Wright-Patterson AFB, OH; [4]Wright State Research Institute, Beavercreek, OH*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** The demand for Intelligence Surveillance and Reconnaissance (ISR) products within the Department of Defense (DoD) and Intelligence Community (IC) has exponentially increased over the last 15 years of operations. ISR missions in the Air Force alone increased 1200% over a 10-year period, while in that same time period the ISR analyst workforce increased only 33%. Vagal nerve stimulation (VNS) has been shown to significantly augment plasticity and improve memory and performance of cognitive tasks in both rats and humans. In this study, we examined the effects of VNS applied transdermally (i.e. non-invasively) on the synthetic aperture radar (SAR) image analysis learning rates and learning retention in healthy, active duty Air Force members. **METHODS:** Sixty participants completed four 1-hour training sessions followed by a test, with each occurring on a separate consecutive day. Participants were trained on two separate target types with training for one target occurring on days 1 and 3 while the other occurred on days 2 and 4. The tVNS was paired with training on days 1 and 3 only. Retention tests were provided 24 hours, 1 month, and 3 months after training concluded. Twenty participants received 4 minutes of tVNS at 10 Hz before and after training, twenty others received the same stimulation paradigm at 25 Hz, and twenty others received sham tVNS. Attention and reaction time tests were also given each day. **RESULTS:** The data analyses revealed a significant main effect of tVNS applied at 25 Hz on both target detection accuracy and visual search times. Paired t-tests showed tVNS at 25 Hz produced significantly greater improvements in test scores from the baseline test on each stimulation day. In addition, the 25 Hz tVNS group was found to have 24 hr, 1-month, and 3-month retention test scores that were 60-70% higher than those of the sham group. The data also revealed higher performance for the 25 Hz tVNS group on the Mackworth Clock test and psychomotor vigilance test. **DISCUSSION:** The data suggest that tVNS (when delivered at 25 Hz) may improve image analysis training by up to 70% and this performance advantage is coupled with enhancements in sustained attention. The results also indicate that tVNS also enhanced attention and arousal, which may have facilitated learning and retention of the material presented during training. These results provide initial evidence that tVNS may be a powerful tool to accelerate training in military environments.

**Learning Objectives:**

1. The effects of trandermal vagus nerve stimulation (tVNS) on image analyst training.
2. The effects of transdermal vagal nerve stimulation on attention and arousal.
3. The effects of transdermal vagal nerve stimulation on physiology.

***Tuesday, May 08*** ***2:00 PM***
***Sapphire***

## S-039: PANEL: TEAMWORK MAKES THE DREAM WORK: A MULTI-DISCIPLINARY APPROACH TO PROBLEM SOLVING IN AEROSPACE MEDICINE HISTORY

**Chair: James Davis**
*Bossier City, LA*

**Chair: Troy Faaborg**
*Alexandria, VA*

**PANEL OVERVIEW:** Aviation has a strong history of collaborative efforts that led to innovation and advancement in the field of flight. Aerospace medicine has been on the leading edge of those efforts from the very beginning. As technological advances pushed the boundaries of flight, from altitude to speed to duration, aeromedical professionals have worked together to address the increasing demands on for aviators throughout history. We begin with a summary of achievements in aerospace science told from the perspective of scientists and their relationships with one another; from Hooke and Boyle in the 1660s to Graham and Fick in the mid-1800s. Specifically we will discuss the evolution of the Gas Laws during that time against the social and economic backdrop of that era. Next, we will discuss the work of Antoine-Laurent Lavoisier (1743-1794) and his discovery of "pure air" alongside the efforts of his contemporaries, such as Carl Wilhelm Scheele, Joseph Priestly and Henry Cavendish during the chemical revolution. Fast forward a century, and we explore the contributions of Rudolph Schroeder (1885-1952), a gifted mechanic. Although not a medic by trade, he used his multi-disciplined background to make key contributions to the body of high altitude physiology knowledge that we take for granted today. World War II proved that aviation was an international endeavor. We will explore the contributions of Canadian Dr. Wilbur R. Franks (1901-1986) who was instrumental in the creation of the first workable anti-gravity suit to combat the physiological effects of more advanced and maneuverable aircraft. Finally, we will discuss Dr. John Paul Stapp (1910-1999) an MD and PhD and flight surgeon who tested the limits of human survivability during aircraft crashes. In 1946, the Army Air Corps was beginning to build aircraft that could fly higher and faster. They needed to also enhance their understanding of the physiological limits of the human body. Dr. Stapp's work expanded the knowledge of acceleration and high altitude physiology and prepared airmen for the modern aircraft we use today. These are examples of the multi-disciplinary efforts of the aerospace medicine professionals as part of a storied tradition.

### [182] EVOLVING THE GAS LAWS: CLASSICAL CLASHES, COLLABORATIONS AND CORRECTIONS

C.A. Richards
*USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

*(EDUCATION - TUTORIAL)*

The late 17th- early 19th century was a hotbed for fierce competition, simultaneous discoveries, and rise of physical chemistry as well as early aerospace physiology in a rapidly changing European landscape. With the advent of the hot air balloon, scientists quickly designed and published experiments based on environmental and physiological changes, which occurred as humans first took flight. These early pioneers did not work in isolation, but discussed their findings with each other, competed for recognition, and even corrected each other's discoveries with later findings and publishings. In this presentation, a few of the greatest early achievements to aerospace science will be told from the perspective of the scientists and their personal relationships to each other. From Hooke and Boyle in the 1660s, to Graham and Fick of the mid 1800s, the Gas Laws of the surrounding air will be proffered, re-worked, and even co-created in the midst of revolution, war, and rapid modernization.

**Learning Objectives:**
1. Name the founders of the Gas Laws mentioned, and to what their physical phenomenon each Law refers.
2. Be able to differentiate which Laws discussed have multiple simultaneous discoverers.
3. Identify which Laws were even further defined by later scientists post-discovery.

### [183] THE DISCOVERY OF OXYGEN: A BREATHTAKING STORY FROM THE CHEMICAL REVOLUTION

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

*(EDUCATION - TUTORIAL)*

**PROBLEM STATEMENT:** The discovery of oxygen significantly changed the history of chemistry and physiology. **TOPIC:** Although Antoine-Laurent Lavoisier often receives credit for the discovery of oxygen, the story is much more complicated. Because most combustible items lost weight when they burned, many scientists in Lavoisier's time thought that process of burning involved the loss of a mysterious substance to air. Many of Lavoisier's contemporaries believed in the *phlogiston theory*, in which flammable substances contained a universal element of fire. This began to change in the mid-1700s. Two scientists, Carl Wilhem Scheele and Joseph Priestly, wrote to Lavoisier, explaining how they had generated a new gas that caused a candle flame to burn brighter and appeared to enhance respiration. Lavoisier never replied to these letters, but began to perform experiments on his own, eventually coming to the conclusion that there was no mysterious substance: Combustion involved a reaction between the burning object and this newly-discovered gas. In June 1783, Lavoisier reacted oxygen with another recently generated gas called *inflammable air* and produced "water in a very pure state." He correctly concluded that water was not an element; it was a compound that consisted of these two gases. Lavoisier named "inflammable air" *hydrogen* and "pure air" *oxygen*, and proposed a rationale for what would become the modern science of chemistry. This profound realization would forever change our understanding of both chemistry and physiology. **APPLICATIONS:** The discovery of oxygen caused fundamental changes in our approach to chemistry which still resonate today.

**Learning Objectives:**
1. Understand how the work of multiple scientists led to the discovery of oxygen.
2. Explain how the alchemical theory of "phlogiston" undermined our understanding of chemistry and physiology for decades.
3. Explain how the reaction of hydrogen and oxygen to create water fundamentally changed our understanding of chemistry.

### [184] RUDOLPH SCHROEDER: MECHANICIAN, TEST PILOT AND AVIATION SAFETY PIONEER

D. Thomas
*U.S. Air Force, Rocklin, CA*

*(EDUCATION - CASE STUDY HUMAN PERFORMANCE)*

Rudolph Schroeder (1885-1952) was a gifted mechanic that began his fledgling career paired with Otto Brodie (barnstorming pilot) in 1910. A graduate of the Crane Technical School in Chicago, Schroeder was working to develop his own glider designs when he joined up with other aviation-minded folks on the exhibition flying circuits. After moving between several pilots in the exhibition circuits, he learned to fly himself--later enlisting in the U.S. Army Signal Corps to be among the first military aviators at the onset of WWI. Two years later, he was assigned as Chief Test Pilot, McCook Field, Dayton, OH in programs that focused on increasing the safety and survivability of military aviation. He was the first aviator to fly with the Smith designed parachute pack, the first to open a night-flying school, and set several altitude records for unpressurized flights in open-cockpit biplanes reaching altitudes above 30,000 feet. Although not a medic by trade, this adventurous man with a serious demeanor used his multi-disciplined background to make key contributions to the body of high altitude human physiology knowledge that we take for granted today.

**Learning Objectives:**
1. List the influences Rudolph Schroeder made to understanding high-altitude physiology and the aviation environment.
2. Describe the impact of this knowledge on future advances in aviation technology.

### [185] DEVELOPMENT OF ANTI-GRAVITY SUITS TO COMBAT ACCELERATION FORCES

R. Dodge
*Aerospace and Operational Physiology, Air Force, Enid, OK*

*(EDUCATION - TUTORIAL)*

**PROBLEM STATEMENT:** Since World War II, our aircraft technology has exceeded our physiological limitations, necessitating the development of countermeasures for acceleration forces. **TOPIC:** The physiological effects of acceleration were first noted during World War I, when pilots would occasionally complain of visual impairments and loss of consciousness when recovering from dive maneuvers. However, it was not until World War II when the effects became more pronounced with the advancement of aircraft technology and maneuverability. World War II proved that aviation was an international endeavor with the development of special pants that apply pressure to the abdomen and legs, keeping the blood in the upper body and head during high Gz maneuvers. We will explore the contributions of Canadian Dr. Wilbur R. Franks (1901-1986), who was instrumental in the creation of the first workable anti-gravity suit to combat the physiological effects of high performance aircraft. Though his initial suit was cumbersome and impractical, it proved effective and mitigated the effects of acceleration forces exceeding +6 Gz. He later evolved his product into the first generation of air-inflated bladders, similar to those that we still use in anti-gravity suits today. **APPLICATIONS:** Anti-gravity suits continue to be a necessary component to tolerance of acceleration forces induced by high performance aircraft. Though our aircraft technology has exponentially advanced over the decades, the foundational design of anti-gravity suits is still based on the works of Dr. Franks.

**Learning Objectives:**
1. The participant will be able to understand how the anti-gravity suit was developed to combat acceleration forces.

### [186] JOHN PAUL STAPP: THE FASTEST MAN IN THE WORLD (IN 1954)

M.M. Metzler
*Aerospace & Operational Physiology, U.S. Air Force, Tyndall AFB, FL*

*(EDUCATION - PROCESS)*

In 1946, the United States Army Air Corps was just beginning to build aircraft that could fly higher and faster than any others in history. They needed to also enhance their understanding of the physiological limits of the human body. Enter Dr. John Paul Stapp. When Dr. Stapp joined the Army Air Corps in 1944, he already had an MD and a PhD, and was assigned as a flight surgeon after WWII. His assignment: test the limits of human survivability during aircraft crashes. The current known limit of human deceleration at the time was -18 Gx. Dr. Stapp set out to test that limit…using himself as a test dummy. In 1954, Dr. Stapp experienced over -40 Gx as his rocket sled, the "Sonic Wind I" went from 632 mph to a complete stop in 1.4 seconds. He also set the land speed record at the time, labeled by Time Magazine as the "Fastest Man on Earth". Throughout his tenure as a U.S. Air Force flight surgeon, Dr. Stapp exponentially expanded knowledge of acceleration and altitude physiology, proving that humans could survive high altitude, high speed ejections, and paving the way for today's fifth generation fighter aircraft. Dr. Stapp retired from the U.S. Air Force in 1970 at the rank of Colonel, after 26 years of service. In 1979, he was inducted into the International Space Hall of Fame, and the Aviation Hall of Fame in 1985. Dr. Stapp died in 1999 at the age of 89.

**Learning Objectives:**
1. To understand and appreciate Dr. John Stapp's historical contribution to the practice of aerospace medicine.

***Tuesday, May 08*** ***2:00 PM***
***Ballroom A***

## S-040: PANEL: AEROMEDICAL RESEARCH LABORATORIES: CAPABILITIES AND OPPORTUNITIES FOR COLLABORATION – PART 2

*Sponsored by AsMA Science & Technology Committee*

**Chair: John Crowley**
*Fort Rucker, AL*

**Chair: Barry Shender**
*Patuxent River, MD*

**PANEL OVERVIEW:** This panel, organized and sponsored by the Science and Technology Committee of the Aerospace Medical Association (AsMA), is one of two educational panels that aim to introduce aeromedical research organizations (military, government, industry, or academia) to discuss their capabilities and potential opportunities for collaboration with other scientists across the world. The contributors to part 1 of the panel are: (1) Dr. Estrella Forster of the Federal Aviation Administration's Civil Aerospace Medical Institute, Oklahoma City, OK, U.S.; (2) Dr. Erin Smith and Dr. Philip Farrell of the Canadian Forces Environmental Medicine Establishment and the Defence Research and Development Canada, respectively, Toronto, Canada; (3) Col. (Dr.) Lina Sanchez, Commander of the Colombian Air Force's Aerospace Medicine Center, Bogota, Colombia; (4) Col. (Dr.) Alden Hilton, Commander of the U.S. Air Force School of Aerospace Medicine, Dayton, OH, U.S.; and (5) Dr. Thais Russomano, who will discuss the activities of the Human and Aerospace Physiology research group at King's College, London, UK. Limitations in the program did not allow us to include other aeromedical research organizations in U.S. and abroad – we hope to do so in future AsMA meetings. The panel will include a discussion of topics that the participant organizations consider amenable to the potential formulation of collaborative research efforts. It also offers an opportunity to leverage scarce resources and encourages an internationally united approach towards enhancing world aviation safety.

### [187] FAA AEROMEDICAL RESEARCH LABORATORIES

E.M. Forster
*CAMI, FAA, Oklahoma City, OK*

*(EDUCATION - TUTORIAL)*

The Civil Aerospace Medical Institute is the medical certification, education, research, and occupational medicine wing of the Office of Aerospace Medicine under the auspices of the FAA's Office of Aviation Safety. Its aerospace medical research program has been formulated to keep abreast of emerging human safety risk issues such as those brought by the aging pilot population and changes in their health condition; advances in medicine and engineering; introduction of designer drugs and other illegal substances into the market; improved aircraft materials, equipment, cabin configurations, life support systems, and evacuation assistive devices; expansion of the transportation envelope; and growing complexity of data, software, technology, and systems integration practices. Personnel at the *Bioaeronautical Sciences Laboratories* perform research to assess aircrew health; develop biochemical methods to detect the presence of medications, toxins, and other substances that may impact an airman's performance in-flight; and identify biomarkers that signal environmental and other stressors. They also maintain all autopsy records proceeding from the investigation of U.S. fatal aircraft accidents. Personnel at the *Protection & Survival Laboratories* provide information, procedures, and equipment evaluations relative to aircraft accident investigation, crash survival, radiation exposure, and safety of passengers and crewmembers during normal operations and emergency events. They are key contributors to the development of human safety regulatory language and maintain the only repository of integrated civil aerospace medical information. Research outcomes include the development and/or improvement of aircraft certification criteria, evidence-based aeromedical decision-making processes, education programs, and

accident investigation practices, all intended to manage risk for the benefit of the most important aspect of the world's airspace system—the human operator and the public s/he serves. Facilities that support these activities include B-747 Aircraft Environment Research Facility, Flexible Aircraft Cabin Simulator, Water Tank, Altitude Chamber, Impact Sled, and High-Performance Computer.

**Learning Objectives:**

1. Introduce the activities of the aerospace medical research division of the FAA to identify potential opportunities for research collaboration across the world.

### [188] AEROSPACE MEDICINE COLLABORATIVE RESEARCH OPPORTUNITIES AT CFEME AND DRDC

P.S. Farrell[2] and E. Smith[1]
*[1]CFEME, Canadian Forces Health Services, Toronto, ON, Canada; [2]Human Systems Integration Section, Defence Research and Development Canada, Toronto, ON, Canada*

*(EDUCATION - TUTORIAL)*

**MOTIVATION:** The Canadian Forces Environmental Medicine Establishment (CFEME) and Defence Research and Development Canada (DRDC) Toronto Research Centre (TRC) have been partners for more than seventy-five years, and continue to seek international collaboration in aeromedical research. A human factors research laboratory, flight simulation and task modelling laboratory, 3D laser anthropometry laboratory, hypobaric chamber and human centrifuge are a few of the facilities available for collaborative research. Today's aeromedical problems are multi-faceted and require not only a multi-disciplinary approach, but also multi-organization collaboration with academia, industry, OGDs, and international partners. This presentation focuses on current international collaborative activities, as well as identifies future collaboration opportunities with CFEME and DRDC. **OVERVIEW:** Aeromedical research at CFEME and DRDC TRC spans several projects, including: Aircrew Neck- and Back-trouble Assessment & Mitigation Solutions, Fatigue Avoidance Scheduling Tool Validation, Advanced Aircrew Accommodation Models, Anthropometrics, Low Level Hypoxia, Operational Vision Requirements and Assessment, Human Factors Engineering for Surveillance Aircraft, Processing, Exploitation, and Dissemination Concepts, Unmanned Aircraft System Operator Training Requirements and White Matter Hyperintensities related to Hypobaric Exposure. There is additional clinical research and international collaboration in exercise and human performance and aerospace cardiology, respectively. Many of these projects involve collaborative efforts under 1) NATO Human Factors and Medicine Panel and Information Technology Systems panels, 2) TTCP HUM group Collaborative Projects or Joint Projects, and/or 3) US/CA Technology Research and Development Program. **SIGNIFICANCE:** Given the current fiscal climate, it is becoming increasingly beneficial to collaborate and leverage each other's research beyond simple information sharing. In order to further maximize resources, there is a move afoot to conduct face-to-face planning of joint experiments, share experimental protocols, participants, equipment and facilities amongst the nations. Resource sharing is slightly more costly in some ways than simple information sharing, but the leveraging and outcome benefits significantly outweigh the costs.

**Learning Objectives:**

1. To understand the relationship between CFEME and DRDC Toronto.
2. To be aware of the research facilities available for collaborative research at CFEME/DRDC Toronto.
3. To be aware of the current aeromedical research being conducted at CFEME/DRDC Toronto.

### [189] AEROSPACE MEDICAL CENTER: LOOKING TO THE FUTURE THROUGH THE RESEARCH CENTER IN AERONAUTICAL AND SPACE BIOMEDICAL SCIENCES.

L.M. Sanchez and M.A. Corzo Zamora
*Colombian Air Force, Bogota, Colombia*

*(EDUCATION - TUTORIAL)*

During the last 23 years, the Aerospace Medical Center of the Colombian Air Force (CEMAE) has been working in different fields of aerospace medicine such as aeromedical certification, physiological training, education, and research. Nowadays, CEMAE has 9 laboratories which have different applications that include aeromedical and human factors research and training in different operational scenarios. These changes have promoted its recognition as a reference center in Central and South America. Other areas of CEMAE are related to medical evaluation focused in aeromedical certification processes that generate huge amounts of research data. Looking for an expansion of research, CEMAE and the Educational Directorate of the Colombian Air Force have created the Research Center in Aeronautical and Space Biomedical Sciences (CIBAE). Their objective is to present and promote processes to increase knowledge in aerospace medicine and related fields through scientific networks between the Air Force, allied universities, and other public and private institutes. A brief description of the areas of interest that CIBAE supports will be discussed: aeromedical certification, human factors, flight and space physiology, extreme environments, altitude medicine, and physiology. Currently, CIBAE is conducting several research projects, including Antarctica and uninhabited air vehicles (UAVs). CIBAE is the leader of the research line in human factors in aviation, an effort that integrates the Master's degree program in Operational Safety in Aviation of the Postgraduate School of the Colombian Air Force. Through CIBAE, CEMAE is growing constantly to promote an aerospace culture, increasing science and technology networks that allow higher standards for effective and safe flight operations.

**Learning Objectives:**

1. To review the structure and fields of study at CEMAE and CIBAE.
2. To analyze the future of research networks in aerospace medicine and aviation operational safety.

### [190] UNITED STATES AIR FORCE SCHOOL OF AEROSPACE MEDICINE - OVERVIEW

D.D. Hilton, R.S. Mayes and R. Hersack
*USAFSAM. Wright-Patterson AFB, OH*

*(EDUCATION - TUTORIAL)*

**MOTIVATION:** USAFSAM executes the 711th Human Performance Wing (711HPW) and AFRL Defense Health Program-funded research mission. USAFSAM's research portfolio exceeds $50M in funding and includes over 150 active projects per year. The research portfolio is wide-ranging, with major efforts in human performance, force health protection, and en route care. **OVERVIEW:** The United States Air Force School of Aerospace Medicine (USAFSAM) is a part of the 711HPW within AFRL. Headquartered at Wright-Patterson Air Force Base with five geographically separated units, USAFSAM employs over 600 active duty and civilian members. USAFSAM is a unique institution; in addition to containing the U.S. Air Force aeromedical research laboratory; USAFSAM also has primary missions in education and consultation. Through these missions, USAFSAM supplies the Air Force with four broad capabilities: Aerospace and Operational Medicine; public health and preventive medicine; occupational and environmental health; and en route care and expeditionary medicine. USAFSAM has a long history of excellence; established in 1918, it has played a central role for the Army Air Corps and the U.S. Air Force for 100 years. As an educational institution, USAFSAM offers training for all "Team Aerospace" career fields through 80+ courses and graduates over 4000 students per year. Internationally, USAFSAM has educated students from over 130 countries since 1923. As a center of aeromedical expertise, USAFSAM conducts a robust consultation mission, with four services completing 8800+ consults per year. **SIGNIFICANCE:** Within USAFSAM, the education, consultation, and research missions are interconnected. USAFSAM's research benefits from its organizational location within the 711HPW and connection to Navy Aeromedical Research Unit. USAFSAM research is multi-disciplinary and highly collaborative, including U.S. Department of Defense and federal agencies, multiple universities, and numerous partner nations.

**Learning Objectives:**

1. Understand the role USAFSAM plays in aeromedical research, as well as education and consultation for the Aerospace Medicine Enterprise.

### [191] AEROSPACE PHYSIOLOGY AND MEDICINE AT KING'S COLLEGE LONDON

T. Russomano, D. Gradwell, T.G. Smith and S. Harridge
*King's College London, London, United Kingdom*

*(EDUCATION - TUTORIAL)*

The Centre of Human and Aerospace Physiological Sciences (CHAPS) is a cross-disciplinary department of the School of Basic and Medical Biosciences (Faculty of Life Sciences & Medicine), Guy's Campus of King's College London (KCL). It is the largest such grouping within the UK. CHAPS research addresses fundamental questions regarding human physiological function and adaptation in health, disease and aerospace and extreme environments. Its activities focus on 4 overlapping areas: Aerospace and Extreme Environment; Muscle: Form and Function; Movement, Function and Behavior; Respiratory Physiology and Medicine. CHAPS has pioneered the establishment of aerospace medicine as a clinical specialty within the UK, as well as the first aerospace medicine clinic. CHAPS' academic activities are based on integrative and translational research conducted in collaboration with other groups within KCL and King's Health Partners (one of five accredited Academic Health Sciences Centers in England), and externally with partners including the UK Royal Air Force Centre of Aviation Medicine and European Space Agency, which facilitates delivery of both research and post-graduate teaching. The laboratories are equipped with tools for a range of human physiological research (muscle, cardiovascular and metabolic systems) and has the biomedical capability for an array of ground-based analogues of microgravity (e.g., hyper buoyancy floatation) and aerospace conditions (e.g., tilt-table; climatic chamber with hypoxic capability). Our center delivers a unique portfolio of post-graduate programs. Science students can undertake a one-year full-time MSc program in Human & Applied Physiology or Space Physiology & Health. Medical doctors may study for the Diploma in Aviation Medicine (DAvMed) awarded by the Royal College of Occupational Medicine, as well as a KCL Diploma or MSc in Aerospace Medicine. We have PhD students from different countries and our MSc students can undertake their research projects at our international partner institutions. CHAPS is an academic teaching and research center which strives for excellence in the areas of human physiology, aerospace medicine and space physiology. Its portfolio of post-graduate programs is unique and in the most recent evaluation of its research (REF 2014), 82% of its research outputs were judged as world-leading or internationally excellent.

**Learning Objectives:**

1. To understand the nature and purpose of interdisciplinary academic activities and research in human physiology, space life sciences and aviation medicine.
2. To present the rationale supporting cross-translational physiological and biomedical research and development in the UK academic system.
3. To discuss collaborative efforts related to international collaboration in space life sciences and aviation medicine.

***Tuesday, May 08*** ***2:00 PM***
***Senators***

## S-041: PANEL: AEROSPACE MEDICINE BOARD REVIEW SERIES #2

*Sponsored by ASAMS*

**Chair: Timothy Burkhart**
*Annapolis, MD*

**PANEL OVERVIEW:** The Aerospace Medicine Board Review series will review core topics in Aerospace Medicine and is designed to prepare Aerospace Medicine specialists for the ABPM re-certification exam. Topics are presented in three sessions, adhere to the ABPM Study Guide Outline, and intended to cover its entirety over the course of three consecutive years. Combined with the annual RAM Bowl and Aerospace Medicine Grand Rounds sessions, these board review sessions will address preventive medicine core topics along with core knowledge areas of Aerospace Medicine. This panel will cover essential elements of Health Exposures (vibration), Neoplastic Diseases (epi, screening, prevention), and Aviation Organizations and Functions.

### [192] AEROSPACE BOARD EXAM REVIEW - HEALTH EXPOSURES: VIBRATION

A.L. Solis
*Naval Aerospace Medical Institute, Navy Medicine Operational Training Center, Pensacola, FL*

*(EDUCATION - TUTORIAL)*

Health Exposures to the Aerospace community include Vibration and Toxic Exposures, the Aerospace Medical professional should be aware of the health effects of the exposures in order to recognize the symptoms associated with the exposure as well as the mitigation measures in order to provide appropriate care to the aviation personnel.

**Learning Objectives:**

1. The participant will be able to Define Vibration.
2. The participant will be able to identify disorders caused by Vibration.
3. The participant will be able to describe the operational implications of vibration exposure.

***Tuesday, May 08*** ***4:00 PM***
***Ballroom D***

## S-042: PANEL: PILOT-PHYSICIANS: WHAT HAVE YOU DONE FOR ME LATELY?

*Sponsored by IAMFSP*

**Chair: Christopher Backus**
*Joint Base Maguire-Dix-Lakehurst, NJ*

**Chair: William Smith**
*Clovis, NM*

**PANEL OVERVIEW:** The synergy of multidisciplinary problem solving is central to solving complex aeromedical issues. Pilot-physicians are an important component of aerospace medicine teams in both civilian and military settings as they merge two disciplines as pilots and physicians, allowing thorough integration in one person, leading to a deep experiential synergy. Their dual qualifications as both pilots and physicians make them subject matter experts on optimizing human performance in aircraft on which they are qualified to fly, as well as other aircraft with similar mission capabilities. This panel will present case studies that demonstrate unique contributions made by pilot-physicians in both military and civilian organizations. The presentations will demonstrate how pilot-physicians seamlessly integrate with inter-disciplinary teams due to their dual qualifications in both medical and operational environments. The resulting contributions optimize human performance & operational effectiveness and, as a result, make important contributions to the body of knowledge Aerospace Medicine and optimization of Human Performance.

### [193] THE USAF PILOT-PHYSICIAN PROGRAM: APPLYING HUMAN SYSTEMS INTEGRATION PRINCIPLES TO OPTIMIZE AIRMAN PERFORMANCE.

W. Mueller
*U.S. Air Force, Falls Church, VA*

*(EDUCATION - CASE STUDY HUMAN PERFORMANCE)*

**PROBLEM STATEMENT:** This talk will describe how the USAF Pilot-Physician Program helps achieve synergy with other aerospace medicine professionals by applying principles of Human Systems Integration (HSI) to optimize human performance in weapon systems to which they are assigned. **BACKGROUND:** The USAF Pilot-Physician Program is an integral part of the USAF Aerospace Medicine Enterprise and provides dual-rated officers who serve as subject matter experts in the operational missions and weapon systems to which they are assigned. As a result of this blended expertise, pilot-physicians are well-positioned to identify human-centric capability gaps in their respective mission sets. By applying principles of HSI, Pilot-Physicians work with other aerospace medicine professionals, MAJCOM requirement directorates, and the Air Force Acquisition & Sustainment Enterprise to solve these capability gaps and optimize human performance in the

accomplishment of Air Force missions. **CASE PRESENTATION**: The USAF Pilot-Physician program and HSI execution strategy will be presented to demonstrate how the Air Force Medical Service leverages Pilot-Physician expertise across mission sets, MAJCOMs, and Weapon System Program Offices. Examples of how pilot-physicians work with multidisciplinary teams to solve complex aeromedical issues will be presented, to include returning the F-22 to its full operational capability, fielding full-coverage G-suits, and identifying hypocapnia as an important consideration in investigation unexplained physiologic events. **OPERATIONAL RELEVANCE:** The USAF is powered by airmen and fueled by innovation. In order to maximize the effectiveness of the weapon systems that deliver global reach, vigilance, and power for America, the human performance of Air Force airmen operating these systems must be optimized. The blended aeromedical and operational expertise delivered by the USAF Pilot-Physician Program helps achieve this vision for the USAF.

**Learning Objectives:**

1. Attendees will learn how the USAF Pilot-Physician Program works with medical and operational professionals to achieve synergy in solving complex aeromedical operational problems by the application of HSI principles.
2. Attendees will be able to describe the principles of Human Systems Integration (HSI) and be familiar with its nine domains.
3. Attendees will become familiar with examples of how HSI principles were applied by USAF Pilot-Physicians to solve selected aeromedical operational problems.

## [194] USAF PILOT-PHYSICIAN PROGRAM PERSONNEL RECRUITMENT, RETENTION, AND SUSTAINMENT

J.S. Woolford
*U.S. Force, Baltimore, MD*

*(EDUCATION - CASE STUDY HUMAN PERFORMANCE)*

**PROBLEM STATEMENT:** The goal of the USAF Pilot-Physician Program is to prevent human performance and man-machine interface problems from reaching mature operational systems. Accordingly, the program director strives to maintain a validated manning requirement of 24-28 pilot-physicians, each dual-qualified as both operational pilots and aerospace medicine physicians. However, the current roster of active pilot-physicians is not sufficient; the program is less than 50% staffed. The purpose of this presentation is to offer potential solutions to resolve this human resource shortfall by implementing a combination of recruitment, retention, and sustainment initiatives intended to meet and exceed ideal staffing requirements. **BACKGROUND:** Paradoxically, as fifth-generation fighters favorably alter the balance of airpower, human physiology threatens to limit their employment. At an increasing rate, aerospace medicine specialists in general, and pilot-physicians in particular, are tasked to evaluate physiological concerns adversely affecting the operational capability of various manned aircraft. Physiological issues believed mitigated decades prior have re-emerged, requiring renewed focus on classic phenomena including acceleration/absorptive atelectasis and 'hypoxia-like' symptoms. Given both of Lockheed Martin's multi-billion dollar fifth-generation fighter programs, the F-35 "Lightning II" and the F-22 "Raptor", are manufactured only as single-seat variants, the value of a qualified pilot-physician to the modern aerospace medicine research enterprise is beyond question. However, grooming each pilot-physician requires significant government investment in terms of time and money, the precise amounts depending upon their assigned weapon system. This is an enormous public investment, and therefore it is critical that each pilot-physician is focused solely upon human factors issues that only these dual-rated officers can credibly address, and their skills are needed more now than ever. **OPERATIONAL RELEVANCE:** If the USAF Pilot-Physician Program is to maximize its unique potential as a critical force-multiplier during this era of high-visibility aerospace acquisition and concomitant sequestration, the program director must implement new recruitment, retention, and sustainment policies designed to remedy the program's chronic personnel shortfall in order to validate its strategic importance in support of the United States' vital national interests.

**Learning Objectives:**

1. Appreciate the potential 'return on investment' of a properly utilized USAF pilot-physician.

## [195] A PRELIMINARY REVIEW OF THE CIVILIAN AIRLINE PILOT-PHYSICIAN ROLE: BENEFITS AND CHALLENGES

A. Schiemer
*Australasian Society of Aerospace Medicine, Sydney, Australia*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Civilian airline pilot-physicians are few in number but provide a unique perspective on both the pilot role and that of the aviation medical examiner, particularly the relationship between the two. Often however, there is limited input from employers to simultaneously progress both careers. A survey was undertaken of past and current airline pilot-physicians in an attempt to quantify benefits to the member and employer, as well as identify the career challenges involved. **METHODS:** Multiple airline pilot-physicians at varying stages of either their medical or flying career were identified, and their responses to a questionnaire collated. Questions specifically related to career progression, medical and flying training were provided, as well as personal opinions relating to the dual role being discussed. Further questions on input received from respective employers regarding the perceived benefits and/or detriments were also included. **RESULTS:** The results identified several common benefits, particularly those surrounding the improvement in understanding the flight environment and the relevant stressors involved. Such exposure for an aviation medical examiner was noted to be highly useful by several responders. Common difficulties identified included time constraints in maintain flying currency whilst progressing a demanding medical career. **DISCUSSION:** At the time of writing, there were no established civilian training programs for pilot-physicians in major airlines across the globe. Current roles vary depending on the individual and the airline, and those pilot-physicians succeeding in such positions mostly do so via marked personal efforts to qualify and maintain a dual currency. Whilst the preliminary information obtained has identified key commonalities with regard to the role itself and the benefits to an airline, further study is required from the employer perspective, particularly when looking at the potential development of formalised airline pilot-physician programs in the future.

**Learning Objectives:**

1. Identify the potential benefits to an employer provided by a civilian pilot-physician in an airline setting.

## [196] MUSCULOSKELETAL OPTIMIZATION TO ENHANCE MISSION EFFECTIVENESS

C. Borchardt
*U.S. Air Force, Fort Walton Beach, FL*

*(EDUCATION - CASE STUDY HUMAN PERFORMANCE)*

**PROBLEM STATEMENT:** This case report highlights the analysis and interventions suggested to improve USAF U-28 mission effectiveness by responding to the increased healthcare needs of aircrew caused by awkward posturing during prolonged missions in suboptimal ergonomic conditions. **BACKGROUND / LITERATURE REVIEW:** Numerous Air Force missions take place in aircraft not originally designed for the missions they are being utilized for. This often means crew positions are not ergonomically optimized to provide a comfortable workspace for long durations experienced during reconnaissance missions. Pilot-Physicians are in a unique position to both participate in the mission and clinically capture the aircrew's increased healthcare utilization that result from sub-optimal aircraft ergonomics. Pilot-Physicians can therefore provide valuable feedback, analysis, and ideally interventions to improve the aircrew's workstations, performance, and mission effectiveness. **CASE PRESENTATION:** A multidisciplinary approach to increased musculoskeletal complaints among USAF U-28 aircrew was applied to improve crew comfort and mission effectiveness. This effort included dedicated physical therapy support in response to increased flight medicine presentations, surveys to assess the incidence and prevalence of symptoms among squadrons, in-flight assessment of crew conditions by pilot-physicians, and an ergonomic assessment performed by the 711th Human Performance Wing. The ergonomic assessment was correlated with survey and clinical presentation data to provide leadership with actionable recommendations that contrasted various workstation changes with the corresponding expected improvements in health and mission effectiveness.

**OPERATIONAL / CLINICAL RELEVANCE:** This case demonstrates the valuable relationship between operational medicine professionals and the missions they support. Pilot-physicians can bridge the clinical and operational environments which provide opportunities for early identification of operational challenges that can effect heath. Pilot-physicians are also often uniquely positioned to enlist the support of organizations like the 711th HPW to build effect multidisciplinary teams of professionals that do not exist at most operating locations. This U-28 effort provides a template that is intended to be utilized in other recently identified challenging missions that result in disproportionate healthcare utilization and decreased mission effectiveness.

**Learning Objectives:**

1. Become familiar with the impact of an effective multidisciplinary approach to USAF musculoskeletal challenges experienced in small aircraft packed with equipment and operators whose posture is suboptimal due to cramped physical confines. Examples of team composition and their contributions will be provided to include pilot-physicians, anthropomorphic professionals, and physical therapists.

### [197] NARCISSISTIC PERSONALITY DISORDER IN AN AIRCREW CANDIDATE

M.F. Harris
*Aerospace Medicine, Mayo Clinic, Rochester, MN*

*(EDUCATION - CASE STUDY HUMAN PERFORMANCE)*

**PROBLEM STATEMENT:** Narcissistic Personality Disorder, a disqualifying criterion, may not be identified when assessing candidates for aircrew selection. **BACKGROUND/ LITERATURE REVIEW:** The potential for personality disorders to affect flight safety and mission completion should be widely considered. Currently, the DOD and the FAA recognize personality disorders as unsuiting for aviation duty. The symptoms may affect judgment, interfere with CRM and adversely affect individuals' ability to adapt to stressful situations. **CASE PRESENTATION:** A 26 year old member was applying for an aircrew position. The member had been in an MVA 1.5 years prior to presentation with severe injuries and complications during recovery. The patient did recover and was found retainable for military duty in current AFSC of Maintenance. The airman presented for a physical to become a loadmaster. The application was complicated by extensive medical records. During this time, the member demonstrated behaviors far outside the norm for a candidate competing for an aircrew position. Discussions with the commander brought to light that the member had been denied re-enlistment in the current AFSC. A history of entitlement, exaggerated self-importance, manipulation of others, expectation of favors and over-stating achievements was also revealed. These reports were consistent with the behavior during the records review. My experience as a pilot alerted me to the danger this type of behavior could cause to mission safety. I decided that the physical could not be granted due to Narcissistic Personality Disorder. **OPERATIONAL/ CLINICAL RELEVANCE:** This case highlights the difficulty with personality disorders and aircrew selection. Had there been no past medical history to prolong the case, the personality disorder would have not have come to this author's attention. Had I not previously been a pilot, I would not have understood the implications of this disorder and the crew environment. The use of manipulation for personal gain coupled with the reactions of rage and contempt when dealing with criticism could compromise flight safety in normal ops and emergency situations. Personality disorders are difficult to recognize in the short period that Flight Surgeons have with a candidate but it should be treated as any other disqualifying condition. This case illustrates the need for awareness of Personality Disorders for Flight Surgeons when assessing the fitness for duty of candidates.

**Learning Objectives:**

1. Identify difference between narcissistic personality traits and narcissistic personality disorder in aircrew.
2. Evaluate suitability for aircrew duty applicants who meet physical standards but demonstrate behavior far outside the norm for typical candidates.
3. Communicate reasons for disqualifying a candidate for behavioral issues indicative of personality disorder pathology.

***Tuesday, May 08*** ***4:00 PM***
***Ballroom E***

## S-043: PANEL: PROCESS IMPROVEMENT AND THE FUTURE OF OUR MILITARY MEDICAL SYSTEM: JUNIOR FLIGHT SURGEONS LEADING ANALYTICAL THINKING

**Chair: Charles Clinton**
*Xenia, OH*

**Chair: Kenneth Taylor**
*Columbus, MS*

**PANEL OVERVIEW:** The rapidly changing operational environment that the military operates within drives a unique set of requirements to sustain superior performance. Our medical system is very different from the civilian system, and our previous history and current training process demonstrates our unique outlook on medicine. In this panel, junior flight surgeons will present their views on specific sectors within the Air Force's flight medicine environment. We will demonstrate that the operational necessities of yesterday are no longer relevant and provide a forum to discuss the operational necessities of today and how Flight Surgeons can most effectively tailor our medical system to meet those needs. Our first presentation will continue in the theme from the Junior Flight Surgeon's panel, which we hope to host directly before this panel. A flight surgeon from Duke Field will present a case report of an AFSOC U-28 pilot who suffered an idiopathic deep venous thrombosis (DVT) and the management of DVT as it relates to long flights and how the aviator was able to be returned to flying status. Our second presentation begins the exploration of the future of our military medical system with another AFSOC flight surgeon from Cannon AFB who will discuss his experiences as the coordinator for the 2017 IDMT rodeo. He will discuss major shortcomings and epidemiological data. Our third presentation will be a descriptive study of General Medical Officer (GMO) usage at two UPT bases: Laughlin AFB and Columbus AFB. This will examine how GMOs are currently being used in our Air Force system and will pose the question of whether this use is appropriate. Our final presentation will be a debate in which two chief flight surgeons will debate two GMO flight surgeons. The main discussion question will be "Should general medical officers continue to exist in military medicine?" Each side will present the pros and cons of GMO use from a medical, economic, political, and practical perspective.

### [198] DVT IN A SPECIAL OPERATIONS PILOT--CONSIDERATION FOR ALTERNATIVE ANTICOAGULATION

M. Byrne[1] and E. Reddis[2]
*[1]OSM, 1st Special Operations Support Squadron, Mary Esther, FL;*
*[2]AMDS, 1 Special Operations Medical Group, Hurlburt Field, FL*

*(EDUCATION - CASE STUDY CLINICAL)*

**PROBLEM STATEMENT:** This case reports describes a military fixed-wing pilot who experienced a recurrent spontaneous DVT with significant relief with a novel anti-coagulant. **BACKGROUND / LITERATURE REVIEW:** Manned ISR aircraft are an important component of the Air Force Special Operations involvement in deployed operations. Long duration sorties comprised of loitering and observing in the U-28A/PC-12 can predispose aircrew to the sequelae from venous stasis. **CASE PRESENTATION:** The patient is a 38 year old previously healthy male U-28A pilot with over 4,000 flying hours. He was in his usual state of health when he noted some initial pain in his right calf that felt like a muscle strain. The only recent change in his health or activity was an Anthrax vaccination for an upcoming deployment. However, over 2 weeks, this pain progressed to swelling with redness and pain extending up to his right thigh, causing him to limp. He presented to the Emergency Department for evaluation and was found to have a right lower extremity deep vein thrombosis involving the superficial femoral and popliteal veins. He was started on Rivaroxaban at that time and noted nearly immediate improvement in his symptoms, with complete resolution after several weeks. There were no predisposing risk factors, such as any

surgeries, supplements, is a non-smoker, and no family history of blood clots. Hyper-coaguability work up with a local Hematologist was unremarkable. He completed a trial of anti-coagulation on Rivaroxaban for 3 months, and upon discontinuation, noted a return of his symptoms. At this point, a repeat US noted continued DVT in the same area. He was continued on Rivaraoxaban for an additional 3 months, however after 2 weeks of cessation, had a recurrence of his pain, requiring re-start of anti-coagulation for life. **OPERATIONAL / CLINICAL RELEVANCE:** This case highlights the point that healthy aircrew are susceptible to deep vein thromboses which are amenable to treatment with novel anti-coagulants. Traditional Vitamin K Antagonists such as warfarin are historically the accepted aeromedically waiverable medication for DVT, however with the minimal side effects and continued safety associated with novel anticoagulation medications (NoACs), we suggest that flight surgeons advocate for their use in the appropriate patient population. **Sources:** Kearon C, Akl E, Ornelas J et al. Antithrombotic Therapy for VTE Disease CHEST Guideline and Expert Panel Report. *CHEST.* 2016; 149(2): 315-352

**Learning Objectives:**

1. The participant will be able to understand that treatment of unprovoked Deep Vein Thrombosis is amenable to traditional as well as novel anti-coagulants, with medication choice guided by expert guidelines.
2. The participant will be able to understand the difference in monitoring of different anticoagulant agents and the potential implications on a flyer's availability.

### [199] PERFORMANCE ASSESSMENT ON THE EFFECTS OF STRESS ON SABC AND TCCC TRAINED MEDICS

P. Hendley
*Cannon AFB, NM*

*(ORIGINAL RESEARCH)*

Air Force medics host a vital role in the Department of Defense medical system; however, their utilization down-range versus home station differs drastically. Cannon AFB hosts an annual competition for Air Force medics to come together at the EMT Rodeo and showcase their skills. At the 2017 competition a majority of the teams struggled to perform basic medical tasks under normal combat stressors (weather, noise, hostile fire, etc.). This ongoing study is aimed to isolate the difference between the self-aid buddy care and tactical combat casualty care trained medics and their ability to work under combat stressors. Participants will be assessed for their abilities to manage hemorrhage with time to tourniquet, secure an airway, and achieve vascular access in both a lab and in a combat stressed environment. Training is paramount to readiness; therefore, it is vital to understand which training practices prepare our medics to perform at the highest possible effectiveness.

**Learning Objectives:**

1. Differentiate any training practices that best prepare medics to work under stress.

### [200] SPECIALIZED UNDERGRADUATE PILOT TRAINING BASE FLIGHT AND OPERATIONAL MEDICINE PROGRAM REVIEW

P. Moore
*Flight Medicine, Laughlin AFB, TX*

*(EDUCATION - PROCESS)*

**MOTIVATION:** The 2016 AETC Strategic Plan places Air Education and Training Command as "the foundation of airpower for America." In the face of an Air Force pilot shortage, the Specialized Undergraduate Pilot Training (SUPT) mission of AETC is critical for the foundation of American airpower. This presentation will review the Flight and Operational Medicine (FOM) program at an AETC SUPT base, Laughlin AFB, in order assess support of the AETC mission. **OVERVIEW:** Laughlin AFB is an SUPT base with the mission to "Graduate the World's Best Military Pilots." This presents one of the most demanding flight medicine environments with an average of 1067 sorties every week. Additionally, approximately half of the pilots at Laughlin AFB are Flying Class I, representing a higher medical standard to maintain flying status. There is a significant financial and time investment placed in each Student Pilot necessitating this higher standard. Important decisions are made at Laughlin AFB with each class of students every three weeks about whether to medically recommend proceeding with this initial investment. Decisions of this magnitude require both general medical knowledge and flight medicine experience. Historically, there have been gaps in the experience levels of flight surgeons at Laughlin AFB, leading to periodic degradation in the FOM program. **SIGNIFICANCE:** Any degradation in the FOM program at Laughlin AFB or at any other SUPT base has the potential to have critically adverse operational significance. A trend of placing predominantly junior flight surgeons at Laughlin AFB is an area that could be addressed to maintain a robust FOM program in order to sustain quality in one of the most demanding flight medicine environments.

**Learning Objectives:**

1. Recognize the importance of experienced flight surgeons at AETC SUPT bases.

### [201] *A DEBATE ON THE FUTURE OF THE GMO FLIGHT SURGEON*

K.R. Taylor[1], R. Bachmann[1], C. Fisher[2] and J. Sterett[3]
*[1]Flight Medicine, 14th Medical Group, USAF, Columbus, MS; [2]Premise Health, San Antonio, TX; [3]Colorado Department of Corrections, Colorado Springs, CO*

*(EDUCATION - PROCESS)*

**MOTIVATION:** In the face of medical sub-specialization in the last 50 years and the rise in prevalence of Independent Duty Medical Technicians (IDMTs), Independent Duty Corpsmen (IDCs), Nurse Practitioners (NPs) and Physician's Assistants (PAs), many have wondered if the future of the Air Force is turning away from the General Medical Officer (GMO). In the face of the 2017 GMO pay cuts under the new Consolidated Special Pay (CSP) and the loss of the priority that GMOs previously held in the Joint Service Graduate Medical Education Selection Board (JSGMESB) that took effect this application cycle, many perceive that the military may be phasing out GMOs. **OVERVIEW:** GMOs comprise a large percentage of flight medicine assets across the United States Air Force, Navy, and Marine Corps. GMOs have been so heavily used to fill the severely undermanned career field of board certified flight surgeons that GMOs have become a commodity themselves. Currently, the Navy is so critically undermanned in GMO spots that 100% of interns must re-match to residency slots and those that choose flight medicine have a minimum 3 year mandatory service before re-applying to JSGMESB. The Air Force has hundreds of flight surgeon spots across the system, most of which are filled by GMOs. GMOs are therefore the physicians that everyone needs but no one wants. This presentation will be a formal debate between Drs. Bachmann and Fisher and Drs. Sterrett and Taylor. Formal debate rules will apply with traditional point and counterpoint structure and strict time limits. Col Charles Clinton will moderate. **SIGNIFICANCE:** Requiring a huge percentage of physicians to serve a GMO tour while de-valuing the position as occurred in 2017 has a high probability of resulting in exodus of junior physicians who serve a GMO tour and then leave the military. The military must decide now if they want to replace GMOs with IDMTs, IDCs, PAs, and NPs or curb the GMO de-valuation and continue the program. This debate will be framed to answer the question "Should we continue to have GMOs in the military or not," answering the question from medical, operational, monetary, and political aspects.

**Learning Objectives:**

1. The listener will understand the pros and cons to having GMOs in the military from a medical, operational, monetary, and political standpoint.
2. The listener will be able to use the contents of the presentation to generate new discussions with colleagues.
3. This panel is designed to spark a need for change in the GMO flight surgeon pay, utilization, or existence.

***Tuesday, May 08*** ***4:00 PM***
***Wedgewood***

## S-044: SLIDE: HEARTS & MUSCLES & BONES, OH MY!

**Chair: Alex Garbino**
*Houston, TX*

**Chair: Jeff Myers**
*Merritt Island, FL*

**4:00 PM**

**[202] DEVELOPMENT AND EVALUATION OF PERFORMANCE METRICS QUANTIFYING FIT IN SPACESUIT EXO-SYSTEMS**

R.A. Fineman[1], T. McGrath[3], A.F. Abercromby[2] and L. Stirling[3,4]
*[1]Division of Health, Science & Technology, Massachusetts Institute of Technology, Cambridge, MA; [2]NASA, Houston, TX; [3]Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, MA; [4]Institute for Medical Engineering and Science, Massachusetts Institute of Technology, Cambridge, MA*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Fit is an area of the human-spacesuit interaction that is not well understood or defined, especially in how it relates to operational performance and injury risk. Current decisions regarding fit are made qualitatively by crewmembers and engineer experts during fit-checks and familiarization runs. An analysis of Mark III fit-checks revealed possible areas for quantifying fit quality. This work developed and evaluated new metrics for quantifying dynamic fit (i.e., the relative motion between the human and suit). **METHODS:** Three participants donned the Mark III spacesuit, each with three levels of indexing between the participants' lower body and the hip brief. Participants performed a walking task with inertial measurement units on the right thigh and shin of both the human and suit. Heel-strike, stance, toe-off, and swing were identified for each step and the relative coordination metric (RCM) was computed between the human-suit thigh and shin. A PCA method was used to estimate human and suit knee angles. A Bland-Altman analysis was used to analyze these angle differences. **RESULTS:** All three participants had significant main effects of indexing and gait phase on RCM values at the thigh and shin. Participants 2 and 3 human and knee angles had decreased RMSE with increased indexing using the Bland-Altman method. Participant 1 had the opposite effect (increased RMSE with decreased indexing). **DISCUSSION:** From the RCM analysis, the relative motion favoring the human prior to toe-off could be evidence of the feet lifting out of the boot and was observed for all subjects. While knee joint angles may be synergistic between the suit and human, other aspects of the human-suit interaction are not detected by this single metric, highlighting the complexity of quantifying suit fit. Motion with the same human and suit knee is possible without interaction, thus there can be a relative motion between the human and suit. Participant 1 had the opposite effect of indexing on knee angle from Participants 2 and 3. Since this participant performed the tasks in opposite order to the other participants, this could be evidence of fatigue as the participant fights the suit vs. synergizing with its design.

**Learning Objectives:**

1. To understand the difficulties in obtaining and quantifying what constitutes a "good" suit fit.

**4:15 PM**

**[203] THE EFFECTS OF 7 DAYS OF WHOLE BODY UNLOADING USING A HYPERBUOYANCY (HBF) FLO-TATION BED ON SKETETAL MUSCLE MASS**

T. Morris-Paterson[1], E.J. Jones[1], C. Tsai[2,3], H. Hasegawa[2,3], O. Carmichael[4], K. van Someren[5], Z. Puthucheary[6], D.A. Green[7], S.B. Zanello[1], I. Rosenzweig[2,3] and S. Harridge[1]
*[1]Centre of Human Aerospace Physiological Sciences, King's College London, Teddington , United Kingdom; [2]Sleep and Brain Plasticity Centre, Department of Neuroimaging, IoPPN, King's College London, London, United Kingdom; [3]Sleep Disorders Centre, Guy's and St Thomas' Hospital , London, United Kingdom; [4]Pennington Biomedical Research Center, Baton Rouge, LA; [5]Dept of Sport, Exercise & Rehabilitation, University of Northumbria, Newcastle, United Kingdom; [6]Institute of Health and Human Performance, University College London, London, United Kingdom; [7]KBRwyle, European Astronaut Centre, Cologne, Germany*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** The loss of skeletal muscle mass and function is one of the major outcomes of exposure to a micro-gravity (μG) environment and remains a major problem terrestrially, such as for the ageing population. A recently introduced analogue of microgravity centers on a hyper saline filled water bed (hyper buoyancy flotation, HBF) which has been shown to induce other features of exposure to μG, such as spinal extension. The aim of the present study was to determine the feasibility of undertaking 7 days of supine unloading on the HBF and to determine the effects on whole body skeletal muscle mass. METHODS: Sixteen healthy male subjects aged (26.8 ± 3.7 yrs) were recruited to the study. Six weeks prior to unloading each subject underwent a one week control period during which time their diet was controlled. Before and after the control period and at fixed time of day (08:00 to 11:00h) subjects had their total skeletal muscle mass measured using magnetic resonance imaging (Siemens MAGNETOM Verio 3T, Siemens Healthcare, Erlangen Germany). For the intervention period the subjects were asked to lie supine on the HBF for 7 days, during which time they were also fed a controlled diet. Subjects were allowed a maximum of 15 mins per day off the HBF for personal hygiene. One day prior to and within (1.5-3hrs) post unloading further MRI scans were performed for the determination of whole body skeletal muscle mass. **RESULTS:** Four subjects withdrew from the protocol prior to commencement of the unloading period for reasons not related to the study. All 12 subjects who were entered the intervention arm of the study, successfully completed the 7 day period of unloading. The control period resulted in no change in whole body muscle mass as determined by MRI (32.06±5.14 v 31.83±5.07 kg). The intervention period showed a significant ($p<0.002$) change (32.19±5.33 v 31.25±5.33 kg) (ANOVA with repeated measures, followed by Tukey post hoc test). **DISCUSSION:** The HBF was shown to be a well-tolerated and feasible model for longer-term studies of unloading. Seven days of unloading was sufficient to induce a small, but significant, loss of skeletal muscle mass.

**Learning Objectives:**

1. Understand the accuracy of three methodologies to measure induced muscle atrophy.

**4:30 PM**

**[204] NOVEL FRACTURE MANAGEMENT OPTIONS DURING SPACEFLIGHT**

T. Swaffield[2] and K.R. Lehnhardt[1]
*[1]Department of Emergency Medicine, George Washington University, Washington, DC; [2]The George Washington University School of Medicine and Health Sciences, Washington, DC*

*(EDUCATION - PROCESS)*

**MOTIVATION:** It is well known that bone mineral density (BMD) decreases during long-duration spaceflight. While the risk of bone fracture in a microgravity environment is believed to be low, the potential risk for fracture increases upon re-entering a gravity environment such as the Moon or Mars. The purpose of this study was to identify novel methods to treat a fracture if one were to occur during an exploration mission. **OVERVIEW:** In addition to standard non-operative management modalities such as splinting, pulsed electromagnetic field (EMF) therapies have been used on Earth to treat delayed union or nonunion fractures, possibly reducing time to bone union. During a long-distance space mission, EMF therapy could play an important role in promoting fracture healing given its safe and noninvasive approach. Another promising, non-invasive therapy is low intensity pulsed ultrasound (LIPUS). LIPUS is a form of mechanical energy that can be transferred into living tissue as high frequency pressure waves, resulting in biochemical changes at the cellular level that promote fracture healing. In addition, intermittent PTH injections have anabolic properties, stimulating skeletal remodeling and increasing BMD. When coupled with LIPUS, data has shown this promotes tissue repair and regeneration, enhances bone formation, and accelerates bone fracture healing. In the event of a complicated fracture, surgical intervention with a universal external fixation device is a potential solution. External fixation is likely more ideal than internal fixation in spaceflight as it eliminates the need for open surgery and can reduce surgical morbidity given its minimally invasive approach. **SIGNIFICANCE:** A variety of novel treatment strategies for potential fractures during spaceflight are being explored and studied. Some of these methods may be essential to fully develop for future successful exploration missions, given that a fracture could have a detrimental impact on the crew's ability to perform their duties. These innovative strategies for fracture treatment

may not only benefit future astronauts, but may also influence fracture management protocols on Earth.

**Learning Objectives:**

1. At the end of this presentation, audience members will be able to outline innovative strategies to manage a fracture during a space exploration mission.

### 4:45 PM
### [205] ISS CREWMEMBER AEROBIC CAPACITY COMPARED WITH METABOLIC COST OF SIMULATED EXPLORATION EXTRAVEHICULAR ACTIVITY

M. Downs
*Human Physiology, Performance, Protection, and Operations, KBRwyle, Seabrook, TX*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Human spaceflight will soon transition from 5-6 month stays on the International Space Station (ISS) to exploration class missions that may include up to 1,000 days aboard vehicles with limited exercise capabilities. The primary goal of current exercise countermeasures has been to maintain preflight aerobic capacity while on ISS or to return to preflight levels as soon as possible after landing, but this may not be sufficient to ensure success during exploration class missions with longer durations, more physically demanding extravehicular activities (EVA), and concluding with capsule water landings from which crewmembers must be able to perform unassisted egress. **PURPOSE:** To compare recent ISS astronauts' in-flight $VO_2$peak levels with those required for effective performance of exploration EVA tasks. **METHODS:** Maximal oxygen consumption ($VO_2$peak) of recent ISS astronauts, measured before, during, and after flight (N=11), was compared with: a) measured $VO_2$ during ISS EVAs (N=23); and b) $VCO_2$ measured while performing a variety of exploration ambulatory and stationary tasks wearing a planetary spacesuit prototype in simulated lunar and Mars gravity (N=6). **RESULTS:** $VO_2$peak (mean ± SD; L/min): Preflight = 3.1 ± 0.5; Flight Day 45 = 2.8 ± 0.5; postflight = 3.1 ± 0.4. ISS EVA $VO_2$: EVA average = 0.7 ± 0.1; maximum 2-minute average = 1.4 ± 0.2 modeled lunar EVA average = 1.5 ± 0.2 with peak values at 1.8. Mars EVA average = 1.7 ± 0.6 with peak values of 2.8. **DISCUSSION:** The metabolic cost of ISS EVAs is significantly less than those measured during simulated exploration EVAs. Maximum workloads in simulated Mars EVAs require metabolic effort close to the average $VO_2$peak levels measured on Flight Day 45 in recent ISS astronauts, and exceed the aerobic capacity of some crewmembers. For most individuals with fitness levels similar to the astronaut corps work rates above 65% of $VO_2$peak cannot be sustained for prolonged durations. The aerobic metabolic demands of planetary EVA exploration and water landing capsule egress necessitate further study. Specifically, consideration for countermeasure and fitness for duty standards development should be targeted towards performance of expected tasks rather than maintenance of preflight fitness.

**Learning Objectives:**

1. Highlight the importance of understanding mission critical exploration task and water landing metabolic requirements in order to provide fitness for duty standards and exercise countermeasure requirements.

### 5:00 PM
### [206] SETTING A VO2 MAX STANDARD FOR NASA ASTRONAUTS DURING SPACEFLIGHT

V. Shahi[3], D. Reyes[2], R.A. Scheuring[1] and E.L. Kerstman[2]
*[1]Space Medicine, NASA Johnson Space Center, Houston, TX; [2]Preventive Medicine and Community Health, UTMB, Galveston, TX; [3]Department of Emergency Medicine, University of California at Los Angeles, Los Angeles, CA*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Aerobic fitness is best measured by maximal aerobic capacity or VO2 Max that is defined as a measure of oxygen utilization and transport. Increased VO2 Max indicates improved oxygen consumption during high-level exercise; it is widely accepted as a predictor of an individual's likelihood of successfully completing a demanding task. As such, agencies and organizations have adopted VO2 Max as part of a comprehensive set of physical requirements. This study reviews the literature and existing medical and occupational VO2 Max data to inform a VO2 Max standard for NASA astronaut training and spaceflight activities. **METHODS:** To identify studies on VO2 Max standards, guidelines, and approaches, three databases were searched from 1970 to 2017: Ovid MEDLINE, Ovid EMBASE, and Web of Science. Identified studies were further evaluated for inclusion in the literature review. Studies pertaining to VO2 Max, and aerobic fitness standards and guidelines from various professions were included. **RESULTS:** Normative data in a large, healthy population conducted in Europe suggests an average VO2 Max of 47.2 ml/kg/min and 38.4 ml/kg/min in men and women, respectively. High endurance athletes can achieve VO2 Max upwards of 70. Firefighter literature suggests an average VO2 Max for fire fighters of between 37.4 – 39.4, with 28.0 – 33.5 as the lower suggested cutoff for performance-specific tasks. Similarly, commercial diving literature suggests a minimum VO2 Max ranging from 35 to 45.5. Extravehicular activity (EVA) data from NASA missions suggest 32.9 as an acceptable task-based aerobic capacity. **DISCUSSION:** Energy expenditure is dependent on intensity of the activity and the activity itself; thus, VO2 Max provides a marker of an individual's *fitness* to complete a given task. Although aerobic fitness is just one parameter necessary for astronaut success in performance of specific tasks, other factors held constant, increased work capacity may be achieved in those with greater aerobic capacity, thus allowing for higher sustained workload and margin of safety. Setting a VO2 Max standard for astronauts will become particularly important as NASA begins to explore beyond low Earth orbit.

**Learning Objectives:**

1. Understand the existing medical and occupational VO2 Max data and how it can be applied to NASA astronauts.

### 5:15 PM
### [207] VEHICLE RESTRAINT CONSIDERATIONS FOR COMMERCIAL SPACECRAFT

L. Speicher[1], R.S. Blue[2] and J. Vanderploeg[2]
*[1]Executive Medicine, Mayo Clinic, Jacksonville, FL; [2]PMCH, UTMB, Galveston, TX*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** There are currently no direct regulations and few guidelines regarding restraint design for commercial spaceflight vehicles. Operators designing vehicles intended solely for private commercial use, particularly short-duration suborbital flights, have questioned the need for 5-point restraints, instead considering the options of fewer restraints and less stringent application requirements. We sought to identify risks and benefits of alternative restraint designs for the commercial spaceflight industry, particularly for the diverse population of commercial spaceflight participants. **METHODS:** A systematic review was conducted on currently available information and published literature of human and animal studies as well as industry standards regarding restraint design, common injuries and patterns of injuries in vehicular trauma, including automobile, aircraft, and spacecraft. **RESULTS:** While data are lacking regarding commercial spacecraft or potential mishap forces, extensive studies are available in analogue environments, including motor vehicle crashes and aviation mishaps, that demonstrate variations of restraint design and relative risks and benefits of these systems. These studies demonstrate superiority of harnesses that include shoulder restraint and a negative-G (crotch) belt to limit torso movement. Injury patterns in anthropometrically varied populations, with factors including sex, obesity, and advanced age, demonstrate increased vulnerability to morbidity and mortality in obese and elderly populations and improved outcomes with more rigorous restraint designs. **DISCUSSION:** Given the varied population anticipated for commercial spaceflight participants and significant reduction in morbidity and mortality associated with 5-point restraint designs, evidence suggests that the use of a 5-point restraint is most appropriate for commercial spacecraft.

**Learning Objectives:**

1. Understand how various restraint designs, including a 5-point harness system, may mitigate injuries in commercial space flight participants.

***Tuesday, May 08*** ***4:00 PM***
***Ballroom B***

## S-045: PANEL: HELICOPTER SEATING FACTORS AND THEIR RELATIONSHIP TO SPINAL PAIN AND OCCUPANT SAFETY

*Sponsored by Science and Technology Committee*

**Chair: Carol Chancey**
*Fort Rucker, AL*

**Chair: Barry Shender**
*Patuxent River, MD*

**PANEL OVERVIEW:** The prevalence of spinal pain in helicopter aircrews has been extensively documented. Potential causes have included head-supported equipment, non-ergonomic seating, long duration missions, and environmental stresses (e.g., vibration). However, the relative contribution of these factors remains unclear. Ideal seating designs should not only provide musculoskeletal support, they must limit severe injury risk during a crash. These two design goals may conflict, with the latter criteria historically taking precedence. This panel explores issues related to rotary-wing aircraft seat design and presents some new data and techniques for studying low back pain. We open the panel with a discussion of knowledge gaps for design of crash protection technologies. Next, is a study that quantified changes in posture ("helo-hunch") with subjective pain. The third presentation provides insight into the question of whether EMG can be used as an indicator of neck pain after impact loading. This is followed by a description of a computational model to predict muscle effort and fatigue that will provide insight into future seating designs. The panel closes with a mitigation study that evaluates three potential lumbar support designs.

### [208] KNOWLEDGE GAPS IMPACTING DESIGN OF ROTORCRAFT CRASH-PROTECTIVE HARDWARE

L.W. Bark[1] and H. Sulpizio[2]
*[1]Human Systems, Naval Air Warfare Center Aircraft Center Aircraft Division, Patuxent River, MD; [2]CHSCWL, U.S. Navy, Norfolk, VA*

*(EDUCATION - TUTORIAL)*

**PROBLEM STATEMENT:** Knowledge voids in acute and chronic injury complicate the design of next-generation crash-protective systems for rotary wing aircraft. **TOPIC:** Crash-protective (CP) hardware has been used in military rotorcraft for several decades. While very effective, serious and fatal injuries continue to occur in survivable mishaps. Existing CP seating systems absorb energy in a mishap and whether the vertical crash pulse was 30g, 50g, or 75g, these systems limit occupant vertical acceleration to a nominal 14.5g. Going forward, microcontroller-based systems will actively adjust CP hardware during a developing crash pulse or deploy an active system, such as a restraint pretensioner or inflatable restraint. CP seating hardware also interfaces occupants to the rotorcraft. As such, it must support mission and career endurance of aircrew and minimize probability of chronic injury such as neck and back pain. Naval aircrew chronic injury data is often gathered from disability claims. Proper surveillance, mitigation, and prevention of chronic pain are not formalized. Lack of documentation on the prevalence, rates, and contributing factors of chronic injury has resulted in poor validation of the problem and ineffective material solutions. Knowledge voids limit design of advanced CP systems. First, crash pulses must be assessed to assure crashes and non-crash events may be discriminated. Crash recorders are under development to record actual mishap data over time. Second, documentation of field injury and causative mechanisms is needed. Mishaps are investigated with primary focus on mishap cause and prevention. Human survival investigation is often a secondary focus on what led to the outcomes for individual occupants. Advanced CP hardware design requires documentation of serious and fatal acute injuries, chronic injuries, and their root causes. This data will inform decisions on which advanced CP hardware makes sense based on patterns of injury and projected reduction of harm, how to design active algorithms, set the activation criteria, and develop the physical requirement of such a system. In short, information will enable program managers, designers, and engineers, to focus on injury mitigation that is supported by field data. **APPLICATIONS:** This topic is applicable to development of optimized endurance crashworthy seating systems, pyrotechnic pretensioners, active energy absorbers, active and inflatable restraints, newer helmet designs, and crash sensor systems.

**Learning Objectives:**
1. To understand how rotorcraft mishap injury data can be used reduce design challenges and engineering uncertainty in development of next generation crash-protective hardware.
2. To understand that mitigation of crash injury through use of advanced systems requires identification and targeting classes of injury that are typically serious or fatal.
3. To understand the important role of back and neck pain or chronic injury surveillance in the prevention and mitigation of injury as well as the validation of ongoing or future material solutions.

### [209] CHARACTERIZATION OF HELO-HUNCH

E.C. Anderson
*4.6.6.3 Crashworthiness, NAWCAD, Lexington Park, MD*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Lower back pain has historically been a problem that plagues aircrew, particularly helicopter pilots. Previous studies have qualitatively identified improper posture, known as "helo-hunch," as a main contributing factor impacting aircrew endurance. This study collected quantitative data on the occurrence and severity of helo-hunch and self-reported pain ratings. The intent was to determine if positional information could be quantitatively related to subjective pain levels reported by aircrew. **METHODS:** Seventeen subjects (14 male, 3 female) ranging in height (68.8+/- 3.5 inches) and weight (175.5 +/- 41.8 lbs.) flew a helicopter simulator for a three hour mission-representative flight, with pain ratings taken every 15 minutes. The test seat was instrumented with linear potentiometers to record pilot posture and movement. Subjects completed a back pain questionnaire and an aircrew flight experience survey. Anthropometric data for each test subject was collected before equipping them with all standard pilot flight gear (~25 lbs.). Baseline upright-symmetrical posture data was collected during the tests. **RESULTS:** Eighty-two percent of data sets collected showed clear trends between deviations from upright-symmetric posture and increased pain. Comments from subjects highlighted several ergonomic issues causing discomfort when in upright-symmetrical posture, causing them to lean forward into helo-hunch position. Shortly after entering hunched position, subjects reported an average 188% increase in pain levels. Sample size limited our ability to correlate subject size and back-pain, however subjects that claimed their seats were improperly adjusted reported greater discomfort than those with proper seat position. **DISCUSSION:** The ability to relate positional data to reported pain enables the development of quantitative metrics by which to measure the improvement of future cockpit modifications. With increased pilot workload, longer mission duration, and helicopter vibrations, aircrew endurance remains an issue of concern. In several subjects the discomfort experienced was above tolerable levels, and was noted as a very severe distraction from their task. As mission capabilities continue to expand, aircrew endurance will place major limitations on the aircrew's ability to execute the objective. This study demonstrated that, by quantifying ergonomic improvements correlated to comfort and endurance, solutions can be more rapidly and effectively developed.

**Learning Objectives:**
1. Pilot posture throughout a flight profile can be quantitatively studied, augmenting the ability to improve aircrew endurance.

### [210] ACUTE LOW BACK PAIN PREDICTION USING A BIOENERGETICS-COUPLED MUSCULOSKELETAL MODEL

P.E. Whitley, P.E. Roos and X.A. Zhou
*CFD Research Corp, Huntsville, AL*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Low back pain attributed to piloting military air vehicles is a significant international problem. Seating, task posture and vibration are reported as major contributors to pain. Improving pilot

operational state through cockpit, seating, and procedure enhancements can be facilitated with a modeling tool addressing acute pain generation during operations. **METHODS:** A computational model was devised using a musculoskeletal (MSK) model to predict muscle effort and fatigue, integrated reduced order lumbar functional spinal units at each lumbar level to predict spinal ligament and disc strain, minimal muscle metabolism model to predict muscle effort interstitial metabolites, acute pain model using muscle interstitial metabolites to predict muscle interstitial pain onset, and spinal facet strain evoking pain from stretch-based nociceptors. The seated 50th percentile male model response was simulated in postural change conditions: neutral (N), 30° forward lean (F), "helo hunch" (HH); plus a four-hour notional helicopter mission profile with maneuvering loads in the HH versus 13° reclined (R) posture. **RESULTS:** F versus N posture results showed increased pain scores and fatigue for specific erector spinae (ES) muscle groups. Average pain score increased 14% in the F with 51% of fascicles showing greater activation, force generation, fatigue, and pain score. For a 1G, 300 second period, HH versus N posture showed greater muscle activation, force, fatigue, and pain scores in specific ES and multifidus groups. R versus HH results showed a 20%, 19%, and 49% decrease in ES group force, fatigue, and pain score. The four-hour mission scenario results showed back muscle reaction to maneuvering accelerations to maintain posture. Metabolism and pain scores decreased in the 1G recovery period, but a 0G recovery phase was needed to return to a resting metabolic activity level for metabolic recovery muscle offloading. **DISCUSSION:** The bioenergetics-MSK model approach has demonstrated utility and is undergoing further development to add chronic pain prediction plus operationally relevant features with validation using human volunteer seating studies and the graded Sorensen test.

**Learning Objectives:**

1. Understand the principles and potential benefit of a musculoskeletal model coupled with a muscle energetics and metabolic model to predict fatigue and onset of acute exertional pain in the maintenance of posture during a piloting task as applied to the helicopter pilot and crew station.

### [211] MUSCULOSKELETAL PAIN MITIGATION THROUGH LUMBAR SUPPORT RESEARCH

B. Hall
*Human Systems, Naval Air Warfare Center - Aircraft Division, Patuxent River, MD*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Fleet feedback has indicated that the lumbar support in a majority of fixed-wing and rotary wing platforms is insufficient to provide an acceptable level of endurance for users. Pilot and aircrew back pain is a significant issue, not just for the USN, but for the DoD as a whole. The efficacy of supplemental lumbar supports was investigated using lab-based endurance evaluations. **METHODS:** Ten (10) active duty E-2 aircrew gave their informed consent and completed three-hour evaluations of three cushion configurations: the baseline E-2 aircraft cushion, and two supplemental lumbar supports (vertically-adjustable foam cushions, of differing stiffness). During these evaluations, subjects reported discomfort ratings (modified General Comfort Rating Scale) and provided qualitative feedback in 30 minute intervals. Subjects rated discomfort for various body regions on a scale ranging from 1 ("completely relaxed") to 11 ("unbearable pain"). **RESULTS:** Collected data demonstrated divergent feedback from study participants. In a majority of evaluations, mission duration correlated well to increasing reported pain/discomfort levels. In general, qualitative feedback indicated discomfort at the interface between the subject and seat at both the seat back and seat pan cushions. Overall, the average discomfort ratings in the lower back were similar regardless if occupants used a supplemental lumbar support (M=3.9, SD=2.4; M=4.1, SD=2.0) or the baseline seat cushion (M=4.3, SD=2.2). While no evaluated cushions produced significant improvements across the population, individual subjects varied in their choice of preferred cushion. **DISCUSSION:** Addressing the efficacy of supplemental lumbar cushions is just one component of what will have to be a multi-pronged approach to mitigating aircrew back pain. In addition, the crash safety of two supplemental lumbar supports was evaluated dynamically during crash testing. In order to quantify impact to occupant excursion and peak lumbar load, supplemental cushions were placed behind a seated Anthropomorphic Test Device (ATD) during the application of a typical rotary wing crash pulse. Ultimately, new requirements must be developed that ensure aircrew endurance, while balancing the need for operational performance and crash safety.

**Learning Objectives:**

1. Supplemental lumbar supports are just one component of what must ultimately be a multi-pronged approach to mitigate musculoskeletal pain.

### [212] ANALYSIS OF EMG AND SYMPTOMS OF HUMAN VOLUNTEERS IN THE IMPACT ACCELERATION PROGRAM AT THE NAVAL BIODYNAMICS LABORATORY

A.S. Dargie[2,3], A.V. Olszko[2,3], C.M. Beltran[2,3], J.S. McGhee[2], D. Dorman[2,4], K.B. Vasquez[2], B.S. Shender[1] and C. Chancey[2]
*[1]Human Systems, NAVAIR, Patuxent River, MD; [2]U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL; [3]Laulima Government Solutions, LLC, Orlando, FL; [4]Oak Ridge Institute for Science and Education, Oak Ridge, TN*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** The Naval Biodynamics Laboratory (NBDL) performed research on human response to whole-body acceleration. In 1991, a series of IRB-approved human research volunteer (HRV) runs were conducted to evaluate head supported mass (HSM) configurations during axial loading (+Gz). Subject condition was documented in pre- and post-run medical forms, including physician-administered examinations and subject self-evaluations. Electromyography (EMG) data were collected from the neck and upper back muscles. Runs conducted at higher accelerations and with greater HSM may yield EMG signal characteristics that correlate to reported symptoms. **METHODS:** Trapezius (TRAP), left sternocleidomastoid (LSCM), and right sternocleidomastoid (RSCM) EMG signals were each analyzed for onset time (start time of EMG activity). Runs were grouped according to nominal peak sled acceleration (PSA) and HSM configuration. Information from medical forms was entered into and accessed from a digital matrix. Post-run symptoms were identified. EMG onset times and symptoms were compared across groups. **RESULTS:** A total of 91 runs (PSA from 4-9G) were analyzed, which included 16 HRV and 9 HSM groups: no helmet (H1), helmet (H2), and helmet plus weight (eccentric, H3-H7, or counter-balanced, H8-H9). Mean onset times and muscle onset sequence varied across HSM groups. Symptoms were reported in 13% of runs. These symptom-runs had PSA between 5-9G and included all groups except H4, H7, and H9. TRAP onset occurred last in muscle onset sequence in 50% of symptom-runs. Greatest number of symptoms per run was reported for a 9G (H2), 6G (H6), and 7G (H6) run; all with TRAP onset occurring last. The most frequently reported symptom, Muscle Soreness, was reported in 66% of symptom-runs and in 83% of symptom-runs with TRAP onset last in sequence. **DISCUSSION:** The study is a preliminary analysis of symptomology-based outcomes from HRV exposed to acceleration while wearing HSM. TRAP EMG onset in muscle onset sequence may indicate a pattern when examining runs with symptoms, especially Muscle Soreness. EMG signal characteristics and symptoms could provide insight into muscular activation in terms of pain, injury, or fatigue; effects that aviators have long experienced in dynamic environments with HSM. Future work will incorporate kinematics, additional subject records, and other covariates.

**Learning Objectives:**

1. The objective is to determine if there is a relationship between EMG onset times of the neck and upper back muscles and symptoms exhibited by subjects exposed to axial loading while wearing head supported mass.

***Tuesday, May 08*** ***4:00 PM***
***Topaz***

## S-046: PANEL: DATA DRIVEN RESEARCH TO RESOLVE PHYSIOLOGICAL EVENTS IN TACTICAL AIRCRAFT

**Chair: Shawnee Williams**
*Dayton, OH*

**PANEL OVERVIEW:** This panel presents results from USAF and USN physiology based research efforts as hypoxic like symptoms in-flight have

recently come to light for both the services. It will address the physiological hazards posed by the flight environment in high-performance aircraft. The first presentation outlines the investigation into whether the aircrew regulator was causing pilot physiological events. The second presentation describes a helmet mounted physiological monitoring and warning system, which measures arterial oxygen saturation, pulse rate and head-level blood perfusion that warns aircrew of impending hypoxia or G-Induced Loss of Consciousness. The final two presentations by the Naval Medical Research Unit-Dayton will identify the successes, shortcomings, and failures of sensors when exposed to an operational environment and evaluate its readiness for delivery to the fleet and in-cockpit use as well as the possibility that hypocapnia may contribute to recent unexplained physiologic incidents observed in F-15 tactical aircraft.

## [213] OXYGEN SYSTEM PERFORMANCE RESEARCH TO RESOLVE PILOT PHYSIOLOGICAL EVENTS

G.W. Miller
*U.S. Air Force, DoD, Wright-Patterson AFB, OH*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** The military has experienced pilot unexplained physiological events (PEs). A number of the events occurred following insidious decompression of the aircraft cabin. Some events occurred on aircraft with air dilution oxygen regulators and liquid oxygen (LOX) converters. This research effort investigated whether the aircrew regulator was causing pilot physiological events. **METHODS:** An aircraft oxygen system was setup at the On-Board Oxygen Generating System (OBOGS) Laboratory, Wright-Patterson AFB OH. Five air dilution aircrew regulators (designated CRU-98) were evaluated. Laboratory automation software was developed to allow simulation of cabin decompression profiles to 25,000 feet, 30,000 feet, 35,000 feet, and 40,000 feet. Also, rapid aircraft climbs and cabin pressure fluctuations were studied. The test setup used a computer controlled breathing machine with sinusoidal breathing profiles of 17 liters/minute (LPM) at 8 breaths/minute (BPM), 30 LPM at 12 BPM, and 40 LPM at 12 BPM. A medical gas analyzer was used to measure oxygen percentage at the mask and the regulator. The alveolar oxygen tension in the lungs was calculated after the decompression using the Alveolar Gas Equation and the NATO Air Standards were used to assess the experimental results. **RESULTS: T**he results showed the aircrew oxygen regulator, when exposed to insidious decompression at low breathing demand flows (<40 LPM), had a delayed oxygen delivery response. Also, rapid aircraft climb rates and cabin pressure fluctuations produced similar results. The mask oxygen percentage dropped well below NATO Air Standard physiological minimum requirement for an extended time period. The calculated alveolar oxygen tension (PaO2) sometimes dropped below 30 mm Hg. **DISCUSSION:** The oxygen regulator delayed oxygen delivery response to an insidious decompression, rapid climb, or cabin pressure fluctuation at low breathing demand flows might initiate a pilot physiological event. The delayed response was confirmed to originate at the regulator. All five regulators had the same delayed response. The simulations resulted in a PaO2 below 60 mm Hg, threshold for hypoxia, and sometimes below 30 mm Hg, threshold for incapacitation.

**Learning Objectives:**

1. The participants will be able to understand the complexity behind legacy oxygen regulators and the unpressurized environment.

## [214] FLIGHT HELMET MOUNTED PHYSIOLOGICAL MONITORING

S. Williams[1] and L. Tripp[2]
*[1]U.S. Air Force, DoD, Wright-Patterson AFB, OH; [2]Warfighter Interface Division, 711 HPW, Wright-Patterson AFB, OH*

*(ORIGINAL RESEARCH)*

**INTRODUCTION**: The flight environment has always posed a physiological hazards to aircrew who fly high-performance aircraft. This has recently come to light for both the U.S. Air Force and U.S. Navy with reports of hypoxic like symptoms in-flight. The U.S. Air Force Research Laboratory, Navy Medical Research Unit Dayton and an Elbit Systems, an Israeli commercial helmet systems company have teamed up to develop a helmet mounted physiological monitoring and warning system, which measures arterial oxygen saturation, pulse rate and head-level blood perfusion. This system is designed to monitor and warn of impending hypoxia or G-Induced Loss of Consciousness (G-LOC). **METHOD:** Ten participants were recruited from the Brooks City Base centrifuge subject pools to participate in this equipment evaluation. Acceleration profiles included a gradual onset 0.1 G/sec onset run to include relaxed and straining G-tolerance. Each subject experienced Rapid Onset Rate (ROR) exposures to +5, 7, & 9 Gz for 15, and 10sec respectively were also used. The last acceleration profile was a ROR +5-9 Gz Simulated Aerial Combat Maneuver with 10 sec epochs each with a maximum of ten +9 Gz peaks. The helmet mounted system data were compared to the data from a FDA approved off-the-shelf pulse oximeter sensor system. Altitude exposures included exposure plateau to 17.5Kft oxygen was disconnected and arterial blood oxygen saturation decreased to 70% at which point the subject was placed on 100% O2 and the altitude returned to ground level. **RESULTS:** The results of this study show that the arterial blood oxygen saturation and pulse rate data generated by the helmet mounted pulse oximeter were comparable to those data generated by a FDA approved pulse oximeter system, both during the resting baseline and the peak G acceleration and altitude periods. **DISCUSSION:** Identify way forward for next generation helmet mounted physiological monitoring and warning system, which expands on arterial oxygen saturation, pulse rate and head-level blood perfusion measurements.

**Learning Objectives:**

1. Understand the FDA approved pulse oximeter system.

## [215] INDEPENDENT VERIFICATION AND VALIDATION OF SENSORS DEVELOPED TO ADDRESS PHYSIOLOGIC EPISODES

S.A. Warner
*U.S. Navy, DoD, Wright-Patterson AFB, OH*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** The Ideal Gas Law (pV = nRT) refers to the measurement of a hypothetical quantity of a gas under conditions which would include temperatures close to room temperature, and pressures approximating one atmosphere. However, these conditions are simply not found in the aviation environment, which has thus far impeded the development of an accurate and valid gas sensor to be used in flight. To obtain a legitimate measure of any kind with a given gas, such as the purity of the oxygen to be breathed by our pilots and aircrew, the pressure, volume, and temperature of that gas must be accounted for. **METHODS:** During their development, variations on sensor technologies are made based on the outcomes from progressive tests to ensure that the functionality of the device is as expected in its intended climate. Prior to acceptance and delivery to the fleet, a final set of independent "Verification and Validation" (V&V) testing must occur. **RESULTS:** These tests, completed by a third party organization, are intended to quantify how closely the product meets the specifications set out by a sponsor. Naval Medical Research Unit Dayton (NAMRU-D) has a one-of-a-kind Sensors Laboratory designed to carry out V&V testing on gas sensors, including commercially available off-the-shelf (COTS) sensors and sensors to be worn by aviators and aircrew. This testing chamber was specifically developed to replicate the ever-changing and dynamic environment found in tactical aviation, where gas concentration, volume, temperature, pressure, and humidity within the chamber can be manipulated either independently or in combination. **DISCUSSION:** Previously, NAMRU-D has completed developmental and independent V&V testing on the Tactical Aircrew Physiological & Cognitive Monitoring System (TAPCOMS), numerous COTS gas sensors, and the various iterations of the Aircrew-Mounted Physiologic Sensor Suite (AMPSS) – most recently, the AMPSS 3.0 Inhalation Sensor Block (ISB) and Exhalation Sensor Block (ESB). Through independent V&V testing, NAMRU-D was able to identify the successes, shortcomings, and failures of each sensor when exposed to an operational environment and evaluate its readiness for delivery to the fleet and in-cockpit use.

**Learning Objectives:**

1. How physiological sensors are tested before flight and cleared for in-cockpit use.

### [216] HYPOCAPNIA IN TACTICAL AVIATION RESULTING FROM HYPOBARIA

M. Clayton Gallo
*U.S. Navy, DoD, Wright-Patterson AFB , OH*

*(ORIGINAL RESEARCH)*

**INTRODUCTION**: This study assessed the possibility that hypocapnia may contribute to the recent unexplained physiologic incidents observed in F-15 tactical aircraft. Hypocapnia (a low concentration of $CO_2$ in the blood) may be caused by hyperventilation and/or hypobaria during flight and can share similar symptoms as hypoxia. When coupled with potential cerebral vasoconstriction caused by breathing increased concentrations of oxygen, such conditions may lead to hypoxia-like symptoms. The primary objective of this study was to examine whether such conditions can produce measurable hypocapnia in participants. A secondary objective was to correlate changes of $CO_2$ across the various monitoring devices. **METHODS**: Sixteen participants were exposed to ground level, 10,000 feet, and 18,000 feet in a hypobaric chamber while breathing elevated concentrations of 50, 60, and 90 percent oxygen, respectively. Participants alternated between sitting quietly with normal breathing and talking out loud by reading a script. In attempt to measure changes in participant's $CO_2$ levels during the exposure, transcutaneous $CO_2$ ($tCO_2$) and exhaled breath ($ETCO_2$) were continuously monitored, and venous blood samples were drawn every five minutes. **RESULTS:** Data suggests that collection of breath samples in an operationally realistic manner was prone to gas mixing, which may have caused spurious $ETCO_2$ values during certain exposure segments. Despite characteristics that present practical difficulties in operational environments (e.g., long warm-up time, slow sample rate, etc.) the $tCO_2$ monitors showed promise. When used simultaneously at different body locations (forehead and chest), paired monitors were similarly and highly correlated ($p<0.05$). **DISCUSSION:** The outcomes of this effort may provide insight into the unexplained physiologic episodes impacting USAF and USN fighter aircraft. Furthermore, transcutaneous and/or mask-based devices may be used for non-invasive, continuous monitoring of aircrew's physiologic and metabolic status during flight operations.

**Learning Objectives:**

1. The effects of hypocapnia.

***Tuesday, May 08*** ***4:00 PM***
***Sapphire***

## S-047: PANEL: CONSIDERATIONS IN ETHICAL PRINCIPALS IN THE PRACTICE OF AEROSPACE MEDICINE- A PANEL DISCUSSION

*Sponsored by ASAMS*

**Chair: Jeffrey Jones**
*Houston, TX*

**PANEL OVERVIEW:** This discussion panel session will discuss topics in aerospace medicine ethics.

### [217] CONSIDERATIONS OF ETHICAL PRINCIPALS IN THE PRACTICE OF AEROSPACE MEDICINE: A DISCUSSION PANEL

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

*(EDUCATION - TUTORIAL)*

Each year there are ethical challenges that arise in the practice of aerospace medicine. It is important that aerospace medicine providers recognize when they have encountered and ethical quandary and have tools at their disposal, to assist in managing the situation. The flight surgeon or aviation medicine examiner must employ diplomacy, compassion and knowledge of ethical principles to be able to effectively negotiate scenarios the airman may place them in. There is an expectation that aerospace medicine practitioners maintain the highest ethical standards of the Aerospace Medical Association and other governing bodies, such as the American Medical Association and federal, state local, as well as international bodies which oversee / govern aerospace medical practice and personnel. This panel will review case studies which pose potential ethical quandaries and discuss the thought processes and action pathways which may be employed by the aerospace medicine provider, as well as those of the airman/ pilot. The panelists will be asked to argue for or against potential actions, and weight the merits, the pitfalls and the possible fall-out of each. After participation, the attendee of the session should be better able to understand the impact of various actions associated with many ethical challenges, and feel better prepared to handle ethical concerns which may arise in their practice.

**Learning Objectives:**

1. To recognize when an airman/pilot may place the aeromedical physician in a position that may raise ethical concerns.
2. To develop possible responses / action plans to ethical challenges.
3. To learn what impact ethical scenarios could have on the practitioner's relationship with the airman and with governing organizations.

***Tuesday, May 08*** ***4:00 PM***
***Ballroom A***

## S-048: SLIDE: RESEARCH ANALYTICS--PAST, PRESENT, & FUTURE

**Chair: Charles DeJohn**
*Oklahoma City, OK*

**Chair: Vivienne Lee**
*Farnborough, Hampshire, United Kingdom*

**4:00 PM**

### [218] INVESTIGATION OF A CLUSTER OF LYMPHOMA CASES AMONG A COHORT OF 2500 COMMERCIAL AIRMEN

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

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** During the period 2006-2010, eight cases of lymphoma were diagnosed among a cohort of 2,500 commercial airmen. The incidence of this rare disease during this period significantly exceeded the expected age-adjusted population rate of 16.8 cases/100,000/year, and this research study was commenced to investigate the possible cluster of cases. **METHODS:** A case-control study was designed including five controls for each patient. Controls were matched with each clinical case to within one year of both their age and date of first aircrew licensing in Hong Kong. Lymphoma type and body sites involved, places of residence, types of aircraft flown during the airman's whole career, social history and past medical history were recorded. **RESULTS:** All lymphoma cases were male with a median age of 46 years (range 22-56). Two cases had a diagnosis of Hodgkin's Lymphoma with the remainder categorized as Non-Hodgkin types. No clear evidence of exposure to exogenous agents known to be related to lymphoma was established. However, half of the affected airmen had served on board military surveillance aircraft during parts of their flying career. **DISCUSSION:** The eight patients noted comprised a defined cluster of lymphoma cases over a discrete 5-year period. No definite cause for these cases has yet been established, and this presentation will conclude with a discussion of possible causative factors for further investigation, and a request to the international Aerospace Medicine community for any available information concerning whether similar cluster phenomena have been noted among airmen in other countries.

**Learning Objectives:**
1. To discuss the available methods and techniques of investigating an unexpected cluster of disease cases within a population of airmen.
2. To review the clinical problem of Lymphoma in airmen, including the aeromedical considerations applicable to the recertification of this occupational group.
3. To discuss the environmental factors that are known to contribute to the development of lymphoma, and their relevance to aviation operations.

**4:15 PM**
**[219] THE HISTORY OF USAF VISION STANDARDS: BACK TO THE FUTURE? - PART III**
D.J. Ivan[1], A.D. Ivan[2] and T.J. Tredici[3]
*[1]ADI Consultants, San Antonio, TX; [2]Social and Behavioral Sciences, Vernon College, Wichita Falls, TX; [3]Ophthalmology, University of Texas Health Sciences Center, San Antonio, TX*

*(EDUCATION - TUTORIAL)*

The third installment of this series tracing the historical origins of modern USAF aircrew vision standards will build on the aeromedical lessons learned during World War One and in the period before the start of World War II. The differences between the flying machines and weapons used in WWI versus those available even at the dawn of the Second World War were staggering. The advent of even more advanced high performance military aircraft and combat tactics that evolved over the course of the war continued to challenge the physiological capabilities of their crew and stress aeromedical support assets. Countries at war were forced to commit vast resources to adapt to and keep up with the ever expanding capabilities of the latest aerial weaponry. Most combatant nations used both military and other governmental sponsored agencies to respond to and solve these new emergent aeromedical problems. Color vision and testing, night vision performance, assorted cockpit optical aids, stereopsis testing, and the development of a reliable machine testing device for mass vision screening dominated the aeromedical research thrusts during this period. This presentation will highlight the key historical accomplishments of the period that were instrumental in defining aeromedical vision standards and policies of the day, many of which continue to thrive after the war.

**Learning Objectives:**
1. Students will learn about the origins of USAF aircrew vision standards.
2. Students will learn about color vision testing events that shaped the future of aviation color vision screening.
3. Students will learn about proper color vision screening.

**4:30 PM**
**[220] REFINEMENTS IN THE METHODOLOGY FOR TRAINING FLIGHT SURGEONS**
**(A SHIFT TOWARD PERFORMANCE-BASED TESTING)**
C.D. Clinton[2] and J. Cornell[1]
*[1]FEEE, USAFSAM, Huntington, WV; [2]FEEE, USAFSAM, Wright-Patterson AFB, OH*

*(EDUCATION - PROCESS)*

**MOTIVATION:** The standard method for testing flight surgeon candidates in the U.S. Air Force School of Aerospace Medicine has been, until recently, modeled in a manner similar to that found in undergraduate medical school. The student attends didactic instruction and laboratories and is tested via written, multiple-choice exam at the end of the course. This testing methodology promotes a disconnect between the flight surgeon candidate and his patient by oversimplifying the problem and its solution. As the Aerospace Medicine Primary course has evolved, more emphasis has been placed on hands-on experience with aviation and case-based learning tied closely to the teaching objectives found within the framework of the flights performed in the Aeromedical Aviation Laboratory. **OVERVIEW:** The role of flight surgeon, at least in the context of the U.S. Air Force, presupposes a thorough knowledge of medicine and the ability to interview and examine patients and derive a diagnosis and subsequent treatment plan. This knowledge lends itself to multiple-choice testing, which has been the standard for evaluation of both undergraduate medical students and seasoned physicians applying for recertification in their various specialties. For the aviator, on the other hand, not only is there a large body of testable book-knowledge regarding weather, navigation, engines, systems, and aerodynamics, there is also a significantly large body of practical abilities that must be demonstrated to be evaluated. Performance-based testing allows for evaluation of the student's ability to diagnose a problem, synthesize a treatment plan, and predict a disposition based on knowledge of the medical issues, environment of flight, physiologic and social stressors on the aviator, and the political and operational needs of the unit. Paper-based testing is two-dimensional by nature and doesn't allow for such a multi-layered filtering of subject, environment, and culture. **SIGNIFICANCE:** Performance-based testing provides a better system for teaching and evaluating flight surgeon candidates by tying cased-based clinical vignettes to the "take-home" lessons learned in the cockpit. This type of testing provides the student with personal experience related to the topic that he or she can apply when evaluating the patient in the linked scenario.

**Learning Objectives:**
1. At the conclusion of this presentation, the participant will be familiar with recent changes to the teaching methodology used for the instruction of Flight Surgeon candidates at the United States Air Force School of Aerospace Medicine.

**4:45 PM**
**[221] WWI PIONEERS AND THE GENESIS OF AMERICAN AVIATION MEDICINE**
C. Fisher
*premise health, San Antonio, TX*

*(EDUCATION - TUTORIAL)*

On the century anniversary of Aviation Medicine, this discussion studies the very genesis of the American Flight Surgeon as the product of an international collaboration and visionary foresight that has endured the test of time, and creates a foundational discussion of the role of the flight surgeon a century ago in the context of the modern application. Prior to American involvement in WWI aviation in the United States was a novelty and the domain of daredevils. Military application of the aircraft had been limited, and selection of pilots was based on willingness rather than qualifications. A small group of foresighted physicians, some with aviation experience, leaned forward, and in the brief months of American involvement in WWI created the science, training and guidance that would save countless lives in subsequent wars and make manned space travel possible. A critical element of this innovation was to train and embed physicians directly in flying training and combat aviation units, a new concept well outside anything attempted before. In the brief months of U.S. involvement, these physicians contributed to remarkable reductions in human cause mishaps and created an employment model that is relevant a century later. This discussion focusses on the creation of the flight surgeon and his role in training and combat support in WWI, examines the contributions of the first cadre of flight surgeons during and after their military careers, and proposes that the construct established de novo is still accurate and relevant a century later.

**Learning Objectives:**
1. Participants will be able to identify critical dates and events that mark the genesis of what is now Aerospace Medicine in the United States.
2. Participants will identify core functions and attributes of the successful flight surgeon in WWI.
3. Participants will identify at least three physicians who would be considered founders of our profession.

**5:00 PM**
**[222] MEDICAL DATA ARCHITECTURE OPTIMIZATION AND BIG DATA ANALYTICS CHALLENGES**
S.L. Zinke-McKee and R. Greenhaw
*Medical Research Division, FAA Civil Aerospace Medical Institute, Oklahoma City, OK*

*(EDUCATION - TUTORIAL)*

**PROBLEM STATEMENT:** There is a great deal of confusion over what constitutes big data as compared to the traditional storage method of relational databases, as well as the advantages or disadvantages of

traditional data storage and processing versus the newer big data methods. **TOPIC:** This panel discussion explores some of the latest technologies and designs associated with big data storage, defines what is and is not meant by big data, and examines when and why you would want to use each architecture for predictive and prescriptive analyses. Several technologies and methods will be defined and described, with a focus on the advantages and disadvantages of each choice based upon the type and amount of data being stored and the types of answers that are desired. The benefits and disadvantages of traditional relational databases, stored on traditional file systems versus the newer methods using distributed file systems such as Hadoop Distributed File System (HDFS) will be discussed. We will also briefly discuss some of the new and interesting ethical challenges associated with the storage and use of the big data from personal medical devices. The information landscape for medical data has changed significantly in the past 10 years, with the popularity of personal health devices, from FitBits and the Fitness application on the iWatch, to Pacemakers that record patient data and send it out for analysis. While these devices and the big data opportunities that they provide are intriguing, they also pose some interesting ethical dilemmas, which will be identified with a brief discussion of the issues. **APPLICATIONS:** Big data analytics methodologies promise to mine large datasets, looking for previously hidden or unknown correlations and hence hypotheses. Currently, there is a great deal of confusion about big data analytics, and if it will replace the traditional methods of analyzing medical data stored in relational databases and tables. This talk seeks to explain the differences between traditional data storage and analysis versus big data to clear up the confusion, to identify the advantages and disadvantages of each technique, and to briefly discuss some of the unique ethical considerations that come with the push to big data, and the new sensors from the internet of things that enable it.

**Learning Objectives:**

1. After the conclusion of this presentation the audience members will be able to describe what is meant by the term "Big Data", and describe at least one advantage of using it versus traditional relational databases, and describe at least one ethical concern over the storage of "Big Data" from personal medical devices.

**5:15 PM**

### [223] WHAT YOU NEED TO KNOW ABOUT BIG DATA ANALYTICS IN AEROSPACE MEDICINE

R. Greenhaw[2] and S.L. Zinke-McKee[1]
*[1]FAA CAMI, Oklahoma City, OK; [2]Medical Research Division, FAA CAMI, Oklahoma City, OK*

*(EDUCATION - TUTORIAL)*

**TOPIC:** In the past few years, big data analytics has received attention as a general set of methodologies applicable to many areas of research. It turns out that researchers in aerospace medicine have been applying many of these techniques in the course of their work over the past few years. The use of big data sources and analysis techniques provides both benefits and problems for medical research in aviation. There are the benefits of access to very large, high-dimensional data sets that can provide insights into otherwise invisible subtle patterns. On the other hand, there are issues of storage, access, scalability, information noise, validity, record matching, ownership, security, and privacy with the data and experimental design and processing capacity issues with the analysis that, while always present in research, are exacerbated by the scale of the data. We will discuss the general field of big data analytics as background to its applicability in aeromedical research. We will follow that discussion with examples of its use in specific aeromedical research studies, including discussion of the benefits it provides and issues that it raises for such studies. **APPLICATIONS:** Many of the big data analytics methodologies can now provide information and results previously unavailable. Therefore, there are likely questions in aerospace medicine that were unasked previously because members of the community assumed their answers were unavailable. Many of those types of questions can now be asked; and some of them answered.

**Learning Objectives:**

1. To understand the primary benefits and issues related to the use of big data in aerospace medical research.

***Tuesday, May 08*** ***4:00 PM***
***Senators***

## S-049: PANEL: AEROSPACE MEDICINE BOARD REVIEW SERIES #3

*Sponsored by ASAMS*

**Chair: Timothy Burkhart**
*Annapolis, MD*

**PANEL OVERVIEW:** The Aerospace Medicine Board Review series will review core topics in Aerospace Medicine and is designed to prepare Aerospace Medicine specialists for the ABPM re-certification exam.

# WEDNESDAY, MAY 9, 2018

***Wednesday, May 09*** ***8:30 AM***
***Ballroom D***

## S-050: PANEL: FOCUS ASPECTS IN AEROSPACE MEDICINE: THE DGLRM PANEL (GERMAN & ENGLISH LANGUAGE)

**Chair: Torsten Pippig**
*Fuerstenfeldbruck, Germany*

**Chair: Oliver Ullrich**
*Zurich, Switzerland*

**PANEL OVERVIEW:** This session is organized by the German Society of Aerospace Medicine (DGLR; Deutsche Gesellschaft für Luft- und Raumfahrtmedizin e.V.). In this session, five presentations are included showing activities and focuses of Aerospace Medicine in Germany. The session consists of 5 Abstracts and is presented in German language.

### [224] HEINZ VON DIRINGSHOFEN (1900-1967): GERMAN PIONEER IN AEROSPACE MEDICINE.

V. Harsch
*Center for Aviation and Travel Medicine, Neubrandenburg, Germany*

*(ORIGINAL RESEARCH)*

**INTRODUCTION:** Heinz von Diringshofen contributed to aerospace medicine through his research on the effects of acceleration and weightlessness on pilots. Beside laboratory examinations he performed acceleration research by in-flight test in the 30s. As well he introduced parabolic flights to simulate 0G in the scientific scope of aerospace medicine research even before WW II. **METHODS:** Archive research, literature research, oral history. Presentation concerns also medical ethical aspects of the use of results gained in human experiments in WW II. **RESULTS:** Heinz von Diringshofen was born in Magdeburg on January 22, 1900, the German city known from Otto von Gerickes vacuum experiments in 1654. Von Diringshofen served as a lieutenant in WW I. Thereafter he studied medicine at the Universities of Berlin and Munich. A maritime medical service with the HAPAG Co. followed before he re-entered service in the "Reichswehr" in 1927. Thereafter von Diringshofen started his military flight training in Lipezk, USSR. In the "Luftwaffe" he later became a colonel and served also at the east-front involved in strategic air medivac. After WW II von Diringshofen lectured aviation medicine at the universities of Frankfurt and Munich. He didn't become a paperclip specialist but contributed as a consultant to the Aeromedical Institute of the Argentinean Air Force from 1951 to 1956. Back in Germany he introduced the term "human performance engineering" while active for German aerospace companies. He became first president of Germanys Society for Aviation and Space Medicine (DGLRM) in 1961, an affiliated association to AsMA since the 60s. **DISCUSSION:** Heinz von Diringshofen is one of the German pioneers in aerospace medicine. It can be assumed that he was not part of the U.S. paperclip