

Learning Objectives:

1. To make the participant aware of international differences in medical requirements and airman certification. It will help them advise airmen anticipate the need for further documentation or certification before competing in a country that may impose restrictions on their being allowed to compete with their current medical and pilot certificates.

[407] AEROMEDICAL SUPPORT FOR AN INTERNATIONAL MULTI-AIR-SPORT EVENT

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INTRODUCTION: With increase in frequency and number of participants of international Air Sport events, aeromedical support for competitors and visitors became complex. The author supported the 4th Asian Beach Games held at Phuket Island, Thailand in 2014. The event involved not only Paragliding and Power Paragliding, but also 26 other sports which included Sambo, Jet ski, Triathlon, etc. There were many aspects to be shared by AsMA members. **METHODS:** The aeromedical support for the Asian Beach Games started with planning with stakeholders. Overall sports event management was by the Olympic Council of Asia and National Olympic Committee of Thailand. The Ministry of Health takes the responsibility for all aspect of the medical support. Regional support came from Ministry of Tourism and Sports. Air Sport safety skills came from FAI. The author's principal role was in inter-hospital interface and aeromedical evacuation. **RESULTS:** The author's regular health service extended to Phuket Island only as aeromedical evacuation network to support complex or complicated medical need from Bangkok area. Example case reports will be presented. **DISCUSSION:** In addition to Olympic Sports, other sports gaining popularity, including parachuting from Air Sports, are holding larger and more complex events. As not all of sports associations are skillful in holding a multi-disciplinary event, aerospace medicine specialists should be more proactive in assisting event organizers.

Learning Objectives:

1. To understand the complexity of aeromedical support for an international multi air sport event.

Thursday, May 14

Northern Hemisphere Ballroom

8:15 A.M.

50TH ANNUAL HARRY G. ARMSTRONG LECTURE**The Kennedy Space Center and NASA's Vision for the Future**

Robert Cabana

Center Director, NASA-John F. Kennedy Space Center, FL

Thursday, May 14

S. Hemisphere 1

10:00 A.M.

[LXXVII.] SLIDE: MUSCULOSKELETAL ISSUES AND HUMAN PERFORMANCE

Chair: Paul Young

San Antonio, TX

10:00 a.m.

[408] EXPOSURE-RELATED DIFFERENCES ON NECK AND TRUNK MUSCULOSKELETAL CHARACTERISTICS IN US ARMY HELICOPTER PILOTS

T. Nagai¹, J.P. Abt¹, T.C. Sell¹, M. Lovalekar¹, B.W. Smalley², M.D. Wirt³, and S.M. Lephart¹

¹Warrior Human Performance Research Center, Neuromuscular Research Laboratory, University of Pittsburgh, Pittsburgh, PA; ²U.S. Army School of Aviation Medicine, Fort Rucker, AL; ³U.S. Army Institute of Surgical Research, Fort Sam Houston, TX

INTRODUCTION: A high prevalence of nonspecific neck pain (NP) and low back pain (LBP) is reported among military helicopter pilots, especially in senior and master pilots. Due to exposures to physical stress during flight (altitude, noise, vibration, poor sitting posture (due to confined cockpit space), fatigue, night-vision goggle, and additional protective gears), pilots may gradually deteriorate their neck and trunk musculoskeletal characteristics that predispose them to NP/LBP. Therefore, the purpose of this study was to compare neck and trunk strength, flexibility, and posture among pilots with various flight-hours. **METHODS:** A total of 115 male helicopter pilots participated in laboratory testing and were divided into five groups based on total flight-hours (0-999hrs (n=61), 1000-1999hrs (n=22), 2000-2999hrs (n=17), 3000-3999hrs (n=8), and 4000+hrs (n=7)). Laboratory testing included isometric cervical muscular strength and isokinetic trunk muscular strength, cervical/lumbar spine active range-of-motion (ROM) and hip rotation passive ROM, forward head/shoulder posture, and pectoralis minor length. Strength values were normalized to body weight. Based on the tests for normality and equality of variance, appropriate one-way analysis of variance and post-hoc analyses were used to examine the group differences (p<0.05). **RESULTS:** When compared to the pilots with less than 1000 flight-hours, there were significant reductions in neck extension and lateral flexion strength and lumbar spine extension and lateral flexion ROM among the pilots with 3000+ flight-hours. Similarly, significant reductions in cervical spine extension and lateral flexion ROM and increase in pectoralis minor length were found in the pilots with 2000+ flight-hours (p<0.05). **DISCUSSION:** The current findings confirmed exposure-related musculoskeletal changes. Interestingly, cervical spine ROM and posture may be more sensitive to the exposure than neck strength and lumbar spine ROM. Clinically, it is important for clinicians and pilots to monitor their musculoskeletal characteristics and implement strategic intervention programs to minimize those exposure-related declines at different stages of their career.

Learning Objectives:

1. Modifiable musculoskeletal characteristics that are associated with individuals with NP/LBP are described.
2. Exposure-related differences (based on total flight-hours) in musculoskeletal characteristics are described.

10:15 a.m.

[409] DEVELOPMENT OF A METHOD TO IMPROVE THE ANALYSIS OF POSTURAL CONTROL IN HEALTHY SUBJECTS AFTER PROVOCATIVE SETTINGS

C. Gammel, V. Knie, A. Gens, and C. Ledderhos

German Air Force Center of Aerospace Medicine, Fuerstenfeldbruck, Germany

INTRODUCTION: For objective testing of a patient's balance, posturography can be used. In aviation medicine, there is the need for a portable device which is quick, non-invasive and sensitive enough to measure subjects that are younger and, most importantly, healthier than the average patient. The device should supply measurements for healthy subjects while their balance system is exposed to various provocations occurring in flight simulators and disorientation devices as well as during real flights and after G loads produced by the human-use centrifuge. Eventually, the analysis should allow for a statement about the impact of challenges to the equilibrium system for pre-selected subjects in the most sensitive way. **METHODS:** For the tests, a commercially available system (TETRAx IBS) was used. In order to disclose even small disturbances of balance control, we modified the testing procedure following a suggestion of Prof. Kohen-Raz. Ante-posterior and lateral inclinations of the platform made it possible to compare the conventional method with the modified procedure in a group of healthy subjects. Out of the various parameters generally measured by the system, the following parameters were considered in the study: the Stability Index (ST), frequency bands of the Fourier Transformation and the synchronization between left and right toes. **RESULTS:** 178 healthy persons (male/female; age 18 to 55) participated. A statistically significant difference

between the conventional and the modified method could be observed for all parameters and all positions. The effect generally turned out to be more pronounced with the platform being tilted to the left or to the right.

DISCUSSION: The analysis clearly showed a difference between the two methods for the three parameters considered. It could be demonstrated that the modified method is capable of challenging the equilibrium more than the conventional method and thus can be used to uncover minimal disturbances of the equilibrium even in healthy persons.

Learning Objectives:

1. Objective measurement of postural balance.

10:30 a.m.

[410] STUDY OF NECK MUSCULOSKELETAL LOADINGS DURING WALKING AND RUNNING WITH HEAD SUPPORTED MASS

X. Zhou, X. Chen, P.E. Whitley, and A. Przekwas

CFD Research Corporation, Huntsville, AL

INTRODUCTION: As military helmet systems have evolved, the weight of Head Supported Mass (HSM) has steadily increased, which could result in neck fatigue, pain and injury during military operations. Studies devoted to analyzing HSM neck loading have focused on collection of empirical data to establish limits. Modeling and simulation studies are limited, especially for low energy, long duration loading. **METHODS:** A detailed 3d musculoskeletal model was improved and integrated with a whole-body skeletal model. The integrated model was controlled with a musculoskeletal simulator to track one measured gait cycle of walking or running motion. Multiple HSM configurations were fit to the head and investigated for their effects on neck musculoskeletal loading. **RESULTS:** For walking without HSM, low average activation (<10% of Maximum Voluntary Contraction (MVC)) was observed for both flexion and extension muscles. For running, muscle flexors' activation increased significantly (>45% MVC during flying phase) while extensors' activation remained relatively low. With increased HSM loading for both motions, muscle activation for both flexors and extensors increased, and the increase for either group depended on the weight and Center of Mass (COM) position of the HSM relative to the head COM. Maximum disc compressive forces at C7 were between 130N to 206N for walking and between 276N to 443N for running, calculated for a no-HSM case and a heavy HSM case (3.09kg) respectively. **DISCUSSION:** In this study, muscle co-contraction was not considered. Experimental studies are planned to measure cervical spine motions and muscle activation patterns during walking and running with different HSM configurations for model validation and maturation.

Learning Objectives:

1. To understand the effect of HSM on neck musculoskeletal loading during military operations (e.g. marching).

10:45 a.m.

[411] A MUSCULOSKELETAL MODEL FOR STUDY OF MUSCLE RESPONSE IN UPRIGHT AND SLUMP POSTURES

X.G. Chen, P.E. Whitley, X.A. Zhou, and A. Przekwas

CFD Research Corporation, Huntsville, AL

INTRODUCTION: Low back pain has been consistently reported by pilots and aircrew operating military air vehicles for long hours. This study utilizes a 3D musculoskeletal model to investigate the effect of pilots' sitting posture on muscle activation, fatigue, and joint forces in the lumbar region, which can indicate the potential of low back pain and ultimately provide guidelines to reduce low back pain and injury in military personnel.

METHODS: A musculoskeletal model was developed, which includes torso and lumbar muscles, detailed vertebrae, intervertebral discs, and lumbar ligaments. CFDRC's in-house code was used to position the model in upright and slump postures. The human model was first settled into a seat through contact calculation and then the two static postures were maintained for 500 seconds, during which ligaments experienced stress relaxation and muscles were activated and experienced fatigue. Joint forces, muscle activation, and fatigue in the lumbar region were used to examine the biomechanical response of the two postures. **RESULTS:** In both postures, joint forces at lower lumbar level were larger and pitch moments at upper lumbar level were higher. The slump posture generated 25% more joint force and twice

the pitch moment than the upright case. In both postures, lumbar components of erector spinae generated the highest muscle forces. The maximum muscle force in the slump posture was 20% more than the upright case. There was a 5-7% increase in activation of the group in the slump posture versus upright. The most fatigued muscle fascicles and the asymptotic fatigue value were the same in both postures. However the value was reached 10% faster in the slump posture versus upright. **DISCUSSION:** The slump posture required larger lumbar joint and muscle forces, and muscle fatigue was reached faster. Thus it is potentially more prone to low back pain. Our model will further incorporate a lumbar insert to determine the influence on muscle fatigue in long duration aviation tasks.

Learning Objectives:

1. To understand the effect of sitting postures on muscle fatigue and low back pain.

11:00 a.m.

[412] PHYSIOLOGICAL ASPECTS OF WALKING IN HYPOGRAVITY

R.R. Baptista, A.O. Leite, P. Oliveira, G. Paim, T. Silva, P. Vargas, and T. Russomano

Microgravity Centre, PUCRS, Porto Alegre, Brazil

INTRODUCTION: Humans exposed to micro and hypogravity present bone and muscle loss during and after spaceflight. These effects are similar to those associated with aging, bed rest and immobilization. Increased duration space missions have raised the significance of knowledge regarding the effects of micro and hypogravity on the human body. Exercise represents one of the countermeasures to the cited issues. Bone and muscle stress caused by exercise is an important factor for the maintenance of bone and muscle mass, both in astronauts during space missions and humans living on Earth. **METHODS:** Eleven subjects performed 10 min walking in Martian, Lunar and Earth (1G) gravity, after first being seated at rest for 5 min. A body suspension system was used to simulate the hypogravity environment. Oxygen consumption (VO_2), heart rate (HR), rate of perceived exertion (RPE), pain and comfort scales were evaluated. **RESULTS:** VO_2 (mean \pm SD) figures at rest, on the Moon, Mars and 1 G were 0.40 ± 0.22 L/min, 0.49 ± 0.26 L/min, 0.59 ± 0.33 L/min and 0.69 ± 0.37 L/min, respectively. A statistical difference was found between the VO_2 at 1G vs Moon ($P=0.02$). Recorded HR at rest was 72.55 ± 11.17 bpm; 1 G 91.85 ± 13.05 bpm; Mars 101.36 ± 14.74 bpm; and Moon 104.13 ± 17.52 bpm, again with statistical significance between 1G vs Moon only ($P=0.04$). Related to the perception of pain and comfort, respectively, 1 G 0.64 ± 2.11 and 4.73 ± 0.64 ; Mars 5.73 ± 2.57 and 1.64 ± 0.50 and Moon 7 ± 2.28 and 1.55 ± 0.68 . Lastly, the score for RPE at 1 G was 0.55 ± 1.19 ; Mars 2.55 ± 1.86 and Moon 4.36 ± 3.47 . **DISCUSSION:** VO_2 and HR results showed a significant difference between 1G and the Moon. The increased heart rate on Mars and the Moon can be associated with discomfort caused by the harness and counterweights system. This association is confirmed by the results obtained for subjective perception of pain and comfort. However in subjective pain, comfort and RPE, significant differences are found between 1G vs Mars and 1G vs Moon, with extremely significant results ($P<0.0001$).

Learning Objectives:

1. Analyze the respiratory responses of walking in hypogravity and compare with Earth's gravity.
2. Compare the chronotropic responses to walking in hypogravity with 1G.
3. Compare the RPE responses of walking in hypogravity with 1G.

10:15 a.m.

[413] EFFECTS OF HEAD DOWN TILT ON VECTION

H. Yu, S. Sun, F. Pu, Y. Yang, S. Bao, D. Li, and Y. Fan

School of Biological Science and Medical Engineering, Beihang University, Beijing, China

INTRODUCTION: The high-G flight can result in the redistribution of blood, which can affect the visual and vestibular function. Similarly, the head down tilt also alters the distribution of blood. Vection is a common type of illusion determined by vision. The purpose of this study is to investigate whether head down tilt has an effect on the vection. **METHODS:** 9 participants watched the leftward or rightward moving grating stimulus

while standing in front of a screen in a dark room. Grating stimulus lasted 30s to induce vection, and randomly repeated 10 times in each direction. In the test, participants were required to press a designated button when the perception of self-motion appeared and disappeared. The time when the perception of self-motion appeared was the latency of the vection while the period between the appearance and disappearance of the perception was the duration of vection. The participants assessed the subjective vection strength ranging from 0 to 10 after each test. Then, after being tilted -20° head-down for 5 minutes, the participants kept the head-down position to accomplish the same tasks as in the standing position. Two-way ANOVA was used to analyze the latency, duration and subjective strength of vection in the standing and the head down tilt positions. **RESULTS:** The latency, duration and subjective strength of vection had no significant difference in the leftward and rightward stimulus. Compared to the subjective vection strength in the standing position, the strength in the head-down tilt was significant smaller and decreased by 10%. Latency and duration also differed in the two positions, but the changes were not significant which might due to the large individual differences in the reaction time. **DISCUSSION:** The results of the experiment suggest that the -20° head-down tilt can significantly weaken the subjective vection strength.

Learning Objectives:

1. Compare the subjective vection strength in standing position and head down tilt position.

Thursday, May 14
S. Hemisphere 2

10:00 A.M.

[LXXVIII.] PANEL: ADVANCED AEROSPACE MEDICINE FOR INTERNATIONAL MEDICAL OFFICERS (AAMIMO) CLINICAL AEROSPACE MEDICINE CASE PRESENTATIONS

Chair: David Hardy
Wright-Patterson AFB, OH

PANEL OVERVIEW: Advanced Aerospace Medicine for International Medical Officers (AAMIMO) student briefings covering aeromedical cases. Each student will present a case study including clinical presentation, treatment and disposition. Additionally the student will compare/contrast flyer disposition between various U.S. military/civilian standards and those of their home nation military.

Thursday, May 14
S. Hemisphere 3

10:00 A.M.

[LXXIX.] PANEL: PREPARING FOR HUMAN SPACE EXPLORATION: PAVING THE PATH TO RISK REDUCTION

Co-Chair: Sharmi Watkins
League City, TX

Co-Chair: Mark Shelhamer
Houston, TX

PANEL OVERVIEW: This panel highlights several aspects of the work being undertaken by the NASA Human Research Program (HRP) in preparation for long-duration missions outside of low Earth orbit. Themes to be discussed include risk reduction, international scientific collaboration, and key research findings and their impacts on the design of future systems. Specifically, the HRP Path to Risk Reduction and its relationship to human system risks will be discussed. The role of one-year missions, the Twins Study, and international collaboration in informing these risks and preparing for long duration exploration missions will be examined. Other presentations in this panel will delve into specific design considerations for the exploration vehicle, habitat, and medical system.

[414] PLANNING FOR INTERNATIONAL HUMAN RESEARCH ON THE INTERNATIONAL SPACE STATION (ISS)

J.B. Charles

Human Research Program, NASA Johnson Space Center, Houston, TX

INTRODUCTION: Effective use of unique ISS capabilities requires coordinated multinational biomedical research. The five ISS partners chartered Multilateral Human Research Panel for Exploration (MHRPE) for this purpose. **METHODS:** As a demonstration, in 2011 MHRPE asked NASA's Human Research Program (HRP) and the Institute of Biomedical Problems (IBMP) of the Russian Academy of Science to develop a joint program for the 2015 one-year ISS mission (1YM). An overlapping list of 16 HRP, 9 IBMP, 3 Japanese, 3 European and 1 Canadian investigations address risk-reduction in 7 categories: Functional, Behavioral Health, Visual Impairment, Metabolism, Physical Performance, Microbial and Human Factors. **RESULTS:** The joint in-flight investigation, "Fluid Shifts," uses extensive NASA instrumentation during lower body negative pressure (LBNP) to test the role of fluid redistribution in weightlessness in the visual impairment reported by ISS astronauts. LBNP and its medical monitoring equipment are only available in the Russian segment, making Fluid Shifts a pathfinder for future complex investigations. "Field Test" is an important joint pre- and postflight study of astronaut capabilities immediately after a simulated Mars transit. It comprises 3 tests: in Sit-to-Stand, the astronaut stands quickly for 10 seconds; in Recovery from Fall/Stand Test, the astronaut, after 2 minutes prone, stands up as quickly as possible and remains standing for 3½ minutes; and in Tandem Walk, the astronaut walks heel-to-toe along a measured linear course with eyes closed. A preliminary version started in September 2013, and the full version will commence on the 1YM. **DISCUSSION:** Experience gained during preparations for 1YM has identified improvements in both American and Russian processes for future ISS expeditions, including proposed coordinated research on 6-month, one-year and 6-week missions. In this way, the resources and capabilities of ISS can be applied most efficiently to solving the problems facing astronauts from all nations in missions to deeper into the solar system.

Learning Objectives:

1. The general characteristics of the joint American-Russian year-long mission on ISS are described.

[415] THE TWINS STUDY: NASA'S FIRST FORAY INTO 21ST CENTURY OMICS RESEARCH

C. Kundrot¹, M. Shelhamer¹, and G.B. Scott²

¹Human Research Program, NASA Johnson Space Center, Houston, TX; ²National Space Biomedical Research Institute, Houston, TX

INTRODUCTION: The full array of 21st century omics-based research methods should be intelligently employed to reduce the health and performance risks that astronauts will be exposed to during exploration missions beyond low Earth Orbit. In March of 2015, US Astronaut Scott Kelly will launch to the International Space Station for a one year mission while his twin brother, Mark Kelly, a retired US Astronaut, remains on the ground. This situation presents an extremely rare flight opportunity to perform an integrated omics-based demonstration pilot study involving identical twin astronauts. A group of 10 principal investigators has been competitively selected, funded, and teamed together to form the Twins Study. A very broad range of biological function are being examined including the genome, epigenome, transcriptome, proteome, metabolome, gut microbiome, immunological response to vaccinations, indicators of atherosclerosis, physiological fluid shifts, and cognition. Both subjects will have completed two comprehensive baseline data collection (BDC) sessions before flight. Samples and data will be collected from the flight subject throughout his flight; two major sessions during the flight are planned for the ground subject. Both subjects will have two major data and sample collection sessions post-flight. The plans for the Twins Study and an overview of initial results from the BDC sessions will be described as well as the technological and ethical issues raised for such spaceflight studies. An anticipated outcome of the Twins Study is that it will place NASA on a trajectory of using omics-based information to develop precision countermeasures for individual astronauts.

Learning Objectives:

1. Describe the types of knowledge that can be provided by omics research.

[416] RESEARCH PLAN TO REDUCE CREW RISKS DURING HUMAN SPACE EXPLORATION MISSIONS

W.H. Paloski

Human Research Program, NASA Johnson Space Center, Houston, TX

INTRODUCTION: Future human space exploration missions under consideration by multiple space agencies will create unprecedented challenges to the health and performance of the crewmembers selected for assignment to those missions. NASA's Human Research Program (HRP), in conjunction with the agency's Health and Medical Technical Authority (HMTA), has identified a set of hazards that vary in severity with mission design and objectives. These hazards: altered gravity fields, radiation, distance from Earth, isolation/confinement, and hostile/closed environment, lead to a set of 32 mission-specific risks that must be reduced in consequence and/or likelihood to levels acceptable to meet operational requirements as well as medical, ethical, and legal norms. Risk mitigation (reduction to acceptable levels) strategies include establishing human health, performance, and habitability standards that must be met by mission and vehicle designers, as well as developing countermeasures and other risk mitigation solutions, including advanced habitability and medical support technologies, that must be incorporated within vehicle designs. Thirty of these risks require biomedical research and/or technology development for satisfactory mitigation to meet the most challenging design reference mission, a 30-month Mars mission that includes approximately 18 months on the Mars surface. Nine of these 30 risks are currently rated as unacceptable by HMTA, 15 others are rated as marginally acceptable with additional risk reduction desired, and the remainder are not currently rated, as insufficient evidence exists to rate them accurately. HRP subject matter experts have systematically collected and reviewed all of the evidence available for each risk and identified knowledge and/or mitigation gaps thought to be critical to reducing the risk. The HRP research plan focuses on soliciting and funding spaceflight, spaceflight analog, and laboratory research experiments that will fill the highest priority knowledge and mitigation gaps in order to provide risk reduction solutions in time to inform mission and vehicle designers. The success of the HRP research plan depends heavily on access to significant ISS resources between now and 2024.

Learning Objectives:

1. Identify the primary hazards affecting crew health and performance during space exploration missions.

[417] PRIORITIZING MEDICAL RESOURCES FOR EXPLORATION MISSIONSR.V. Shah¹ and E.L. Kerstman²¹*Preventive Medicine, UTMB, Galveston, TX;* ²*Aerospace Medicine, UTMB/Wyle/NASA, Houston, TX*

INTRODUCTION: Long-duration missions beyond low Earth orbit introduce new constraints to the medical system. Factors such as the inability to evacuate to Earth in a timely manner, communication delay, limitations in available medical equipment, and the clinical background of the crew will all have an impact on the assessment and treatment of medical conditions. The Exploration Medical Capability (ExMC) Element of NASA's Human Research Program seeks to improve the way the element derives its mitigation strategies for the risk of "Unacceptable Health and Mission Outcomes Due to Limitation of In-flight Medical Capabilities." **METHODS:** The Integrated Medical Model (IMM) is a probabilistic model designed to quantify in-flight medical risk to astronauts as well as associated medical impacts on space missions, to aid in mission planning and design. For each of the medical conditions encompassed by the IMM project, a suite of medical capabilities best suited to address each condition will be defined with respect to the current terrestrial standard of care. The suite will draw upon the preventive medicine paradigm of primary, secondary, and tertiary prevention to address the following categories: safety/prevention, screening, diagnosis, and treatment. Conducting IMM simulations for each Design Reference Mission

allows the ExMC to identify the conditions that are major contributors of risk for each forecasted outcome of loss of crew life (LOCL), probability of evacuation (EVAC), and quality adjusted mission time lost (QAMTL). The ExMC Element will draw upon these output metrics (LOCL, EVAC, QAMTL) from the IMM and will aim to prioritize portions of the outlined suite of medical capabilities in its assessment. **RESULTS:** This effort outlines a repeatable, evidence-based process with the goal of helping the ExMC Element attain an acceptable risk posture for exploration missions.

Learning Objectives:

1. To understand how the Integrated Medical Model (IMM) can aid the Exploration Medical Capability Element of NASA's Human Research Program to mitigate the risk of "Unacceptable Health and Mission Outcomes Due to Limitation of In-flight Medical Capabilities."

[418] ISOLATION, CONFINEMENT AND HABITABILITY IN EXTREME ENVIRONMENTS OF SPACE EXPLORATIONL.B. Leveton¹ and A. Whitmire²¹*Division of Biomedical Research and Engineering Science, NASA Johnson Space Center, Houston, TX;* ²*Wyle, Houston, TX*

INTRODUCTION: NASA's future exploration missions will place small teams of individuals into the isolated, confined, extreme (ICE) environment of deep space. Crews of 4 - 6 will live and work in a confined spacecraft or habitat, out of view of the Earth, separated by unprecedented distances and durations, with the absence of real-time communications and support from the ground. ICE environments such as Antarctic stations, are often associated with adverse behavioral outcomes including insomnia and depression. Countermeasures to enhance behavioral health and performance must take into account the habitat or spacecraft itself including volume, layout, and the psychological stressors. Isolation studies in analogs of various fidelity to exploration missions are utilized to characterize and assess behavioral risks, validate monitoring and countermeasures, and establish standards. Determining the minimum acceptable net habitable volume for exploration spacecraft must be determined from both human factors and behavioral health perspectives and with an understanding of what the negative consequences for psychosocial well-being and performance of the crews embarked on exploration missions. This presentation describes those factors, the approach that was undertaken to derive a minimal acceptable volume, and the type of isolation studies needed to validate potential habitable volume requirements.

Learning Objectives:

1. To understand what is meant by minimal acceptable net habitable volume.
2. To understand what the psychological stressors are associated with living and working in an isolated, confined extreme environment associated with exploration missions.
3. To understand how ground analogs are used to characterize and counteract behavioral health and performance risks associated with exploration missions.

[419] HABITAT DESIGN FOR EXPLORATION MISSIONS

M. Whitmore

Habitability & Human Factors Branch, NASA Johnson Space Center, Houston, TX

INTRODUCTION: As NASA plans to explore space beyond low-orbit, spacecraft design in terms of crew habitable volume and internal layout becomes very critical to enable safe, effective, efficient and acceptable working and living environment for the astronauts, including effective 3-dimensional (3-D) space utilization of the habitable volume and operational task flow. Current approaches to defining habitable volume and internal layout have been primarily human-in-the-loop mock-up evaluations and limited use of computational models, such as Jack mannequins and CAD models of spacecraft to visualize physical dimensions for volume driving tasks. The task volumes are drawn from legacy hardware, the Human Integration Design Handbook (NASA, 2010), the American Bureau of Shipping (ABS) Guide for Habitability (ABS, 2001), and applicable vehicle mockups. These task volumes are intended to provide the designers a

starting point when designing habitable spaces. At present, NASA does not have computational models of adequate fidelity for the human and their habitat. The models that do exist have not been sufficiently validated; fewer still have been certified. The primary means of in-flight habitability assessments have been limited to the use of crew debrief reports and post-flight analysis of mission video footage. Human factors research is looking to develop more advanced computational models to determine acceptable minimal habitable volume based on Exploration mission characteristics, processes and guidelines for architectural layout of spacecrafts, and providing tools, metrics and processes to assess habitable volume for long-duration missions. These planned research efforts include: habitability assessment of International Space Station (ISS) during the 1-year mission, computational modeling research to develop a tool for calculating the habitable volume, and developing requirements and non-invasive, unobtrusive 3-D space utilization assessment tools for use in microgravity. This research would provide a suite of tools for human factors engineers, habitat designers, and system integrators in driving the design of next generation space vehicles, and help communicating among stakeholders throughout the design and development phases.

Learning Objectives:

1. Determine the appropriate standards, tools and metrics for the next generation Exploration habitat design.

Thursday, May 14
S. Hemisphere 4

10:00 A.M.

[LXXX.] PANEL: THE FINAL FRONTIER: CINEMATIC DEPICTION, PREDICTION AND INSPIRATION OF MANNED SPACE TRAVEL

Co-Chair: William McDonald
Pensacola, FL

Co-Chair: Arlene Saitzyk
Pensacola, FL

PANEL OVERVIEW: From its first cinematic depiction in George Melies' 1902 "Le Voyage dans la Lune" ("A Trip to the Moon") to Alfonso Cuarón's seven-time Academy Award winning 2013 film "Gravity" - and beyond! - space flight has been a popular subgenre of science fiction films. Movies interact with culture in complex ways, uniquely reflecting previously unexamined aspects of society, and sometimes, especially in the case of science fiction, anticipating or even influencing the direction of technical and industrial progress and public policy. We will discuss the many ways movies about space flight have reflected and influenced the popular imagination, from the very beginning of narrative film at the turn of twentieth century, through early developments in rocketry and aerospace science, to the first half-century of manned space flight. A variety of films spanning the entire history of cinema, some well-known, others once influential but now all but forgotten, will be discussed. Brief excerpts from key selections of films about space flight will be shown, along with still photos from other representative examples. Narrative motion pictures have been a unique and powerful medium for expression of mankind's hopes and fears about the exploration of space, and have arguably played an influential role in scientific and societal progress toward realization of the age-old dream of reaching beyond our terrestrial origins to the mysteries beyond.

[420] THE FINAL FRONTIER: CINEMATIC DEPICTION, PREDICTION, AND INSPIRATION OF MANNED SPACE TRAVEL
A. Saitzyk, W.A. McDonald, and T. Walker
Psychiatry, NAMI, Pensacola, FL

INTRODUCTION: This panel is a group presentation by members of the Naval Aerospace Medical Institute (NAMI) Psychiatry Department, and the following abstract reflects concepts covered in the session overview. From classic films like George Melies' 1902 "Le Voyage dans la Lune" ("A Trip to the Moon") to Alfonso Cuarón's seven-time Academy Award winning

2013 film "Gravity" - and beyond! (perhaps to Christopher Nolan's 2014 contender "Interstellar") - spaceflight plays an integral part in science fiction films. **METHODS:** During this panel, we will discuss the many ways movies about space flight have reflected and influenced the mind, and perhaps even predicted its inventions. Films spanning over a century of cinema, some easily recognizable, others once significant but now all but forgotten, will be discussed. Brief excerpts from key selections of films about space flight will be shown, along with still photos from other representative examples. **DISCUSSION:** Narrative motion pictures are a powerful medium for expression of our hopes and fears about the exploration of space, and have played an influential role in scientific and societal progress toward realization of the age-old dream of reaching beyond our terrestrial origins to the mysteries beyond.

Thursday, May 14
S. Hemisphere 5

10:00 A.M.

[LXXXI.] SLIDE: IN PURSUIT OF HUMAN PERFORMANCE

Co-chair: Judith Hayes
Houston, TX

Co-chair: Deborah J. White
San Diego, CA

10:00 a.m.

[421] HUMAN EXPLORATION RESEARCH ANALOG (HERA): USE OF CREW MEMBER EXPERIENCE FOR EVALUATING MEDICAL CAPABILITIES FOR SPACE EXPLORATION

V. Hurst², A. Keenan², and R.V. Shah¹

¹Aerospace Medicine, UTMB/Wyle/NASA, Galveston, TX;

²Wyle, Houston, TX

INTRODUCTION: In 2013, the NASA Human Research Program (HRP) acquired the Human Exploration Research Analog (HERA), a simulated space vehicle habitat, from the Engineering Directorate at the NASA-Johnson Space Center (JSC) for the purposes of conducting research in multiple areas, including Behavioral Health and Performance and Space Human Factors and Habitability. The first campaign of HERA missions conducted by the HRP was based on an asteroid exploration mission and consisted of 4 repeatable 7-day missions, each with a crew of 4. **METHODS:** Each crew was trained at least one week prior to ingress and participated in mission activities designed for high mission fidelity and to assess impacts on team cohesion, mood, and cognitive performance. To better understand the crew perspective for an exploration relevant mission, personnel from the HRP's Exploration Medical Capability element team (ExMC) culled their experiences as part of a HERA crew member to help the ExMC improve its methods for evaluating and integrating medically-related products for such an environment. **RESULTS:** The ExMC is charged with reducing the risk of "unacceptable health and mission outcomes due to limitations of in-flight medical capabilities" for exploration missions. As part of this effort, ExMC personnel are planning to evaluate its products and capabilities within simulated spaceflight environments, including the HERA. This effort will be comprised of, in part, of the ExMC's evaluation of its medical management system prototype for the Exploration Medical System Demonstration (EMSD) project in HERA in early 2015. **DISCUSSION:** The first part of this presentation will cover aspects of HERA Campaign 1 from a crew perspective. The final part will show how the ExMC will take the results and lessons learned from its HERA experience and the EMSD evaluation and fold them into their future evaluations of other exploration-related medical capabilities within the HERA along with other simulated exploration environments (e.g. McMurdo Station in Antarctica and the NASA Extreme Environment Mission Analog (NEEMO) off the coast of Florida, USA).

Learning Objectives:

1. To understand the unique and robust space flight-relevant environment that the Human Exploration Research Analog (HERA) provides to investigators that are developing exploration-related capabilities.

10:15 a.m.

[422] ABOUT THE ADDED VALUE OF DIGITAL EQUIPMENT IN A NEW OPERATIONAL APPROACH AS PART OF HUMAN FACTORS STUDIES, THE FRENCH AIR FORCE A400M TEST FLIGHTS USE CASEC. Bey¹, S. Lini^{1,2}, B. Clavierie¹, J. Andre¹, and S. Hourlier¹¹HEAL, CNRS, Bordeaux, France; ²AKIANI, Talence, France

INTRODUCTION: Objective assessment of performance in real life situations and the workload associated remains a major concern in Human Factors Research. Human monitoring technologies are more and more reliable and autonomous. They are augmenting the Naturalistic Decision Making framework and make possible an activity analysis adapted to different needs and uses. New digital equipment such as wearable eye tracking systems or versatile cameras are making us able to get closer to the effective activity and to transcend the walls of our laboratories, departments and industries as well as to deal with ever-increasing amounts of data resulting of in-situ observation. **METHODS:** In this context, far from replacing or duplicating usual methods, these powerful new tools act as an effectiveness multiplier of good practices. During operational test evaluations of the new European military transport aircraft Airbus A400M, we have implemented for the French Air Force a number of these technologies in addition to usual behavioral Human Factors methods. **RESULTS:** The results achieved by the use of such tools allowed us to overcome the limitations of operational studies (few trained crew members available, reproducibility of situations). It led us to produce a number of appropriate recommendations for operational use. **DISCUSSION:** These recommendations improved the crew safety and the operational performance. It shows the added value of digital equipment in Human Factors studies undertook in operational context.

Learning Objectives:

1. It allowed us to assess the aircrew current performance, their situational awareness, their workload and adaptive strategies due to unforeseen events or crisis situations.

10:30 a.m.

[423] ANALYSIS OF F-35 OBOGS OXYGEN PRODUCTION

P. Lipinski, R. Jager, and R.M. Monberg

USAF, North Pole, AK

INTRODUCTION: Test and evaluation of an installed OBOGS in an integrated aircraft system typically relies on aircrew self-assessment and presentation of clinical symptoms in order to detect off-nominal events and to serve as impetus to assess performance. As such, overall system characterization, such as realized vs. projected oxygen schedule, performance over time, and response to aircraft flight envelope, is oft overlooked in test programs, allowing off-nominal performance to go unnoticed unless symptoms manifest in future aircraft use. **METHODS:** Software tools were developed to evaluate the OBOGS and life support system on a modern fighter aircraft system to be coupled with subjective reporting to better break out system performance and possible deficiencies. **RESULTS:** This presentation focuses on the use of the developed analysis tools to evaluate performance of an OBOGS in a modern fighter aircraft. Results from the analysis include actual oxygen schedules vs. lab schedule, differences across airframes, uncovered dependence on environmental parameters, and avenues for use of the tool in related aspects of aircraft life support systems. **DISCUSSION:** Similar tools can be used to evaluate performance of life support systems in fielded aircraft and to evaluate system health. Such tools in concert with clinical assessment can supplement root cause investigations of symptoms and suspected problems during test and in operations.

Learning Objectives:

1. Understand the performance specifications of the F-35 OBOGS as designed and oxygen production schedule observed in actual use.

10:45 a.m.

[424] CONTRIBUTION OF IN-EAR COMMUNICATIONS TO THE TOTAL SOUND EXPOSURE OF DUTCH NH90 AIRCREWY. Steinman^{1,2}¹Center for Man in Aviation, Soesterberg, Netherlands;²Royal Netherlands Air Force, Breda, Netherlands

INTRODUCTION: Some of the NH90's aircrew reported hearing beeps and whistles in the ears, sometimes for the duration of days, after flying in the NH90. The complaints persisted even after the introduction of the new flight helmet for the NH90 and an earplug with in-ear communications. Therefore as a precaution flight duration on the NH90 was restricted to one hour and an investigation was initiated to determine the cause of the complaints. The investigation concentrated on two areas: NH90 interior noise level and sound levels through the in-ear communications. **METHODS:** Measurements of NH90 interior noise levels were performed using four microphones placed at four different locations in the NH90 and microphones that were attached to the pilot's shoulder. Recordings were made of the electrical signal levels of the in-ear communications during flight. These were used to determine the speech levels through the in-ear communications. All measurements were performed in the NH90 during different flight profiles. **RESULTS:** Noise levels in the NH90 were dependent of the flight profile flown and varied between 90 and 99 dB(A) in the cockpit, and between 84 and 103 dB(A) in the cabin. Sound levels of the in-ear communications were dependent of the user and varied between 3 and 17 dB(A) above the interior NH90 noise reaching the ear. **DISCUSSION:** If the sound attenuation by helmet and earplug with communications is taken into account, the sound exposure levels for the NH90's aircrew is below the safety limit of 80 dB(A). However, depending on the user, sound exposure can exceed 80 dB(A) if speech through the in-ear communication is high. Discipline in keeping the intercom volume at as low as possible levels, as well as constraining its usage to necessary communication only, is essential.

Learning Objectives:

1. The contribution of in-ear communications to total sound exposure of the aircrew is identified.
2. The importance of measuring the sound levels of in-ear communications is demonstrated.

11:00 a.m.

[425] REVIEW OF TWO DECADES OF CENTRIFUGE TRAINING IN INDIA

M. Dahiya, P. Rastogi, S. Khatua, and N. Rao

Institute of Aerospace Medicine, Bangalore, India

INTRODUCTION: In India, the Institute for Aerospace Medicine, Bangalore has been the pioneer in the field of Aerospace Medicine Research since its inception in 1957. Since 1966 the Institute has a Human Centrifuge which was used only for research and medical evaluation till 1991. **METHODS:** A review of records of all the centrifuge runs carried out in the Department of Acceleration Physiology at IAM was carried out. These were available from 1980 onwards. **RESULTS:** In March 1991 a six day High G Course for Indian Air Force fighter aircrew was started. This course was conducted for four years, till 1995, and in 35 courses 178 aircrew were trained. In 1995 the course duration was increased to two weeks and the course was renamed Advanced Fighter Aircrew Indoctrination Course (AFAIC). This course continued for 10 years and in 103 Courses a total of 611 aircrew were trained. This course was closed with the decommissioning of the old centrifuge. A new High Performance Human Centrifuge was installed in 2009, the courses recommenced in Mar 2009 under a new name, Operational Training in Aerospace Medicine (OPTRAM). Two different courses of 3 and 5 day duration were conducted depending on the experience of the aircrew, whether undergoing advanced flying training or experienced aircrew from the squadrons. In Dec 2013 a review of the current training was done and changes made to make the course more operationally relevant.

Learning Objectives:

1. The main learning objective is to understand the four different phases that centrifuge training has undergone in India. Each phase has been a learning process and has contributed to improving training for fighter aircrew. The various steps taken in the past have helped the course grow and reach its current standing. The reasons behind the various parts of the current course become clear as the changes in each phase are discussed.

11:15 a.m.

[426] PARAMETRIC ANALYSIS OF SPINAL INJURY RISK FACTORS: COMPARATIVE ASSESSMENT OF TORSO- AND SEAT-MOUNTED RESTRAINT SYSTEMS

A.M. Albrecht

FEER, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: The new JSF F-35 aircraft will employ a Martin-Baker Mk-US16E seat-mounted harness (SCH) ejection seat system. However, preliminary studies report a higher than expected spinal injury rate upon ejection using the new Mk series seats. But, the risk of spinal injury was deemed acceptable (< 5%) when estimated by the USAF Dynamic Response Index, the primary method used by the USAF for estimating injury risk during aircraft ejections. There is great concern regarding this gross underestimation of spinal injury risk. The reason for this greater than predicted spinal injury rate during Mk seat ejections is due to excessive upper torso motion generated by the combination of new seat-mounted harnesses, forward-mounted headrests, and helmet-mounted systems being employed with these seats. The use of a traditional torso-mounted harness (TH) will reduce this upper-torso motion, increasing protection against spinal injuries upon ejection from the aircraft. **METHODS:** Manikin impact tests were conducted to investigate the effects of various parameters on the cervical and lumbar spine, under simulated ejection conditions, comparing the new SCH to the traditional TH ejection seat systems. **RESULTS:** Statistical analysis of the data demonstrated a significant positive correlation between spinal loads and displacements with various seat, restraint, and equipment configurations and the risk of injury during ejection from high performance aircraft. **DISCUSSION:** The authors conclude that, compared to the new SCH system, ejection from a high performance aircraft using a traditional TH ejection seat system results in a lower incidence of spinal injuries.

Learning Objectives:

1. Comprehend the relationship between seat, restraint, and equipment parameters and the risk of spinal injury during ejections from high performance aircraft.

Thursday, May 14

S. Hemisphere E3

10:00 A.M.

[LXXXII.] PANEL: AEROSPACE MEDICINE REVIEW BOARD #3: OPERATIONAL AEROSPACE MEDICINE AND MANAGEMENT & ADMINISTRATION

Co-chair: Justin Woodson

Bethesda, MD

Co-chair: Charles Clinton

Yorktown, VA

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 each year by specialists in the field and adhere to the ABPM Study Guide outline which will be covered in 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 the preventive medicine core and the four core knowledge areas of Aerospace Medicine: Flight Environment, Clinical Aviation Medicine, Operational Aerospace Medicine, and Management & Administration. This panel will cover essential elements of OPERATIONAL AEROSPACE MEDICINE and MANAGEMENT & ADMINISTRATION in two parts: 1) Organizations and functions (ICAO, DoT, FAA, NASA, NTSB, WHO) 2) crash worthiness; airport disaster management; forensic considerations.

Thursday, May 14

S. Hemisphere E4

10:00 A.M.

[LXXXIII.] PANEL: NEUROLOGICAL EFFECTS OF HYPOBARIC EXPOSURE

Chair: Paul Sherman

Boerne, TX

PANEL OVERVIEW: A strong association has been demonstrated between subcortical white matter injury and exposure to USAF operational non-hypoxic hypobaric conditions. This panel will review recent findings in humans and animals. Presentations will include: structural MRI change associated with hypobaric non-hypoxic exposure; structural MRI changes in USAF personnel associated with a single exposure to hypobaric hypoxic conditions in an altitude chamber; a cerebral MRI study of Norwegian altitude chamber instructors; neurocognitive change associated with subcortical white matter burden associated with hypobaric exposure; neuropsychiatric mortality in high altitude pilots; *Sus acrofa domestica* as a model for hypobaric non-hypoxic exposure; and proteomic and metabolomic studies in a rat hypobaric exposure model.

[427] SINGLE EXPOSURE TO HYPOBARIA AND/OR HYPOXIA TRIAL: PRELIMINARY FINDINGSP.M. Sherman¹, S.A. McGuire², and P. Kochunov³

¹Human Performance/Radiology, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH and Wilford Hall ASC, Boerne, TX; ²Consultation Division, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH; ³Psychiatry, University Of Maryland, Baltimore, MD

INTRODUCTION: We postulated that a single exposure to a hypobaric environment (25,000 ft) with or without hypoxia, would induce transient MRI changes in fractional anisotropy, arterial spin labeling cerebral perfusion and spectroscopy data, in addition to changes in inflammatory biomarkers. **METHODS:** We performed MRI imaging on a 3 Tesla Siemens Verio magnet one day prior, one day post, and three days post altitude chamber exposure, conducted for initial qualifying Air Force flight training requirements. Phlebotomy was performed for laboratory analysis immediately prior to altitude chamber exposure, immediately post altitude chamber exposure, and prior to MRI #2 and MRI #3. Laboratory analyses included S100B, tumor necrosis factor alpha, interleukin-6, interferon gamma, and microparticle analysis. **RESULTS:** Utilization of an arterial spin labeling (ASL) technique demonstrated preliminary results of increased cerebral blood flow to the white matter and cerebral cortex 24 hours post hypobaric exposure. Evaluation of fractional anisotropy and magnetic resonance spectroscopy imaging changes as well as inflammatory biomarkers is in progress. **DISCUSSION:** Preliminary data demonstrates a consistent physiologic change of increased cerebral blood flow 24 hours post hypobaric exposure. Cerebral blood flow is tightly regulated to meet the brain's metabolic demands. Our findings suggest that hypobaric exposure results in a temporary increased metabolic demand on the brain, possibly related to effects upon metabolic or pressure autoregulation.

Learning Objectives:

1. Review MRI white matter changes in high altitude pilots and physiologic chamber technicians and present preliminary findings of brain and systemic physiologic changes after single exposure to hypobaria.

[428] CASE CONTROL: NEUROPSYCHIATRIC DEATHS ARE NOT ASSOCIATED WITH PRIOR SERVICE IN HYPOBARIC OCCUPATIONS IN THE U.S. AIR FORCEJ. Connolly⁵, J. Escobar¹, A. Scher², S. McGuire^{3,4}, and J.D. Voss¹

¹Epidemiology Consult Service, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH; ²Preventive Medicine & Biometrics, USUHS, Bethesda, MD; ³Aeromedical Consult Service, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH; ⁴Neurology, UTHSCSA, San Antonio, TX; ⁵Aerospace Medicine Residency, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: Prior reports identified an occupational association between white matter hyperintensities (WMH) and service as a U-2 pilot (U2P) or altitude chamber aerospace physiologist (PHY), professions that involve exposure to higher altitude than other U.S. Air

Force (USAF) occupational categories. WMH burden is higher in U2P and PHY compared to matched normative USAF doctorate level controls. Increasing WMH burden in various conditions is associated with cognitive decline. Recently, a cognitive difference has been shown in U2P vs. other USAF pilots and between U2P with high WMH burden vs. low WMH burden. Hypothesis: While increasing WMH is associated with a cognitive difference in U2P, it is not associated with neurologic or psychiatric causes of death in USAF members with hypobaric non-hypoxic occupational exposure. **METHODS:** We constructed a case control study using the Air Force Mortality Registry. Cases consisted of all members with neurologic or psychiatric diagnoses on their death certificates. Controls died of cancer. The exposure of interest was serving as a U-2 or SR-71 pilot, SR-71 Reconnaissance System Officer, or aerospace physiologist or technician. **RESULTS:** There were 2,365 neurologic or psychiatric cases, 1 from the exposure group. There were 36,495 cancer controls, 54 from the exposure group. The odds of having a hypobaric occupation if death was from neuropsychiatric causes were 0.29, $p=0.26$. When adjusted for age, sex, and race in a multivariate model by logistic regression, the odds ratio was 0.99, $p=0.98$. **DISCUSSION:** This study did not demonstrate an association of neuropsychiatric mortality with service as a USAF U-2 or SR-71 aircrew, aerospace physiologist, or technician when utilizing cancer mortality as the control. Further study on the long-term morbidity of hypobaric non-hypoxic WMH is needed.

Learning Objectives:

1. To understand that while cerebral white matter hyperintensities are associated with some neurocognitive differences in U-2 pilots, hypobaric non-hypoxic occupational exposure is not associated with neuropsychiatric causes of death.

[429] STRUCTURAL MAGNETIC RESONANCE IMAGING CHANGE ASSOCIATED WITH HYPOBARIC NON-HYPOXIC EXPOSURE

S. McGuire³, P.M. Sherman², and P. Kochunov³

¹University of Maryland, Baltimore, MD; ²Human Performance/Radiology, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH, and Wilford Hall ASC, Boerne, TX; ³U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: We postulated that subcortical white matter (WMH) injury associated with repeated exposure to hypobaric non-hypoxic environments will induce or be associated with other permanent magnetic resonance imaging (MRI) change. **METHODS:** We previously imaged 106 U-2 pilots, 83 altitude chamber personnel, and 162 doctorate controls and demonstrated increased subcortical WMH burden associated with hypobaric exposure. We now compared diffusion tensor imaging and cortical mapping to WMH burden. Statistical analysis was performed utilizing nonparametric methodologies. **RESULTS:** Diffusion tensor imaging change was associated with WMH burden in the insular lobe. Cortical mantle thickness after applying correction for different MRI scanners demonstrated no significant change. **DISCUSSION:** This study demonstrated the MRI fluid-attenuated inversion recovery structural changes previously reported are additionally associated with other structural change as measured by MRI parameters. This change may explain some of the neurocognitive functional difference previously reported in U-2 pilots. Further research is required to better understand the clinical significance and the underlying physiological basis of these changes.

Learning Objectives:

1. Understand the structural changes present on MRI following repetitive hypobaric exposure.

[430] SUS SCROFA DOMESTICA AS A MODEL FOR HYPOBARIC NON-HYPOXIC EXPOSURE

S. McGuire¹, P.M. Sherman², and P. Kochunov³

¹U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH; ²Human Performance/Radiology, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH, and Wilford Hall ASC, Boerne, TX; ³University of Maryland, Baltimore, MD

INTRODUCTION: We postulated repeated exposure to hypobaric non-hypoxic environments will induce magnetic resonance imaging structural change in *Sus scrofa domestica*. **METHODS:** Swine were exposed to repeated episodes of non-hypoxic hypobaria following 1 h of denitrogenation. Magnetic resonance imaging was used pre- and post-exposure as well as 4 wk post-exposure for characterization of structural change. Additionally, inflammatory serological markers and brain necropsy were performed. **RESULTS:** Initial subjects experienced fatal pulmonary decompression sickness. After revising the protocol and decreasing the hypobaric exposure load, no structural change was observed in the first surviving subject. Additionally, no hemosiderin deposits were detected. **DISCUSSION:** This prototype study demonstrated that swine can survive repeated exposure to hypobaric conditions in a tightly controlled environment if exposure is not extreme. However, preliminary fluid-attenuated inversion recovery results suggest this may not be an ideal model. Further research including the inclusion of more subjects with an increasing hypobaric exposure burden is required prior to rejecting this as a model for neurological decompression sickness.

Learning Objectives:

1. Understand the limitations of a *Sus scrofa domestica* model for hypobaric exposure.

[431] NEUROCOGNITIVE CHANGE ASSOCIATED WITH SUBCORTICAL WHITE MATTER BURDEN ASSOCIATED WITH HYPOBARIC EXPOSURE

J. Wood and S. McGuire

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

INTRODUCTION: High-altitude flying is associated with increased risk for neurological decompression sickness, and United States Air Force (USAF) U-2 pilots routinely fly high-altitude missions. Recent USAF research demonstrated that U-2 pilots had significantly lower scores on multiple cognitive measures compared to a control group that were correlated with white matter hyperintensity burden on fluid-attenuated inversion recovery. For this presentation, we correlated neurocognitive results with diffusion tensor imaging (DTI). **METHODS:** U-2 pilots and a pilot control group with no recurrent exposure to hypobaria were compared using a comprehensive neurocognitive screener, the MicroCog: Assessment of Cognitive Functioning. This neurocognitive screening device assesses attention/mental control, memory, reasoning/calculation, spatial processing, reaction time, information processing speed, information processing accuracy, general cognitive functioning, and general cognitive proficiency. Pilots' scores on the cognitive indexes were then compared to results from DTI. **RESULTS:** When correcting for multiple comparisons ($p<.006$), two neurocognitive domains, spatial processing and reaction time, were correlated with DTI tracts. **DISCUSSION:** Consistent with previous research examining neurological diseases, neurocognitive results were associated with DTI. Similarities and differences with other studies, including prior USAF research, will be discussed.

Learning Objectives:

1. To describe the association between neurocognitive testing and DTI results in high-altitude pilots.

[432] A CEREBRAL MRI-STUDY OF NORWEGIAN ALTITUDE CHAMBER INSTRUCTORS

J. Owe¹, B. Munkeby¹, and A. Bjørnerud²

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

INTRODUCTION: Subcortical White Matter Hyperintensities (WMH) have been detected in USAF U-2 pilots. Similar magnetic resonance imaging (MRI)-changes have been discovered in a group of USAF altitude chamber instructors with more than 50 chamber flights above 20,000 ft. In chamber training the exposure is normally of much shorter duration and at lower altitude than in the U-2. The minimum altitude exposure for developing WMH is unknown. At the Institute of Aviation Medicine, Norwegian Armed

Forces Medical Services a standardized chamber procedure aimed at reducing decompression sickness (DCS)-risk has been used since 1980. No cases of DCS have been reported with this procedure. Lack of venous gas emboli on ultrasound evaluation of the training profile also indicates a safe procedure. Contributing factors may be long pre-oxygenation, 45-60 min, including moderate exercise, no exposures above 25,000 ft and less than 12 min at this altitude. The aim of the study is to investigate if these extra safety measures have a protective effect on the development of WMH. **METHODS:** Chamber exposure data on about 20 former and present altitude chamber instructors has been collected. Additionally 20 sex- and age matched healthy controls will be included in the study. MRI will be performed on a 3 Tesla clinical scanner and will include the following structural acquisitions for assessment of cortical and white matter changes: isotropic 1 mm volumetric T1-weighted and fluid attenuated inversion recovery (FLAIR) sequences. In addition, whole brain diffusion tensor imaging (DTI) will be acquired to assess white matter integrity and arterial spin labelling (ASL) will be performed for quantitative assessment of cerebral and white matter perfusion. Finally, a T2*-weighted sequence will be acquired for assessment of microbleeds. **RESULTS:** A detailed description of the exposure variables and associated MRI findings will be presented.

Learning Objectives:

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

Thursday, May 14

1:30 P.M.

S. Hemisphere 1

[LXXXIV.] SLIDE: MATTERS OF GRAVITY

Co-Chair: Nicholas Green

Henlow, Bedfordshire, United Kingdom

Co-Chair: Ulf Balldin

San Antonio, TX

1:30 p.m.

[433] THE CARDIOVASCULAR RESPONSE TO VARIATIONS OF THE VALSALVA MANOEUVRE PERFORMED AT +1 AND +5GZ

A.J. Frizell¹, A. Stevenson^{1,2}, S. Gates¹, D. Parker², and R. Firth²

¹Aircrew Systems, QinetiQ, Wiltshire, United Kingdom; ²Center of Human & Aerospace Physiology Sciences, King's College London, London, United Kingdom

INTRODUCTION: The breathing component of the Anti-G Straining Maneuver (AGSM) increases mean arterial blood pressure (MAP), however, the associated increase in intra-thoracic pressure is thought to compromise cardiac output (CO). Aircrew use short expiratory strains (3s) exchanging breath between each to assist venous return and reduce the decrement in CO, but the timing of the strain and requirement for a full breath exchange may not represent the optimum technique when applied with Full Coverage Anti-G Trousers (FCAGT) **METHODS:** In 8 male subjects, thoracic impedance (TI) stroke volume (SV), heart rate (HR), CO and MAP were measured at +1Gz without FCAGT inflation and at +5Gz with the FCAGT pressurized while at rest and when performing a 40 mmHg Valsalva maneuver (VM). The VM was held for 3s (4 cycles), 7s (2) and 15s (1), with the 3s and 7s condition performed with and without release of the breath between strains. Data were collected over four 3s epochs during the expiratory strain/s, with the average of these data used for comparison between conditions and acceleration levels. **RESULTS:** TI was lower (8.6 ± 1.7 vs. 9.8 ± 1.7 ohms, $P = 0.003$) while SV (68 ± 19 vs. 60 ± 16 ml/min, $P = 0.02$), CO (5.9 ± 1.4 vs. 4.3 ± 1.1 l/min, $P = 0.002$) and MAP were higher (141 ± 36 vs. 94 ± 15 mmHg, $P = 0.001$) with VM at +5Gz compared with +1Gz. At +1Gz, MAP increased initially with VM (15 ± 8 mmHg, $P < 0.05$) before returning to baseline, though significant improvements were again observed at the final epoch due to a compensatory tachycardia. In contrast, MAP was increased ($P < 0.05$) throughout the VM at +5Gz, initially by 16 ± 8 mmHg and by 28 ± 19 mmHg at the final epoch. No differences in MAP responses were observed between conditions at +5Gz. **DISCUSSION:** CO was better supported during the VM at +5Gz, presumably due to increased central blood volume with FCAGT as indicated

by a lower TI. No significant benefit of changing strain duration or the extent of the breath exchange was found, however, the absence of any negative effect suggests that maintaining longer strains and/or lung volume during the breath exchange should not compromise +Gz protection.

Learning Objectives:

1. To characterize the cardiovascular response to the Valsalva maneuver at +1Gz and at +5Gz with anti-G trousers worn.
2. To assess whether the blood pressure response to repeated Valsalva maneuvers is affected by duration of maneuver, or the volume of breath exchanged between cycles.
3. To assess whether the application of a break in-between Valsalva maneuvers offers physiological benefit at +5Gz whilst wearing anti-G trousers.

1:45 p.m.

[434] ANTI-G STRAINING MANEUVER WITH FULL COVERAGE G SUITS AND PRESSURE BREATHING - HOW MUCH, WHEN?

N.D. Green

RAF Centre of Aviation Medicine, Henlow, United Kingdom

INTRODUCTION: Full coverage anti-G trousers (FCAGT) and pressure breathing for G (PBG) provide better protection against +Gz acceleration than legacy systems. Anecdotally, some pilots of aircraft featuring full coverage suits and PBG report they have found no need to perform the anti-G straining maneuver (AGSM), despite having been taught to do so during centrifuge training. These aircraft are typically high G onset rate, high Gz platforms. It is known there is a wide variation in pilot G tolerance, and so a safe but practical approach to G training for use with FCAGT and PBG is needed for aircraft such as the F-35 and Typhoon. **METHODS:** A literature review of the evidence for G protection provided by FCAGT and PBG was conducted, and the levels of reported protection were collated. **RESULTS:** In subjects using FCAGT and PBG, reported acceleration tolerance was variable, but no studies indicated relaxed protection was available to +9Gz when using a conventional seatback angle. The overall number of participants in these studies was small. Compared with a standard AGSM, one study found a modified AGSM technique (2-3 Valsalva cycles, then normal breathing pattern using PBG) was associated with lower energy cost for the same level of G protection. **DISCUSSION:** Evidence suggests aircrew should be instructed to perform an AGSM when using FCAGT and PBG at up to +9Gz. A modified AGSM technique may be sufficient to provide effective G protection with less physical demand.

Learning Objectives:

1. Understand the level of G protection provided by full coverage G trousers and pressure breathing for G.
2. Understand how much anti-G straining is needed when using full coverage anti-G trousers and pressure breathing for G protection.

2:00 p.m.

[435] INTERACTION OF ANTI-G SUIT AND AIRWAY PRESSURES ON CEREBRAL OXYGENATION DURING PROLONGED HEADWARD ACCELERATION

M.J. Gronkvist, M.E. Keramidas, C. Sundgren, and O. Eiken
Environmental Physiology, Royal Institute of Technology, Stockholm, Sweden

INTRODUCTION: During long-duration (> 2 min) exposure to a moderate +Gz load, oxygenation of the cerebral cortex exhibits a prompt initial drop, followed by a further slight decrement. The aims were firstly to determine if and to what extent hypoxemia contributes to the reduction in cerebral oxygenation during prolonged exposure to moderately increased G load, and secondly, to investigate how pressurization of the G-suit abdominal bladder and the airways (pressure breathing against G; PBG) interact as regards such reduction. **METHODS:** 6 subjects were exposed to 4-min +Gz plateaus at 4 and 5 G, with and without pressurization of the anti-G suit abdominal bladder, and with and without PBG (0.3 vs 3.0 kPa). Oxygenation of the cerebral frontal cortex (O_2Hb) was assessed using near-infrared spectroscopy (NIRS). Mean arterial pressure (MAP) and capillary oxyhemoglobin saturation (SpO_2) were measured continuously. **RESULTS:** In all conditions, O_2Hb exhibited a drop at increased G load, in

particular during the 5-G exposures. Both pressurization of the abdominal bladder and PBG tended to reduce the G-induced drop in MAP, and pressurization of the abdominal bladder aggravated the G-induced drop in SpO₂, whereas, PGB tended to counteract this drop. **DISCUSSION:** The results confirm that during prolonged exposure to a moderately increased G load, cerebral oxygenation may continue to drop despite partial recovery of arterial pressure. This continuous gradual drop in cerebral oxygenation is attributable to pulmonary shunting of deoxygenized blood to the systemic arteries, an effect that appears to be aggravated by pressurization of the anti-G suit abdominal bladder but is counteracted by PGB.

Learning Objectives:

1. Circulatory and respiratory effects of the different components of an anti-G system.

2:15 p.m.

[436] PRESSURIZED SLEEVES AND GLOVES FOR G-PROTECTION

T.R. Morgan², U. Balldin¹, and J. Fischer¹

¹Wyle Science, Technology & Engineering, San Antonio, TX; ²711th HPW/HPI, Air Force Research Laboratory (AFRL), San Antonio, TX

INTRODUCTION: The use of positive pressure breathing during G (PBG) with a full-coverage anti-G garment (ATAGS) has been shown to substantially increase G-tolerance and endurance. In a previous study, the G-induced arm pain sometimes associated with this equipment was substantially reduced or eliminated by the simultaneous use of pressurized sleeves and gloves. Since this equipment is effectively a G-suit for the upper limbs, and unpressurized arms accommodate substantial amounts of fluid during pressure breathing, it was hypothesized that the use of pressurized sleeves and gloves in conjunction with COMBAT EDGE and ATAGS might provide an additional increment of G-protection. **METHODS:** In a human-rated centrifuge, 15 well-trained subjects using COMBAT EDGE and ATAGS G-protective equipment were exposed to gradual and rapid onset relaxed G-exposures as well as rapid onset straining and simulated aerial combat maneuver G-exposures up to +9 G_s with and without pressurized sleeves and gloves. **RESULTS:** The pressurized sleeves and gloves did not show any improvement in G-tolerance or endurance compared to the control. However, we saw significantly lower heart rates (6-12%) and subjective effort (11%), along with slightly less peripheral vision loss. There was also a trend toward shorter time-on-target with the pressurized sleeves and gloves. **DISCUSSION:** The association of decreased heart rates and subjective effort with unchanged levels of G-tolerance and endurance implies that less physical work was required to reach the same level of protection when wearing the sleeves and gloves. The trend toward shorter time-on-target in the tracking task may reflect an effect of this equipment on hand mobility and control stick input.

Learning Objectives:

1. The effects of pressurized sleeves and gloves on acceleration protection during high G exposure.

2:30 p.m.

[437] ASSESSMENT OF HEART RATE VARIABILITY DURING SIMULATED PUSH-PULL MANEUVER USING TILT-TABLE

M. Khan¹, S. Vashisth², R. Vijay³, and A.K. Salhan⁴

¹Electrical Engineering, Jamia Millia Islamia, New Delhi, India;

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Gurgaon, India; ³Electronics, Vansthal, Jaipur, India; ⁴Biomedical

Instrument Division, DIPAS DRDO, New Delhi, India

INTRODUCTION: Fighter and aerobatic pilots are subjected to intense difficulties when a -Gz maneuver (push) is performed before a +Gz maneuver (pull). The push-pull maneuver (PPM) is responsible for accidents involving G-induced loss of consciousness (G-LOC). There is a great role of aortic carotid arteries in response to PPM. An effort has been made to design and develop a simple potable system to acquire real time detection of carotid artery pulse waveforms (CAPW). **METHODS:** A tilt table has been designed and developed to simulate PPM in the

laboratory. Further, a non-invasive system has also been built to acquire carotid artery pulse waveform (CAPW). The transducer was placed gently over the neck after palpating and finding carotid artery. The electrical signal from transducer is fed into sound port of computer. All 27 subjects were exposed to various tilt angles from 0° (supine) to -90° (head-down tilt: HDT) and from HDT to +90° (head-up tilt: HUT). The tilt table is rotated at a speed of 45°/sec. The heart rate was calculated from recorded CAPW at various tilt angles and MATLAB used for further analysis. **RESULTS:** Results are presented for heart rate variability from CAPW on virtual oscilloscope during 0° tilt and simulated PPM using tilt table. Reduction in heart rate (HR) is observed when body position is changed from supine to -90° HDT. The heart rate was found in increasing order when body position was changed from -90° HDT to +90° HUT). **DISCUSSION:** The variation in the amplitude and shape of the CAPW contour signified the altered heart contractions showing change in RR interval and amplitude. Two distinct peaks on the recorded CAPW has been found as positive peak representing the increase in arterial pressure due to ventricular contraction during systole and negative peak signifying the sudden reduction in the arterial pressure during diastole. The descriptive analysis of CAPW holds potential to refine cardiovascular stratification in response to PPM. A simple and cost effective piezoelectric sensor based system designed and developed for real time detection of the CAPW. The tilt table replicated the physiological variations related to PPM. Incomplete recovery of heart rate is observed after HDT to HUT.

Learning Objectives:

1. Design and development of tilt table for simulation of push-pull maneuver.
2. Design and development of piezoelectric transducer based system for recording of carotid artery pulse waveforms.
3. Assessment of heart rate from carotid artery pulse waveform.

2:45 p.m.

[438] ASSOCIATION BETWEEN G TOLERANCES AND AUTONOMIC ACTIVITY IN HEALTHY VOLUNTEERS

H. Cho², K. Chiang¹, and H. Chu^{1,2}

¹Aviation Physiology Research Laboratory, Armed Force Kaohsiung General Hospital Gangshan Branch, Kaohsiung, Taiwan; ²Institute of Aerospace and Undersea Medicine, National Defense Medical Center, Taipei, Taiwan

INTRODUCTION: Pilots of high performance aircrafts are subjected to high G forces in flight and may suffer G-induced loss of consciousness. Adequate anti-G straining maneuver provide protection from +Gz acceleration forces. Centrifuge training allows pilots to familiarize with the effects of acceleration and to practice anti-G straining maneuver. Autonomic nervous system plays essential roles in cardiovascular regulation. However, the relationship between individual G tolerance and autonomic nervous system activity is not clear. **METHODS:** Healthy young subjects were divided into basic initial training group (flight surgeons, flight nurses and aviation physiologists), intermediate qualification group (cadets) and advanced qualification group (fighter pilots). Relaxed and strenuous G tolerances were evaluated using human centrifuge. Heart rate and heart rate variability were recorded throughout centrifuge training. Saliva samples were collected before and after training and levels of salivary stress biomarkers (salivary alpha amylase and cortisol) were analyzed. **RESULTS:** 170 healthy young subjects participated in the study. Heart rate increased with +Gz exposure in all subjects. 26.1%, 24.7% and 13.6% subjects in initial training group, intermediate qualification group and advanced qualification group suffered G-LOC. Resting diastolic blood pressure and mean arterial blood pressure were higher in G-LOC subjects than in non-G-LOC subjects. There were positive correlations between Relaxed G tolerance and body fat percentage as well as strenuous G tolerance and resting heart rate. Negative correlation between strenuous G tolerance and height was observed. Salivary alpha amylase activity and cortisol concentration significantly increased under +Gz acceleration. Positive correlations between SDNN during start to RGT of the GOR training and G tolerance were observed. **DISCUSSION:** G tolerance was correlated to SDNN, an index of parasympathetic and sympathetic balance. In the future, HRV parameter may be used to evaluate G tolerance and to guide fighter pilots balancing aerobic exercise and weight training.

Learning Objectives:

1. Knowledge: understand factors that may affect G tolerance.
2. Application: physiologic parameters reflecting different human stress response system may be used to evaluate human response to acceleration.
3. Evaluation: HRV parameter may be used to evaluate G tolerance and to guide fighter pilots balancing aerobic exercise and weight training.

Thursday, May 14
S. Hemisphere 2

1:30 P.M.

[LXXXV.] PANEL: ASAMS CLINICAL UPDATES, PART I

Sponsored by the American Society of Aerospace Medicine Specialists

Chair: Patrick Storms
Dayton, OH

PANEL OVERVIEW: This session, sponsored by the American Society of Aerospace Medicine Specialists, will provide clinical updates for conditions of aeromedical significance.

[439] USAF UPDATE AND REVIEW: HEPATITIS C

P.R. Storms

FEEG, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: Chronic hepatitis C, once considered to be a form of chronic liver disease, is increasingly being approached as an infectious disease, given the development of effective antiviral therapy. The new availability of relatively short course therapy with effective agents has changed the approach to diagnosis, treatment, and follow-up, while having to deal with the considerable cost of these new agents. **METHODS:** Explore the epidemiology, pathogenesis, clinical presentation, diagnostic approach, and treatment options related to chronic hepatitis C. Further explore the unique aspects of the condition and the evolving approach to therapy. **RESULTS:** Review current clinical guidelines related to the diagnostic and treatment approach to hepatitis C. Further, review the USAF Aeromedical Consult Service hepatitis C experience. **DISCUSSION:** Chronic hepatitis C presents unique diagnostic and treatment challenges that warrant consideration in patients presenting with what was previously thought to be a chronic liver disease, rather than a treatable infection.

Learning Objectives:

1. Understand the epidemiology and pathophysiology of hepatitis C.
2. Understand the diagnostic approach and new treatment options for patients suspected of having hepatitis C.
3. Understand the aeromedical implications of hepatitis C in the aviator.

[440] ASAMS CLINICAL UPDATE: HYPERTENSION

C. Mathers

Preventive Medicine & Community Health, UTMB Health, Galveston, TX

INTRODUCTION: This presentation will provide an overview of the Eighth Joint National Committee (JNC 8) guidelines for the treatment of high blood pressure and review the management of hypertension in civil aviation. Cases will be discussed that highlight challenges in the management of hypertension in the aviator, focusing on the Conditions AMEs Can Issue (CACI) worksheet for hypertension.

Learning Objectives:

1. Manage hypertension using the Eighth Joint National Committee (JNC 8) guidelines.
2. Appropriately and accurately complete the Conditions AMEs Can Issue (CACI) worksheet for hypertension.

[441] CURRENT MANAGEMENT OF OBSTRUCTIVE SLEEP APNEA IN AIRMEN

D.G. Schall

Aerospace Medicine, FAA, Des Plaines, IL

INTRODUCTION: ASAMS Clinical Update Panel The incidence of Obstructive Sleep Apnea Syndrome (OSAS) continues to rise in the general population and is reflected in our flying population. Undiagnosed OSAS remains a danger for fatigue related errors in aviation. While obesity is a major contributor, others with normal BMI's may also present with OSAS. The Author, Board Certified in both Aerospace Medicine and Otolaryngology, will present an overview of Diagnosis, Evaluation and current treatment for OSAS as well as how to manage failures and non-compliance. **DISCUSSION:** The author will review how to screen airmen with various tools to assess for risk of OSAS. An overview of treatment options and their effectiveness will be discussed to include CPAP/BiPAP, Oral appliances, Positional therapy and Hypoglossal nerve stimulation. Failures and non-compliance interventions will be also be reviewed.

Learning Objectives:

1. Participant will be able to assess how to evaluate for Obstructive Sleep Apnea and discuss modalities of treatment currently available to airmen.

[442] MANAGEMENT OF SINUS DISEASE IN AVIATORS

D.G. Schall

Aerospace Medicine, FAA, Des Plaines, IL

INTRODUCTION: Sinus disease can be multi-factorial and requires proper workup and evaluation in order to begin effective treatment strategies. The author will review how to evaluate Aviators with sinus disease to include recurrent sinusitis, nasal polyposis, and nasal tumors. **DISCUSSION:** An overview of how to appropriately work up Airmen with Sinus disease will be discussed, to include proper clinical examination, imaging, pharmacotherapy and surgery. Aeromedical disposition after therapy will also be reviewed.

Learning Objectives:

1. Participant will be able to assess airmen with Sinus disease and recommend effective treatment options to allow for early return to flying duties.

[443] USAF UPDATE AND REVIEW: OBESITY

R. Allnutt

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

INTRODUCTION: Obesity is increasingly an important diagnosis with aviation implications. Obesity and the tendency to gain weight is affected by genetic factors, type of diet, and most importantly by total caloric intake balanced against energy expenditure. **METHODS:** Explore the epidemiology, pathogenesis, clinical presentation, diagnostic approach, and treatment options related to obesity. Further explore the unique psychosocial aspects of the condition and the wide range of treatment options. **RESULTS:** Review current clinical guidelines related to the diagnostic and treatment approach to obesity and the implications of the diagnosis in aerospace medicine. **DISCUSSION:** The medical and behavioral aspects of obesity are unique. Talking about obesity with aviators and prompting action on advice to lose weight is notoriously difficult. The pros and cons of the recent policy change regarding evaluation of elevated Body Mass Index (BMI) as outlined by the FAA will be discussed.

Learning Objectives:

1. Understand the epidemiology and pathophysiology of obesity.
2. Understand the treatment options for patients with BMI of greater than 30.
3. Understand the aeromedical implications of BMI of greater than 40 in the aviator.

[444] DIAGNOSIS AND TREATMENT OF AMYLOIDOSIS IN CIVILIAN PILOTS

L. Steinkraus

Medicine, Mayo Clinic, Rochester, MN

INTRODUCTION: Amyloidosis is a broad term for a group of syndromes related to protein abnormalities resulting in deposition of the abnormal proteins within various tissues. Primary aeromedical concerns relative to sudden incapacitation include the potential for cardiac and neurologic structures, but other structures affected (kidney, eye) may result in more subtle degradation of function that could be functionally significant. This presentation will review the pathophysiology and epidemiology of amyloidosis with a focus on the aviation population. Additionally, case reports will be presented to highlight the aeromedical implications of the disease as well as pathways for pilots to return to flight duty. **METHODS:** Literature review as well as use of case presentations will be used to elucidate the clinical presentation, course and aeromedical implications in pilots with amyloidosis. **RESULTS:** While a relatively rare disease, amyloidosis has classically been one of the "great pretenders" mimicking other disease states. Current diagnostic and treatment regimens have evolved which, when the disease is detected and treated in its early stages, may allow for rapid and safe return to flight duties. **DISCUSSION:** Incidence of amyloidosis has been decreasing in some populations while increasing or changing in other groups. Aeromedical specialists should be familiar with some of the clinical syndromes in which amyloidosis must be on the differential or effective treatment and duty disposition will be adversely impacted.

Learning Objectives:

1. Understand the basic pathophysiologic processes involved with amyloidosis.
2. Be prepared to discuss clinical syndromes in which amyloidosis must be considered.
3. Be prepared to explain to pilots initial steps required to allow consideration for return to flying duties after diagnosis of and treatment of common amyloidosis presentations.

[445] I "DUST MITE" HAVE TO SNEEZE -- THE LATEST THAT WE "NOSE" ABOUT ALLERGIC RHINITIS

J. LaVan

Residency in Aerospace Medicine, Naval Aerospace Medical Institute, Pensacola, FL

INTRODUCTION: Allergic rhinitis (AR) is a common condition, affecting up to 1 in 3 people in the United States and other industrialized countries, and the prevalence is increasing, particularly in urban areas. Due to the high prevalence, it is clear that aviation candidates and aviators will present with this diagnosis. Untreated, the symptoms of allergic rhinitis can cause fatigue and sedation and can potentially cause declines in cognitive function. The symptoms can also cause sleep disruptions, reducing restorative sleep, and leading to further increases in fatigue and decreases in daytime performance. Initial treatments with sedating antihistamines seemed to only compound these problems. However, treatments have evolved and continue to evolve from the initial, limited use of sedating anti-histamines to the current, multi-faceted approach allowing tailored treatment of allergic rhinitis. These treatments demonstrate varying degrees of safety, effectiveness and convenience, and thus have varying effects on aviators. Pathophysiology, current treatment guidelines and aeromedical implications of the diagnosis and treatment of allergic rhinitis will be described and current aeromedical disposition recommendations from major authorities will be reviewed.

Learning Objectives:

1. Recognize the pathophysiology and symptoms of Allergic Rhinitis.
2. Discuss options for treatment of the spectrum of Allergic Rhinitis.
3. Identify aeromedical implications of Allergic Rhinitis and its treatment and review current recommendations for aeromedical disposition from major authorities.

[446] COLOR VISION DEFICIENCY AND THE UNITED STATES AIR FORCE AVIATOR

T.C. Richardson

Aerospace Ophthalmology, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: The most common form of color vision defect is an inherited X-linked red/green deficiency, affecting 8-10% of males and

0.4-0.5% of females. Congenital deficiencies are typically the result of alterations (shifts) of one or more retinal pigments, referred to as an anomalous trichromat (have all three cones). These account for 5-6% of all congenital deficiencies, resulting in individuals who have altered accuracy in color perception, resulting in confusion between reds and greens. Approximately 2% of males exhibit dichromacy or absence of a cone (L, M, or S). Absence of the L-cone is referred to as protanopia, while absence of the M-cone is termed deuteranopia. Tritan (S-cone) defects are extremely rare, occurring in approximately 0.005% of the population. Acquired color vision defects can be caused by a myriad of pathologies. The most common acquired color defects present with S-cone deficiencies, although several disorders are noted to affect red-green color vision. Retinal diseases such as central serous retinopathy and drug toxicity can both be associated with red-green and blue cone defects. Color vision changes have been also been found as an indicator of optic nerve pathology. Aeromedically, color vision deficiency is disqualifying for entrance into all U.S. Air Force (USAF) aircrew positions, regardless of the severity and visual status. Trained aircrew may be waived for continued flying duties after passing an operational check confirming their ability to correctly identify and recognize cockpit/display colors and symbology. Current use of various colored spectacle lenses and blue blocking intra-ocular lenses are not authorized or waiverable for USAF aircrew, although high contrast visors (blue blockers) are allowed for color normal individuals. In this presentation, we will present data from the USAF Aeromedical Consultation Service to report the prevalence of color deficiency among active duty pilot and non-pilot populations, as well as the career impact on current aircrew and aircrew applicants diagnosed with color deficiency.

Learning Objectives:

1. Describe the types and incidence of various forms of color deficiency.
2. Report on the prevalence of color deficiency among USAF active duty aircrew.
3. Discuss USAF aeromedical policy on color deficient aircrew and aircrew applicants.

Thursday, May 14
S. Hemisphere 3

1:30 P.M.

[LXXXVI.] PANEL: PERSONALIZED HEALTH AND PERFORMANCE

Chair: Richard Hersack

Wright-Patterson AFB, OH

PANEL OVERVIEW: "Personalized Health and Performance" was identified as an Air Force game changer in the 2013 "Global Horizons: United States Air Force Global Science and Technology Vision" Report. "Personalized Health and Performance" provides unprecedented real-time and continuous feedback with quantification at the individual airman level from complex data resolution across scales from genes to the whole body, and enables an assessment of the physical and cognitive state of the airman for personalized solutions to sustain, optimize, and enhance each airman's performance and health lifecycle. In 2014, the 711th Human Performance Wing (711th HPW) recognized the importance of their role in realizing this game changer and identified it as one of its strategic vectors. The 711th HPW's portfolio comprises integral research tied to this game changer in the areas of genetic models of performance, 'omics' and biomarkers, novel micro sensing devices, the application of wearable sensors and integrated sensor suites, and models of physical and cognitive state assessments. This panel session provides an overview of the Global Horizons Study as well as the approach taken to identify and define the "Personalized Health and Performance" game changer for the US Air Force. Additionally, research efforts conducted across the 711th HPW's Science and Technology and Defense Health Program portfolio are presented and highlight the value of investigating individual differences, researching technologies for individual quantification and feedback, and discovering the impact of these considerations for airmen selection, training, protection, and performance.

[447] PERSONALIZED HEALTH AND PERFORMANCE: A GAME CHANGER FOR THE AIR FORCE AND THE 711TH HUMAN PERFORMANCE WING

J. Parakkat and W. Nelson

711th Human Performance Wing, Air Force Research Laboratory, Wright-Patterson AFB, OH

INTRODUCTION: As noted in the 2013 *Global Horizons: United States Air Force Global Science and Technology Vision* report, *Personalized Health and Performance* (PH&P) was identified as a top Air Force Game Changer through a strategic analysis of the global pharmaceutical and healthcare sector. The purpose of this paper is to describe the strategic deep dive methodology employed to identify the PH&P game changer and to discuss its relevance for the 711th Human Performance Wing. The deep dive involved: 1) a detailed survey of the Pharma/Health sector; 2) the identification of global trends that are transforming the industry; 3) an identification of threats and opportunities for the Air Force in terms of these trends; 4) an identification and prioritization of the S&T in the near, mid, and far terms, and the Air Force's role in terms of lead, follow, watch; 5) the identification of game changers for the Pharma/Health sector; and 6) the identification of a potential game changer for the Air Force. *Personalized Health and Performance* is the result of a super-convergence of transformative technological advancements that are reaching a sufficient level of technical maturation, including the 'omics, quantified-self technologies, nanotechnologies, and big data. And, the PH&P game changer provides unprecedented real-time and continuous feedback with quantification at the individual airman level, with complex data resolution across scales from genes to the whole body, and enables an assessment of the physical and cognitive state of the airman for personalized solutions to optimize each airman's performance and health lifecycle. In 2014, the 711th Human Performance Wing recognized the importance of their role in realizing this game changer and identified it as one of its strategic vectors.

Learning Objectives:

1. An understanding of the strategic deep dive methodology used to identify the Personalized Health and Performance Game Changer.
2. An understanding of the Personalized Health and Performance Game Changer and technological super convergence.

[448] STRESS, GENETICS AND BEHAVIORAL PERFORMANCE

R. Jankord and K. Carhuatanta

Air Force Research Laboratory, Wright-Patterson AFB, OH

INTRODUCTION: Performance under stress determines mission effectiveness. The purpose of our research is to identify genetic factors that convey resiliency for cognitive performance in a high stress environment. **METHODS:** To identify the critical genetic factors, a behavioral genetics mouse model was utilized. Mouse strains with various genetic backgrounds went through control or chronic stress conditions and then completed a series of behavioral tests (spatial memory, emotional memory, anxiety and stress response). Quantitative trait loci (QTL) mapping was completed to map the effects of stress on behavioral performance onto specific chromosomal regions. **RESULTS:** The genetic mapping of behavioral data resulted in the identification of QTL corresponding to: 1) genes that affect learning and memory performance; and 2) stress-sensitive genes that affect cognitive function. **DISCUSSION:** By studying identified gene targets and identifying key biological networks that control cognitive performance in a high stress environment we are providing insight into the mechanistic relationship between genetic background, environment exposure, and individual performance. Understanding the relation between genes, environment, and performance will allow the Air Force to personalize training and protection based upon the individual and support Airman mission alignment to best meet mission objectives.

Learning Objectives:

1. Gain an appreciation of the role of animal models in advancing our understanding of the relationship between genetic background, life experience and individual performance.

[449] COUNTERMEASURES TO REDUCE MUSCULOSKELETAL INJURIES AND MONITOR PERFORMANCE IN SPECIAL OPERATORSM. Wade², J. Ordway³, L. Caldwell³, and R.B. O'Hara¹¹U.S. Air Force School of Aerospace Medicine, U.S. Air Force, Wright-Patterson AFB, OH; ²Department of Aeromedical Research, Wright-Patterson AFB, OH; ³U.S. Air Force School of Aerospace Medicine, Air Force Research Lab, Wright-Patterson AFB, OH

INTRODUCTION: Military training in Special Operations Force (SOF) is challenging and requires mental and physical capabilities akin to professional athletes. The rigors of physical training and prolonged deployments without adequate rest and food intake can compromise physical performance resulting in increased musculoskeletal injuries. The purpose of this is to present various field performance tests and safe dietary supplements that may further benefit the SOF community through decreased medical expenditures, increase operator longevity and reduce dropout rates.

METHODS: A search of the literature for 2000-2012 was performed using the Air Force Institute of Technology search engines (i.e., PubMed and ProQuest).

RESULTS: There exists multiple physical health risks associated with the high training and operational tempo of the SOF community. Inexpensive and safe dietary supplements can improve physical recovery and reduce musculoskeletal injury, one of which is protein supplementation. A group of Marine recruits supplemented with protein and reported 33% fewer total medical visits, 28% fewer bacterial/viral infections, 37% fewer muscle/joint problems, and 83% fewer medical visits due to heat related injuries. Additionally, a combination of glucosamine HCL (1500 mg/day), chondroitin sulfate (1200 mg/day) and manganese ascorbate (228mg/day) resulted in fewer complaints of joint pain in thirty-four men from the Naval Special Warfare Command with degenerative joint disease (DJD). Operational and training noise exposures can result in reduced operator effectiveness secondary to permanent hearing impairment. Normal-hearing recruits undergoing 2 months of repeated high level impulse noise exposure (gunfire, explosives etc.) took 167 mg of magnesium aspartate daily. Results showed that hearing damage was significantly reduced in the magnesium group compared with placebo. **DISCUSSION:** Specific countermeasures to reduce injuries do exist within the military community, and unfortunately are undervalued.

Learning Objectives:

1. To identify countermeasures strategies to reduce recovery rates after physical training and post field operations in Special Operators.
2. To provide Special Operations Commanders with specific countermeasures and dietary information that could mitigate overuse injuries during training and field operations.
3. To identify specific field tests and dietary supplements that could be used to prevent injury and enhance performance.

[450] COMBINING PHYSIOLOGICAL SENSORS THAT PROVIDE PERSONALIZED READINESS INDEX TO PREDICT PEAK PERFORMANCE AND MUSCULOSKELETAL INJURY RISK IN SPECIAL OPERATIONS FORCESJ. Hagen³, M. Wade², R.B. O'Hara¹, E. Eveland⁴, A. Myers³, and L. Caldwell²¹U.S. Air Force School of Aerospace Medicine, U.S. Air Force, Wright-Patterson AFB, OH; ²Department of Aeromedical Research, Wright-Patterson AFB, OH; ³RHXXBC, Wright-Patterson AFB, OH; ⁴RHCPT, Wright-Patterson AFB, OH

INTRODUCTION: The recent influx of commercial physiological monitoring technologies has gained significant interest in elite athletics and the United States Special Operations Forces (SOF) to monitor and enhance physical performance. Physical activity, cardiac activity, heart rate variability, hydration status, and sleep are all essential parameters to track performance. However, these parameters exist in different commercial sensors each with its own software, making it more difficult for the user to integrate all of the data into meaningful information that could be used to augment their physical training plan. **METHODS:** Commercial physiological sensors that have been tested against gold standards in a laboratory setting and evaluated for ease of use and wearability have been combined into one user-friendly system, the Combat Readiness System (CRS), designed and

implemented at the 711HPW. This novel system uses input from multiple physiological sensors and physical performance data to provide the warfighter and athlete with a Readiness Index that predicts peak physical performance and musculoskeletal injury risk. The CRS includes measures of quantitative physical exertion, heart rate variability, resting heart rate, sleep, physical activity, hydration status, and body weight. Key user groups in elite collegiate athletics and SOF will use the CRS during five months of intense physical training while concurrently collecting physical performance data and tracking incidence of injury. **RESULTS:** Data from the CRS will be analyzed with multiple regression to develop a population-specific regression model to predict physical performance readiness for each user. **DISCUSSION:** The unique combination of physiological sensors in the CRS provides a quantified assessment of physical performance, readiness, recovery status, and musculoskeletal injury risk. Individuals who train special operators and athletes can use the CRS as a tool to modify physical training regimens to optimize performance and reduce injury rates.

Learning Objectives:

1. To combine multiple physiological sensors into one system that predicts physical performance readiness and injury risk.

[451] THE HANDLING OF MEDICAL DATA IN PERSONALIZED MEDICINE - PRIVATE BIOLOGICAL BIG DATA

J.C. Baldwin

Applied Technology and Genomics Center, U.S. Air Force, Dayton, OH

INTRODUCTION: In recent years there has been an increase in low cost, high throughput sequencers. This has fostered a new revolution in genomics and the implications in personalized medicine are wide-reaching. The low cost availability of both human and pathogen genetic information offers unheard of centralization of genetic testing that can unlock customized choices in therapeutics and focused treatment of diseases. These techniques are so valuable that they are rapidly becoming the standard of care for cancer treatment. This field will grow to include other medical specialties, and the future of pharmaceuticals may be in building smart drugs and therapeutics that perform logical operations in cells—such as killing one that is virus-infected or has a cancer mutation. **METHODS:** However, once patients are routinely sequenced, certain ethical and privacy concerns become immediately apparent. A de-identified genome (i.e., one that is lacking name and personal identifiers) is not sufficiently de-identified. Genomic data is vulnerable to 'yearbook attacks'—identification of genetic markers that can identify a person without a name. Data breaches of genomic data have the potential to do harm to the patient. In this presentation, we will discuss methods we have implemented in our laboratory to store genomic data efficiently to handle large amounts of information (petabytes and exabytes). **RESULTS:** With proper planning, both the technical problems of biological big data and the ethical issues of mining and cloud computing can be addressed in the early phases of implementation to safeguard the future of personalized medicine. **DISCUSSION:** We will also discuss data access and data mining issues to further build personalized medicine pipelines. We will touch upon future issues and mitigation strategies to build a way to safely access this information in ways that allow limited de-identified access to protect the PII (DNA) while allowing good research options.

Learning Objectives:

1. Gain an understanding on the methodology of DNA sequencing and data analysis and the science that underlies their function.
2. Gain insight into how sequencing may be used to detect clinically important disease.
3. Gain insight into how the way this data may impact privacy and how to prevent a data breach.

Thursday, May 14

S. Hemisphere 4

1:30 P.M.

[LXXXVII.] PANEL: JOURNAL SEMINAR: WRITING AND SUBMITTING A PAPER TO AEROSPACE MEDICINE AND HUMAN PERFORMANCE

Chair: Frederick Bonato
Montclair, NJ

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

[452] JOURNAL SEMINAR: WRITING AND SUBMITTING A PAPER TO AEROSPACE MEDICINE AND HUMAN PERFORMANCE

F. Bonato¹, P. Day², R. Trigg², D. Sventek², D. Gradwell³, and E. Boudreau⁴

¹*Aerospace Medicine and Human Performance, Montclair, NJ;*

²*Aerospace Medical Association, Alexandria, VA;* ³*Aerospace*

Medicine, King's College London, London, United Kingdom; ⁴*Oregon Health and Science University, Lake Oswego, OR*

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

Thursday, May 14

S. Hemisphere 5

1:30 P.M.

[LXXXVIII.] PANEL: AUGMENTING HUMAN PERFORMANCE WITH TRANSCRANIAL DIRECT CURRENT STIMULATION (tDCS)

Sponsored by the Life Sciences and Biomedical Engineering Branch

Co-Chair: Richard McKinley

Wright-Patterson AFB, OH

Co-Chair: Lindsey McIntire

Dayton, OH

PANEL OVERVIEW: This panel will discuss new research in non-invasive brain stimulation showing performance enhancement in cognitive

abilities such as attention and memory as well as performance retention during periods of sleep deprivation. We will also cover new possible applications of this technique in the military such as image analysis and cyber operations. Additionally, neural mechanisms causing these performance enhancements will be discussed. The panel will also cover innovative technological advancements in electrode design that bring the technology closer to a form factor that is deployable for the military.

[453] AUGMENTING HUMAN PERFORMANCE DURING 30-HOURS OF SUSTAINED WAKEFULNESS WITH TRANSCRANIAL DIRECT CURRENT STIMULATION (TDCS)

L. McIntire², R.A. McKinley¹, J. Nelson², and C. Goodyear²

¹Human Effectiveness Directorate, 711 Human Performance Wing, Wright-Patterson AFB, OH; ²Infoscitex, Dayton, OH

INTRODUCTION: A common complaint in military operations is sleep deprivation from extended duty hours. Caffeine is a common countermeasure; however, the benefits of caffeine decline rapidly and with chronic use. We hypothesized that using 2mA of anodal transcranial direct current stimulation (tDCS) to the prefrontal cortex for 30 minutes could remediate the deleterious effects of performance on sustained wakefulness comparatively to that of caffeine because tDCS has been successful at augmenting human performance tasks related to attention and working memory; two cognitive resources that are known to degrade greatly during sleep deprivation. We also believed that tDCS would exhibit less negative subjective mood changes when compared to caffeine. **METHODS:** Three groups of ten participants in each group received either active tDCS and placebo gum, caffeine gum with sham tDCS, or sham tDCS with placebo gum during 30-hours of sustained wakefulness. Participants completed a 30 minute vigilance task, 10 minute working memory task, and 10 minute psychomotor vigilance task (PVT) beginning at 1800 hours and continued every two hours throughout the night until 1100 the next day for a total of 9 sessions. At the end of each session participants also filled out 3 subjective mood questionnaires. **RESULTS:** Our results show that once intervention was given at 0400 that the tDCS intervention prevented a decrement in vigilance and the performance benefit lasted until the conclusion of the study. Comparatively, the caffeine group only had a benefit at 0400 testing before returning to levels comparable to our control group for the duration of testing. The tDCS group performed significantly better ($p=.05$) than both groups at all sessions once intervention was given for the vigilance task. The tDCS group also performed significantly better ($p=.05$) on latency in the short-term memory task, reaction times on the PVT task, and subjective mood ratings when compared to the placebo group. **DISCUSSION:** Our data suggests that tDCS could be a powerful fatigue countermeasure that could be more beneficial than caffeine because the effects last longer and subjective mood remains more positive.

Learning Objectives:

1. Ability of tDCS to be used as a fatigue countermeasure.

[454] AUGMENTING VISUAL SEARCH ACCURACY WITH TRANSCRANIAL DIRECT CURRENT STIMULATION (TDCS)

J. Nelson¹, R.A. McKinley², L. McIntire¹, and C. Goodyear¹

¹Infoscitex, Beavercreek, OH; ²Human Effectiveness Directorate, 711 Human Performance Wing, Wright-Patterson AFB, OH

INTRODUCTION: Military operators within the Air Force endure vigorous and tedious man hours dedicated to monitoring and locating targets from satellite aperture radar images. Such tasks are performed by air traffic controllers, cyber defense operators, image analysts and unmanned aerial vehicle operators. With the monotonous and repetitive nature of these tasks, a vigilance decrement will result. As each operator's vigilance declines, critical targets can be missed resulting in failure of the overall mission. The objective of the study is to applying a form of non-invasive brain stimulation known as transcranial direct current stimulation (tDCS) to the frontal eye field (FEF) to augment human cognition and improve accuracy during a visual search task. **METHODS:** A total of eleven active duty military participants participated in this study. Each of the participants completed a 30 minute visual search task on four

separate days. Day one was considered a training session while days two, three, and four were testing sessions. Each session was randomized and participants received either anodal, cathodal, or placebo stimulation on each day. A 2mA electrical current was administered during the tDCS sessions. **RESULTS:** The data was analyzed in 10 minute time intervals for the task (i.e. 0-10, 10-20, 20-30 min). The results showed that the anodal and cathodal stimulation displayed a higher accuracy percentage during the 10-20 and 20-30 minute time intervals compared to the training and placebo conditions. It was also noted that a vigilance decrement was observed for the training and placebo conditions during the task. However, applying the non-invasive brain stimulation mitigated the vigilance decrement allowing the participants to retain attention and detect the critical targets. **DISCUSSION:** The evidence from the study suggests that using anodal and cathodal tDCS of 2mA over the FEF allows the operator to perform the visual search tasks at a higher efficiency. The vigilance decrement was reduced using this form of brain stimulation allowing the participants to be more attentive during the task. In doing so, the study has provided insight in augmenting human performance and the benefit for operators performing target recognition and target detection tasks.

Learning Objectives:

1. Applying anodal and cathodal tDCS over the frontal eye field region of the brain improves target detection accuracy.

[455] EFFECTS OF TRANSCRANIAL MAGNETIC STIMULATION (TMS) AT THE NEURAL LEVEL

N. Bridges^{2,3}, R. McKinley², L. McIntire¹, J.T. Nelson⁴, and C. Goodyear¹

¹Infoscitex, Dayton, OH; ²Applied Neuroscience, Air Force Research Laboratory, Wright-Patterson AFB, OH; ³Drexel University, Philadelphia, PA; ⁴Air Force Medical Service, Lackland AFB, TX

INTRODUCTION: The behavioral effects of repetitive transcranial magnetic stimulation (rTMS), a non-invasive brain stimulation technique, have been studied in humans over the past few decades. The cortical physiological and biochemical mechanisms of action of rTMS, however are not well understood. In an effort to help elucidate these mechanisms, this study examined neurometabolites brain changes immediately following a single session of low frequency rTMS. **METHODS:** Eleven subjects received functional magnetic resonance imaging (fMRI) and proton magnetic resonance spectroscopy ([1H]MRS) immediately before and after 20-minute 1 Hz rTMS. During fMRI, participants performed a Sternberg working memory task which was used to determine the region of interest (ROI) for MRS imaging. Following baseline imaging, rTMS was directed within this ROI using neuronavigation. Over the course of two experimental sessions, half of the subjects received sham (placebo) and real stimulation the first and second experimental day while the other received vice versa. **RESULTS:** Reaction time (RT) performance significantly decreased from baseline values for sham but not for real rTMS. Of the neurometabolites investigated, glutamate and glutamine (Glx), N-acetylaspartate (NAA), creatine (Cr) and choline (Cho), none showed a significant correlation with RT performance. Glx/Cr changes, however, significantly correlated with Naa/Cr changes for sham but not real stimulation. Conversely, Glx/Cr changes significantly correlated with Cho/Cr changes following real but not sham stimulation. **DISCUSSION:** As expected, low frequency rTMS influenced the learning process associated with repeated exposure to the Sternberg Task. The results suggest that these behavioral effects, resulting from a single short-term session of rTMS, relate to neurometabolite correlations more so than their absolute (ratio) levels. Additionally, the results suggest that the way these molecules correlate with one another influences this learning process. With a better understanding of the physiological and biochemical mechanisms occurring in the cortical tissue and cellular level it is our hope that we can also better understand the resulting behavioral effects and apply rTMS more effectively.

Learning Objectives:

1. The effects of magnetic induction on brain metabolites in healthy human participants.

[456] DEVELOPING HOMOGENEOUS CURRENT DENSITY ELECTRODE TECHNOLOGY FOR TRANSCRANIAL DIRECT CURRENT STIMULATION (tDCS)

R. McKinley¹, M. Resor³, H. Dong⁴, L. McIntire², J. Nelson², and C. Goodyear²

¹Applied Neuroscience, Air Force Research Laboratory, Wright-Patterson AFB, OH; ²Infoscitex, Dayton, OH; ³Mechanical Engineering, Wright State University, Dayton, OH; ⁴Mechanical and Aerospace Engineering, University of Virginia, Charlottesville, VA

INTRODUCTION: Recently, the Air Force has been examining the efficacy of a form of non-invasive brain stimulation known as transcranial direct current stimulation (tDCS) to enhance cognition in military operators. The technique passes a weak electric current between two electrodes placed on the scalp to modulate brain activity in targeted areas. Because of the high resistance of the skin, electric current tends to build up at the edges and create spikes around the perimeter. These spikes are believed to be the primary cause of skin sensation (itching, warming, and tingling) and are also the primary causal factor in cases of skin irritation or burns. This project aimed to design new electrodes that produce a more even current distribution and smaller edge spikes.

METHODS: We developed a finite element model of the skin-electrode interface. The model was validated using model parameters and predictions published in Krasteva and Papazov, 2002. Our model utilized a higher structured mesh density, which provides a greater resolution of the predicted current distribution. We then modeled our existing EEG-based electrode arrays and examined the current distribution over the surface. An electrode optimization design study was conducted by varying key dimensional parameters. The *major breakthrough* here was a contoured shape in the electrode itself. This provides a smaller gel layer at the inner edge of the electrode which increases continuously toward the outer edge. As a result, the impedance is lowest in the center of the electrode and greatest at the outer edge. **RESULTS:** The FEM modeling results show the current distribution is much more homogeneous using the new electrode design that implements a contour over the surface. Amplitude of the edge spikes were reduced by an order of magnitude (0.665 A/m² in the EEG electrodes vs. 0.067 A/m² in the new electrodes).

DISCUSSION: The modeling data suggests that the contoured electrodes could provide vast improvements in safety and comfort for tDCS. However, further testing with human participants is required.

Learning Objectives:

1. The homogeneity of the electric current at the skin-electrode interface will lead to lower skin sensations and greater safety of transcranial direct current stimulation.

[457] IMPROVING VIGILANCE PERFORMANCE WITH TRANSCRANIAL DIRECT CURRENT STIMULATION (tDCS)

B.J. Tabares¹, R.A. McKinley², L. McIntire³, and J. Nelson³

¹Wright-Patterson AFB, Dayton, OH; ²Human Effectiveness Directorate, 711 Human Performance Wing, Wright-Patterson AFB, OH; ³Infoscitex, Dayton, OH

INTRODUCTION: Military operations within the Air Force require a tremendous amount of vigilance to perform a given task. This is especially valid for individuals monitoring and controlling unmanned aerial systems and remotely piloted aircraft. Lapses in vigilance, such as missing targets or critical information, can be catastrophic to the overall Air Force mission. The objective of this study is to administer 2mA of transcranial direct current stimulation (tDCS) to the dorsolateral prefrontal cortex to reduce the vigilance decrement and improve performance. Specifically, the study will reduce the negative effects of sustained vigilance by augmenting neural physiology with non-invasive brain stimulation. **METHODS:** A total of twenty active duty military personnel comprised into two groups participated in the study. Each group completed the 40 minute vigilance task on four separate days. Day one consisted of the training session on the task. The following three sessions were randomized testing days where the participants received either anodal, cathodal and placebo brain stimulation. One group received tDCS 10 minutes into the vigilance task, whereas the other group received tDCS 30 minutes into the vigilance task. **RESULTS:** The analyzed data showed

that anodal and cathodal brain stimulation applied to the dorsolateral prefrontal cortex reduced the effect of sustained vigilance compared to the placebo condition for both groups. Hence, tDCS effectively reduced the vigilance decrement resulting in higher detecting accuracy of the critical targets. **DISCUSSION:** The findings from the study indicate that applying 2mA of anodal and cathodal tDCS to the dorsolateral prefrontal cortex improved vigilance performance during the task. This study has displayed evidence that with the use of tDCS, human performance can be augmented resulting in higher target detection accuracy. As a result, the use of tDCS in an operational environment would be beneficial for individuals involved with tasks that require high levels of vigilance.

Learning Objectives:

1. Does tDCS improve vigilance performance in a realistic Air Force task environment?
2. What are the differences between the anodal, cathodal, and placebo conditions?
3. Are there performance differences between the 10-minute condition and 30-minute condition of tDCS?

Thursday, May 14

S. Hemisphere E3

1:30 P.M.

[LXXXIX.] PANEL: AEROSPACE DENTISTRY

Sponsored by the International Association of Aerospace Dentistry

Chair: Michael Hodapp

Houston, TX

PANEL OVERVIEW: Dental health plays a crucial role in a crewmembers general health, safety, as well as preventing barometrically related dental anomalies. Dentistry has changed dramatically in the last 25 years with new innovations and techniques that can enhance the diagnostic capabilities of the clinician, as well as enhance the lifestyle of the patient provided the service, and minimise oral complications. The International Association of Aerospace Dentistry (IAAD) will present a panel of topics related to the field of dentistry, and how it relates to crewmember health, safety, and prevention of barometrically related oral issues.

[458] DENTAL CONCERNS FOR AVIATORS

M.H. Hodapp

Michael H. Hodapp, DDS, Houston, TX

INTRODUCTION: What are the recommendations for aviators in regards to dental issues and treatment? What are the current guidelines? This is a subject that is often overlooked, and rarely discussed, however is vital for the safety of the pilot, crew and their passengers.

METHODS: An in depth review of current, as well as early publications of dental flight related issues. A summary of the recommended protocols by different authors will be generated to aid in clinical decision making for the aviator. **RESULTS:** This presentation will cover the published recommendations based on an extensive review of literature. Topics, such as barodontalgia, root canal treatment, oral surgery, as well as general dentistry are addressed. **DISCUSSION:** Safe practices have to be in the minds of both aviators and clinicians alike. Clinical guidelines aid the physician in making wise choices when it comes to crew safety. The objective of this presentation is to give both the clinician and aviator a baseline of protocol to follow when dental trauma and dental treatments arise.

Learning Objectives:

1. To have a general understanding of dental conditions and treatments that can affect crew safety, and the recommended protocols to follow to help minimize any complications.

[459] IMMEDIATE IMPLANT PLACEMENT AND PROVISIONAL CROWN PLACEMENT AFTER VERTICAL FRACTURE IN AN AIR HOSTESS; CASE REPORT

J.L. Dominguez-Mompell, J. Lara, A. Restoy, J.M. Losada, and V.M. Lopez Pizarro
Oral and Maxillofacial Surgery, Hospital Principe de Asturias, Madrid, Spain

INTRODUCTION: Vertical root fracture (VRF) according to the American Academy of Endodontics is treated by the removal of the dental element, and placement of a fixed or removable prosthesis, or the placement, and restoration of an osseointegrated implant. The aim of this case report was to evaluate the immediate placement of implants in dental sockets after extracting teeth with (VRF) and, to minimize the aesthetic impact, by using the natural crown as the provisional restoration. **METHODS:** A 29-year-old air hostess arrived at our office with a chief complaint of dental trauma during her last flight. The clinical and radiographic examination revealed symptoms of pain to cold and percussion. A diagnosis of vertical root fracture in her left central incisor was determined. The classical approach would have been to extract the offending tooth, make a provisional prosthesis, and after a healing period of 4 months, insert an implant. The decision was made to place an immediate implant, and use her natural extracted tooth as provisional crown thereby preserving the bone around the extraction site, reducing the number of surgeries, and allowing the patient an esthetically pleasing result. The natural crown was modified every 2-3 weeks with the addition of composite resin to the apical portion of the tooth. Four months postoperatively, the implant cover screw was exposed, eliminating the need of a 2nd stage surgery. An implant supported crown was fabricated, achieving an esthetically pleasing result. **DISCUSSION:** A primary objective during extractions, especially in cases of VRF, is the preservation of adequate bone support. Immediate implants help preserve the both the vertical height, as well as the horizontal width of the extraction site. By utilizing this approach, the extraction site was preserved, the number of surgical interventions was reduced, and the patient was able to return to work with an esthetically pleasing result.

Learning Objectives:

1. An esthetically pleasing result can be achieved by immediate implant placement after tooth extraction.
2. Immediate implant placement reduces treatment time and bone resorption in implant surgery.

[461] OPERATIONAL IMPACT OF TONGUE PIERCING ON FRENCH MILITARY PILOTS: A CASE REPORT

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¹*International Association of Aerospace Dentistry, Tijuana, Mexico;*
²*Military Medical Center of Draguignan, Draguignan, France;*
³*Military Hospital St. Anne, Toulon, France;* ⁴*Military Medical Center of Avord, Avord, France*

INTRODUCTION: Tongue piercings have become more common in newer generations. However, they may lead to co-morbidities in civilians as well as active duty military personnel. We present a single-case patient observation of the impact of tongue piercings in military pilots, in addition to general co-morbidities with the use of this implant. **METHODS:** A single-case study and review of the literature. **RESULTS:** While flying in the midst of combat action and in an extremely stressful situation, a military helicopter pilot with a tongue piercing got his tongue caught in between the bicusps producing a fracture of the mesio-lingual cusp of tooth #16. Secondary pain led to his inability to continue to perform his military duties. A more detailed oral cavity inspection at the dental facility demonstrated fractures of several teeth, pain to cold substances, and tongue lesions secondary to the fractured enamel. **DISCUSSION:** This case enabled us to analyze other pathological conditions associated with tongue and lip piercings. Our review of the literature found that the presence of tongue piercings may lead to comorbidities such as infections (hepatitis B and C, HIV, Epstein Barr virus), excessive salivation, inflammation (leading to potential dysplasia), secondary respiratory obstruction, speech impediment, neuralgia, difficulty in

mastication, bleeding, ageusia, paresthesia, gingivitis, osteitis, and osteomyelitis. Chipped and/or fractured teeth have been reported in 47 to 80% of cases.

Learning Objectives:

1. To identify the potential complications of tongue piercings on flight personnel.
2. To identify oral pathology that may be associated with tongue piercings.

[460] RECONSTRUCTIVE SURGERY FOR DENTAL IMPLANTS IN AERONAUTICAL POPULATION

J.L. Chao¹, J.L. Dominguez-Mompell¹, R. Dominguez-Mompell², and A. Restoy¹
¹*Oral and Maxillofacial Surgery, Hospital Principe de Asturias, Madrid, Spain;* ²*Clinica Principe de Vergara, Madrid, Spain*

INTRODUCTION: It is not unusual for a patient to present for a consultation at the oral surgeon's office and be informed that he or she may require a "bone graft" in order to maximize the outcome of their dental implant surgery. Although there are many different grafting materials available, autogenous bone grafts are still considered the "gold standard". One of the primary concerns, when performing intraoral bone grafts, is the postoperative period. For the aeronautical population, disruption of flight status due to healing, is a primary concern for both the crew, and for the company involved. **METHODS:** Ten atrophic mandibles were reconstructed using autogenous bone grafts, harvested from the retromolar area. Five cases were performed following the "box technique" principles, using a subperiosteal tunnel approach. Five of these, were conducted using the same principles, but a classical open approach with releasing incisions in the covering periosteum were used to ensure a tension free closure. Antibiotic therapy, anti-inflammatory drugs and corticosteroids were prescribed to all patients. **RESULTS:** 23 implants were inserted in 10 reconstructed areas. 1 Patient included in the open approach group had a suture dehiscence that compromised part of the graft but didn't prevent from the correct implant insertion. The postoperative recovery period was better in those patients where the tunnel approach was used. The crew members were allowed to return to normal duties 4-6 days after the procedure. Those treated by an open approach needed 8-11 days to recover, prior to returning to their duties. **DISCUSSION:** Bone grafting in the oral cavity today is a routine, predictable and painless procedure. The box technique combined with the tunnel approach minimizes the recovering post-op process allowing the patient to restore its normal activity (life) within 4-5 days.

Learning Objectives:

1. Bone augmentation in oral implantology may lead to a period of convalescence of civil and military aeronautical population that might be reduced using this minimally invasive type of surgery.

Thursday, May 14
S. Hemisphere E4

1:30 P.M.

[XC.] PANEL: MANEUVERING THROUGH DOD'S HUMAN RESEARCH PROTECTION PROGRAM: DISCUSSIONS OF FOUR TOPICS IN HUMAN-PERFORMANCE RESEARCH

Chair: John Wightman
Wright-Patterson AFB, OH

PANEL OVERVIEW: Improving human performance and man-machine integration is critical to advancing many aerospace capabilities. Research often involves human subjects in such a way as to make the knowledge gained generalizable. This panel will address four hot HRPP topics, and highlight unique issues and efficient methods for protocol approval within the USAF. Topic #1: Over the last year, a decentralized review process for DoD-supported research proposals by

delegating approval authority to Human Research Protection Officials. HRPOs within the Air Force Research Laboratory decreased average turnaround times 95% by creating education programs and standardized tools to meet submission requirements. Topic #2: Deconfliction between foreign and US laws is required to conduct research in non-US populations, but it may be possible for a single IRB to be used and a centralized review of research facilitate navigation of host-nation laws, requirements, and cultural sensitivities. Topic #3: Investigations into the influence of genomes and biomarkers on human performance can be conducted with special attention to appropriately tailored privacy protection methods. Consent documents for DNA collection and procedures for data handling are of paramount consideration, because terms will significantly impact future uses. The issues are more vexing when a military component is engaged in or the subject of genetics-related research due to differences between DoD and civilian laws and regulations. Topic #4: Once a study is completed, the dataset is typically destroyed, as its specific purpose has been realized. Resource expenditures and subject participation risk can be decreased and greater return on investment can leveraged by retaining these datasets for future analyses of yet unknown research questions. Prospectively designed data repositories may enable this, but require special considerations during the consent process and lengthy safeguarding of personally identifiable information. In summary, deliberate preplanning can avoid unnecessarily constraining human-performance research and allow for an efficient HRPP-approval process.

[462] EXTRAMURAL RESEARCH SUBMISSION TO THE HUMAN RESEARCH PROTECTION OFFICIAL (HRPO)

S.L. Pryber¹ and A.P. Tvaryanas²

¹*Air Force Research Lab, HPW/IR, Department of Defense, Wright-Patterson AFB, OH;* ²*Human Systems Integration Directorate, Air Force Research Laboratory, Wright-Patterson AFB, OH*

INTRODUCTION: The HRPO is tasked with component-level review and oversight of DoD-supported research involving human subjects conducted by non-DoD institutions per DoDI 3216.02_AFI 40-402. The HRPO review of the research activity and the non-DoD IRB's review is required to ensure compliance with Federal, DoD and DoD Component regulations. Historically, these reviews often took between 90 to 120 days to complete. Contributing to this lengthy review process was an average time of 45 days from the time an initial submission package was submitted until all required documents were secured and the protocol package could be considered complete enough to begin HRPO review. It is imperative that a most efficient process be established and sustained in order to receive, review and approve research conducted and supported by the DoD in non-DoD institutions engaged in non-exempt human subject research. The need for early education of all stakeholders as to the extramural requirements for review and approval would promote an understanding of what is required. The development of comprehensive tools to assist investigators and program managers and establishing educational opportunities, one-on-one training sessions with program managers and investigators would ensure success.

Learning Objectives:

1. Understand the unique requirements of HRPO review and approval related to extramural research.
2. Identify the root-causes for the excessively long review and approval times.
3. Identify ways to reach new stakeholders (Program Managers, Contracting Officers and investigators) not familiar with the HRPO review requirement.

[463] U.S. DEPARTMENT OF DEFENSE AND AIR FORCE REQUIREMENTS FOR APPROVAL OF INTERNATIONAL HUMAN-SUBJECT RESEARCH

J.M. Wightman

¹*Institutional Review, Air Force Research Laboratory, Wright-Patterson AFB, OH;* ²*Department of Emergency Medicine, Wright State University, Dayton, OH*

INTRODUCTION: Investigators proposing human-subject research outside the US should be aware of the various levels of approval required before committing to a timeline or initiating recruitment and data collection. At a minimum, administrative review and approval at the DoD-Component level must occur, and this will not be accomplished until after the Institutional Official confirms that all applicable laws and requirements of the foreign country have been addressed in the protocol with source citations and any legal or other consultations documented. Only then can the Institutional Review Board (IRB) and subsequently the designated Human Research Protection Official (HRPO) consider the protocol for approval, which will also involve confirming compliance with US federal and state laws and other regulatory requirements. When reviewing protocols proposing international research, IRBs are also required to consider cultural factors in the host-nation setting where the research will take place, and this may further necessitate consultation with one or more subject-matter experts. Department of Defense Instruction 3216.02 and Air Force Instruction 40-402 specify review requirements for approval of international research. Protocols must comply with US federal and state laws, as well as any applicable laws and other regulations of the host nation(s). When these come into conflict, especially with regard to the provisions in 32 CFR 219, the most protective laws and regulations must be followed. Legal counsel is generally advised. All USAF-supported international research proposals must be submitted to the Air Force Medical Support Agency, Research & Acquisitions Modernization Directorate, Research Oversight & Compliance Division (AFMSA/SGE-C). The Assistant Secretary of Defense for Research and Engineering under the authority of the Under Secretary of Defense for Acquisition, Technology, and Logistics is the final arbiter of any conflicts. Despite the many layers of protection, the protocol submission process can be streamlined in three ways: 1) knowledge of the order in which tasks must be accomplished; 2) consultation regarding foreign laws and cultural sensitivities; and 3) establishing IRB or other oversight agreements in advance.

Learning Objectives:

1. Review key points of the DoD Instruction that governs the protections for human subjects in DoD-supported research in foreign countries.
2. Outline three key additional considerations when requesting IRB approval of protocols proposing research in foreign countries.
3. Identify the Air Force organization where authority for DoD-Component oversight of human-subject research has been delegated by the Air Force Surgeon General.

[464] PRIVACY AND SECURITY WITH A GENETICS FOCUS

K.E. London

Chair, Institutional Review Board, Air Force Research Laboratory, Wright-Patterson AFB, OH

INTRODUCTION: Research involving genetics is increasingly seen in many contexts, to include genome-informed medical practice, environmental genetics, and pharmogenetics. In some instances genetics are being studied to better understand correlations to athletic, physiological, and cognitive performance. The collection, storage and use of specimens used for genetic research bring complex and unique privacy and security implications. With appropriate tailored privacy protection methods such as coding, key control, and access agreements, genetic related data could be properly handled and used in current and future research. The consent and other terms in place for the original DNA collection are of paramount consideration, because those terms will significantly impact future uses of the specimen data. Health Insurance Portability and Accountability Act (HIPAA) covered entities must have increased vigilance to consider whether the transfer of genetic information from it to another entity was encompassed in the original HIPAA authorization when the DNA specimens were collected, or if another HIPAA permission applies. The issues are more vexing when a military component is engaged in or the subject of genetics related research because genetics privacy laws are different in the military compared to the civilian sector with the 2008 passage of the Genetic Information Non-Disclosure Act (GINA).

Learning Objectives:

1. Identify the unique privacy interests and concerns related to genetic data with comprehension of methods to maintain privacy and confidentiality of biological specimens such as coding, limited/controlled access, honest-broker mechanisms, de-identification processes, limited data-use agreements, etc.
2. Recognize that the data use terms in place at initial collection of DNA for genetic research is significant to the future research using the same DNA.
3. Review key elements and language of the Genetic Information Non-Disclosure Act (GINA) and its applicability to military populations.

[465] DEVELOPMENT OF A RESEARCH DATA REPOSITORY: MAXIMIZING THE OPTION VALUE OF DATA

A.P. Tvaryanas

Human Systems Integration Directorate, Air Force Research Laboratory, Wright-Patterson AFB, OH

INTRODUCTION: A great deal of time and other resources is invested in planning and executing research protocols to include the creation of study-specific datasets. The immediate value of research data is evident to those who collect it with the particular study purpose in mind. Unlike material things, however, data's value does not diminish when it is used; it can be harnessed for multiple purposes. Moreover, data is what economists call a "non-rivalries" good, meaning that one person's use of it does not impede another person's. The "option value" of data is what one can gain from all the possible ways it can be employed. There are two primary ways to tap into the option value of data: basic reuse and recombinant data, the latter defining the activity of combining one dataset with another. From the perspective of human subject research, the risk to benefit ratio that is a primary concern of the Institutional Review Board can be improved for any particular study by considering the option value of data. The potential for data reuse or recombinant data contributes to the benefit side of the ratio by increasing the number of study questions that may be addressed from a particular data collection activity. However, data reuse may also contribute to the risk side of the ratio unless there are well designed systems in place to facilitate safe data reuse. Research data repositories are current examples of such systems. The data repository provides a means for storing datasets created during the execution of research protocols. It also serves as a resource for investigators to identify datasets to mine or datasets to grow by commingling with other preexisting or new data. Facilitating the latter commingling requires consideration of retention of personal identifiers and designing extensibility into study datasets from the outset.

Learning Objectives:

1. Understand the option value of research data.
2. Understand the risks and benefits of data reuse and recombinant data in research.
3. Understand the purpose and key functions of a research data repository.

Thursday, May 14

S. Hemisphere 1

3:30 P.M.

[XCI.] SLIDE: G PERFORMANCE: TRAIN IT, MEASURE IT
Co-Chair: Peter Hodgkinson

RAF Henlow, Bedfordshire, United Kingdom

Co-Chair: Robert Monberg

North Pole, AK

3:30 p.m.

[466] IN FLIGHT HIGH ONSET G TRAINING IN THE ROYAL AIR FORCE

G.G. Kennedy

Aviation Medicine Flight, RAFCAM, Marlborough, United Kingdom

INTRODUCTION: Following the fatal crash of a Hawk fast jet training aircraft attributed to Almost Loss of Consciousness (A-LOC), it was mandated that UK Ministry of Defence (MoD) aircrew exposed to high sustained G should be fully compliant with STANAG 3827. The RAF's legacy centrifuge is incapable of the required 3G/sec onset rate and so an alternative means of compliance, using RAFCAM's Hawk aircraft was agreed and established. **METHODS:** An in-flight high G onset training course was developed and trialed and has now been delivered to a number of subjects. Successful completion of centrifuge training is mandatory before this training is permitted. The training course features incremental exposure up to +8Gz at onset rates of up to 10G/sec through a series of scripted maneuvers. Due to the large number of aircrew requiring training, qualified flying instructors from each unit have been trained to become trainers/subject matter experts at squadron level, allowing them some ownership of G training and G awareness. **RESULTS:** The training has been well received with positive feedback from subjects, and has built on the skills gained on the centrifuge in a more authentic setting. A survey of aircrew who have undertaken this training is currently being conducted. **DISCUSSION:** Aircraft based high G onset training has been developed to cover a centrifuge capability gap which should cease when the RAF's new centrifuge is brought into service. However, the future fast jet combat aircraft force does not feature 2 variants, and preservation of aircraft based high onset G training on relatively cost effective platforms such as the Hawk trainer should be considered.

Learning Objectives:

1. The audience will learn how in-flight high onset G training is undertaken in the RAF.

3:45 p.m.

[467] HIGH-G TRAINING : THE ROYAL MALAYSIAN AIR FORCE EXPERIENCE
S. Annamalai¹, M. Newman³, and Z. Jusoh²
¹Aerophysiology, Institute of Aviation Medicine, RMAF, Shah Alam, Malaysia; ²Director IAM, RMAF, Institute Of Aviation Medicine, RMAF, Kuala Lumpur, Malaysia; ³The NASTAR Center, Southampton, PA

INTRODUCTION: Fighter pilots undergo high-G training to increase their understanding of G-stress, practice anti-G straining maneuver (AGSM) technique and improve overall G-tolerance. Traditional G-training methods involve didactic lecture and exposure to G-stress using a human centrifuge. The present study investigated the effectiveness of a new high-G training protocol adopted by the Royal Malaysian Air Force (RMAF). **METHODS:** The study population consisted of 60 fighter pilots that participated in human centrifuge training at the RMAF Institute of Aviation Medicine between 2009 and 2014. Pilots were randomly selected from the entire RMAF pilot database and assigned to either the 'Old Methods' or 'New Methods' group based on the date of their centrifuge training. Methodological changes between the groups include the introduction of a warm up and low-G familiarization profile, a modification to the physiological G-tolerance metric and a shift of simulated air combat maneuver (SACM) and tactical flight simulation (TFS) to a second day of training. Instances of GLOC and the number of pilots that were unable to complete the training were recorded for each group. **RESULTS:** GLOC was reported by 12 of the 30 pilots (40 %) in the 'Old Methods' group compared with 2 of 30 pilots (6.7%) in the 'New Methods' group. Ten (10) pilots from the 'Old Methods' group were not able to complete the training (33.3%). All pilots from the 'New Methods' group were able to complete the training. **DISCUSSION:** The new protocol for G-training introduced by the RMAF has significantly reduced the number of pilots that GLOC during training. These methodological changes have also increased the overall number of pilots that are able to complete the training protocol despite an equal or greater exposure to G-forces during the new training regimen.

Learning Objectives:

1. To understand how G-training methodology can affect pilot performance and training effectiveness.

4:00 p.m.

[468] FIRST EXPERIENCE ON PHYSIOLOGICAL TRAINING ON 17 MILITARY JET PILOTSA. Macovei¹ and D. Popescu²¹Research and Aeronautical Physiology, National Institute of Aerospace Medicine, Bucharest, Romania; ²Deputy Manager, National Institute of Aerospace Medicine Bucharest, Romania

INTRODUCTION: During the last trimester of 2013 and the first half of 2014, we debuted the Physiological Training for Romanian pilots with initial training on a group of 17 experienced jet pilots at the National Institute of Aerospace Medicine in Bucharest. Having been given the unique opportunity on doing initial physiological training on experienced pilots, it seemed proper to share some results and opinions on the matter. **METHODS:** To evaluate training efficiency we have employed a rating based on the written test scale and a scale for practical demonstrations (altitude chamber and rapid decompression, spatial disorientation, night vision). Presentation contains details on each method employed. No G training was available on our facility so there will be no statements on this part. We have collected post training anonymous questionnaires regarding the perceived efficiency, also graded for theory and for practice, as well as free comments. **RESULTS:** There have been three training sessions, and the mean scores increased from first session to second one, and then slightly dropped in the third. (9.33 -> 9.55 -> 9.53 for practical demonstration and 9.01 -> 9.9 -> 9.8 for the theoretical part, as means per group). For the first session, the theoretical and practical grades were not correlated per individual trainee, and they were more correlated for the second and third session. The perceived usefulness of training was high (9.42 -> 9.50 -> 10 graded for theoretical part and 9 -> 9 -> 9.8 for the practical part). The main complaints have been the language difference and the equipment, especially for the altitude chamber (masks, ability to employ own equipment), and lack of more details regarding G readiness. **DISCUSSION:** Being experienced pilots, we found no surprise in their ability to cope with theoretical considerations, despite the medical language barrier. What we did find surprising was their perceived usefulness of the training, which we did not expect to have such an impact on experienced pilots, some of them having experienced hypoxia and spatial disorientation in real flight. The problem of optimizing training equipment remains as high as ever. We look forward for their feedback on how the training has improved the rest of their career.

Learning Objectives:

1. The role of physiological training.
2. Initial physiological training for experienced pilots.

[469] W/D

4:15 p.m.

[470] A NEW GOLDEN AGE? VALIDATION OF WEARABLE ACCELEROMETERS IN HIGH PERFORMANCE JET AIRCRAFTG.M. Rice¹, T. VanBrunt¹, D.H. Snider², and R.E. Hoyt²¹Residency in Aerospace Medicine, Naval Aerospace Medical Institute, Pensacola, FL; ²College of Science, Engineering and Health, University of West Florida, Pensacola, FL

INTRODUCTION: The advent of new technologies such as wearable accelerometers and bio-sensors has enabled researchers to reliably estimate movements and accelerative forces on the human body during low G maneuvers (<2 Gs). However, these devices have yet to be validated in extreme operational environments such as high performance jet aircraft. The objective of this study was to correlate the Gravitational forces (G-forces) detected by commercially available portable/wearable accelerometers with the G's forces detected by high performance aircraft. **METHODS:** We compared the "In-Flight" G-Forces detected by the Actigraph™ and Zephyr Biopatch™ to the F-18 A & C's Carrier Inertial Navigation System (CAINS-2) during 20 flights performed by the Navy's Flight Demonstration Squadron (Blue Angels). Data was excluded if the devices were inadvertently turned off or fell off, or if the plane data was incomplete or unavailable. **RESULTS:** Of the twenty flights analyzed, 10 complete in flight comparisons were made, accounting for 25,700 seconds of correlation for both the Actigraph™ and Zephyr BioPatch™. Both the Actigraph™ and Zephyr Biopatch™ Gz axis had inverse correlations with that of the F-18 A & C Gz axis, $r = -0.91$ and $r = -0.95$,

respectively. These negative correlations were due to the aircraft's positive z-axis being opposite of the land-based portable accelerometers' positive z-axis. Computation of the portable accelerometers Vector magnitude during each flight yielded highly positive correlations with the aircrafts Gz axis, $r = 0.92$ for Actigraph™, and $r = 0.93$ for Zephyr Biopatch™. **DISCUSSION:** These results strongly suggest the use of these wearable accelerometers is a valid means of detecting G-forces during high performance aircraft flight. Future studies utilizing this surrogate method of detecting accelerative forces combined with physiologic information may yield valuable "In-Flight" normative data that heretofore has been technically difficult to obtain and hence holds the promise of opening the door for a new golden age of aeromedical research.

Learning Objectives:

1. Describe the methodology one utilizes to validate wearable accelerometers to static aircraft accelerometers.
2. Describe differences between portable accelerometers and static accelerometers found within Aircraft.
3. Understand why one may find an inverse relationship between a Gz axis in portable accelerometers compared to static aircraft accelerometers.

4:30 p.m.

[471] PHYSIOLOGIC RESPONSES RECORDED BY WEARABLE BIO-SENSORS DURING "IN-FLIGHT" HIGH PERFORMANCE AIRCRAFT MANEUVERSG.M. Rice¹, T. VanBrunt¹, D.H. Snider², and R.E. Hoyt²¹Residency in Aerospace Medicine, Naval Aerospace Medicine Institute, Pensacola, FL; ²College of Science, Engineering and Health Sciences, University of West Florida, Pensacola, FL

INTRODUCTION: Few studies have evaluated physiologic responses to high accelerative forces "In-flight", and to our knowledge no normative data has been acquired by newer technologies such as wearable/portable biosensors during high performance jet aircraft operations. The primary objective of this report is to describe the physiologic data captured by a commercially available wearable biosensor during high G maneuvers (>5 G). **METHODS:** Subjects were five active duty F-18 pilots of the Naval Flight Demonstration Squadron, aka, the Blue Angels. The device to be evaluated was a FDA approved portable tri-axial accelerometer & bio-sensor called the Zephyr Biopatch™. Variables monitored were heart rate, heart rate variability, respirations, V2 ECG waves, Kcal expenditure, Avg G/sec, and number of accelerations over >5G. Data was excluded if the devices were inadvertently turned off or fell off, incomplete, or not consistent with ECG recordings. **RESULTS:** Of ten flights analyzed, 7 complete biosensor data sets met inclusion criteria. Average flight time for formation pilots was 2546 seconds and 2633 seconds for solo pilots. Formation pilots averaged 8.4 peak accelerations > 5 in the +Gz axis/per flight, while solo pilots averaged 18.2 peak accelerations > 5 in the +Gz axis. Average HR for formation pilots was 90 bpm (Min 64, Max 178), while solo pilots averaged 107 bpm (Min 64, Max 200). Average respirations for solo pilots were significantly lower than formation pilots 12.4 vs 17.7, $p < 0.05$. Average Kcal expenditures for formation pilots were 276 Kcal (Min 184, Max 378), and for solo pilots was 348 Kcal (Min 280: Max 457). **DISCUSSION:** The elevations in physiologic responses detected from this biosensor seem to be associated with increased gravitational exposures. Predictably solo pilots who had a greater number of peak accelerations also had significantly higher average heart rates, and average kcal expenditure. Of interest average respirations were significantly lower for solo pilots. On several occasions significantly elevated heart rates were found to be due to double counting of both R and T waves, and respirations were noted to be < 1/sec. Further inflight evaluations of this biosensor is warranted to validate these physiologic findings.

Learning Objectives:

1. Describe the physiologic variable that portable wearable biosensors may detect in aviation environments.
2. Describe the advantages of portable/wearable bio-sensors in extreme operational environments.
3. Describe the limitations of portable/wearable bio-sensors in extreme operational environments.

Thursday, May 14
S. Hemisphere 2

3:30 P.M.

[XCII.] PANEL: ASAMS CLINICAL UPDATES II

Sponsored by the American Society of Aerospace Medicine Specialists

Chair: Patrick Storms
Dayton, OH

PANEL OVERVIEW: The purpose of this session is to provide clinical updates on medical conditions of aeromedical interest. The presenters are aeromedical clinical experts and aerospace medicine residents. They will present topics related to the assessment and treatment of aviators and special duty personnel suffering from specified medical conditions of aeromedical interest. Presentations will include recommendations for treatment and discussions of the aeromedical implications of the specified disease conditions.

[472] ALCOHOL USE DISORDER: CLINICAL AND AEROMEDICAL PRACTICE GUIDELINES

T.L. Correll

Neuropsychiatry, 711 HPW/ U.S. Air Force School of Aerospace Medicine /FECN, Wright-Patterson AFB, OH

INTRODUCTION: Alcohol use is widely accepted and utilized in our society and by United States Air Force (USAF) personnel. It is known to be one of the most problematic interferences in the careers of many USAF aviators. Even legal, sanctioned use of alcohol can have adverse effects on aviation safety and optimal flying abilities. A diagnosis of alcohol use disorder is disqualifying for all USAF flying classes and requires detailed and assured treatment to become eligible for a waiver. This presentation will focus on the diagnosis of alcohol use disorder, the transition from Diagnostic and Statistical Manual of Mental Disorders (DSM) IV-TR to DSM-5, and treatment/waiver policy considerations in aircrew. Although specific for Air Force pilots and aircrew evaluated at the Aeromedical Consultation Service, the underlying issues are common to aviators and waiver processes in all the military services and civilian organizations.

Learning Objectives:

1. Understand the diagnosis and treatment of alcohol use disorder in aviators.
2. Enable aviation medical specialists to create the best possible waiver package.

Thursday, May 14
S. Hemisphere 3

3:30 P.M.

[XCIII.] PANEL: SPACEFLIGHT DECOMPRESSION SICKNESS HISTORY AND CURRENT RESEARCH

Co-Chair: Jason Norcross
League City, TX

Co-Chair: Johnny Conkin
Houston, TX

PANEL OVERVIEW: Although there have been no reports of decompression sickness (DCS) during extravehicular activity (EVA), the risk of DCS is still very present. Research on prevention of DCS during microgravity EVA has primarily focused on validation of denitrogenation protocols in the operationally driven spaceflight environment. This focus, while successfully mitigating the problem, has left gaps in DCS knowledge including actual risk of DCS and bubble formation in space,

micronuclei generation, gravitational influences, in-situ treatment protocols, and even long-term consequences of multiple hypobaric exposures. This panel will present an update to the current state of spaceflight DCS knowledge accompanied by research efforts addressing known gaps in this knowledge.

[473] SPACEFLIGHT DCS COUNTERMEASURES AND CONSIDERATIONS FOR EXPLORATION OPERATIONS

J. Norcross

EVA Physiology Laboratory, Wyle Science, Technology and Engineering Group, League City, TX

INTRODUCTION: NASA operates under the philosophy that it is better to prevent than to treat decompression sickness (DCS). There has been no reported case of DCS during 442 extravehicular activities (EVAs) using approved NASA denitrogenation (prebreathe [PB]) protocols. These PB protocols have used in-suit resting PB, exercise enhanced PB, and reduced-pressure-staged atmospheres to successfully mitigate DCS. Although this approach to DCS prevention has been successful, it is costly to both operational time and consumables. The in-suit light exercise (ISLE) PB protocol is the newest option and quickly has become the prime protocol for International Space Station EVAs due to crew preference, ease of implementation, and reduced oxygen (O₂) usage. The ISLE protocol will soon gain enough operational experience so that NASA may consider retiring 2 other validated protocols. Although preferred, ISLE still requires 5 hours of combined mask PB, spacesuit donning, in-suit PB, and general checkout procedures before the EVA. Including all pre-EVA activities (loop scrub, on-orbit fit check verification); day of EVA (PB, airlock operations, metabolic); and post-EVA (O₂ tank recharge and loop scrub), each EVA uses up to 20 lb of O₂ for 2 crewmembers. The time impact for EVA preparation and consumable use will be unacceptable for exploration missions with frequent EVAs and limited to no resupply capability. Therefore, exploration missions plan to use an atmosphere of 8.2 psia with 34% O₂ (balance is nitrogen) coupled with a suit port and 8.2 psia-compatible variable-pressure spacesuit to reduce the EVA preparation time to less than 15 minutes. Validation testing of this exploration atmosphere countermeasure is planned for the near future and must meet the criteria for DCS risk as defined in the NASA Spaceflight Human Standards 2014 update. These standards now provide definitions for acceptable risk for DCS: ≤ 15% Type I DCS incidence, ≤ 20% Grade IV venous gas emboli, both at 95% confidence, and no Type II DCS symptoms during tests of the DCS countermeasure in a hypobaric chamber using EVA simulation.

Learning Objectives:

1. Understand the strategy and historical success used by NASA to mitigate decompression sickness.
2. Quantify and compare the resources such as crew time and consumables used to mitigate spaceflight decompression sickness currently and proposed for exploration missions.

[474] AMBULATION INCREASES DECOMPRESSION SICKNESS IN ALTITUDE EXPOSURE

N.W. Pollock^{1,5}, M. Natoli¹, S.D. Martina^{1,5}, J. Conkin², J.H. Wessel³, and M.L. Gernhardt⁴

¹Center for Hyperbaric Medicine and Environmental Physiology, Duke University, Durham, NC; ²Universities Space Research Association, Houston, TX; ³EVA Physiology Lab, NASA, Houston, TX; ⁴NASA, Houston, TX; ⁵Divers Alert Network, Durham, NC

INTRODUCTION: Musculoskeletal activity accelerates inert gas elimination during oxygen breathing prior to decompression (prebreathe), but may also promote bubble formation (nucleation) and increase the risk of decompression sickness (DCS). The timing, pattern and intensity of musculoskeletal activity are likely critical to the net effect. The NASA Prebreathe Reduction Program (PRP) combined oxygen prebreathe and exercise preceding a 4.3 psi exposure in non-ambulatory subjects (a microgravity analog) to produce two protocols now used by astronauts preparing for extravehicular activity (CEVIS and ISLE). Additional work is required to investigate whether exercise normal to a 1-G environment increases the risk of DCS over microgravity simulation. **METHODS:** The current

studies replicate the CEVIS protocol, each with single exceptions. Experiment 1 (E1) added controlled ambulation (stepping in place) at ground level (undersaturated inert gas state) and at 4.3 psi (spacesuit pressure; supersaturated state) instead of remaining non-ambulatory throughout. Experiment 3 (E3) restricted ambulation to preflight only. The metabolic output was matched between trials. Study endpoints included symptomatic DCS. Decompression stress was also evaluated with circulating bubbles identified with aural Doppler ultrasound (Spencer 0-IV ordinal scale). Fisher Exact Tests compared groups (significant at $p < 0.05$). **RESULTS:** Data collection is complete for E1 (21 person-trials [16 male, 5 female]; 4/20 DCS, 6/21 peak grade IV bubbles) and ongoing for E3 (13 person-trials [11 male, 2 female]; 1/13 DCS, 2/13 peak grade IV bubbles). DCS was significantly greater in E1 vs. CEVIS (0/45 DCS, 3/45 peak grade IV bubbles) trials ($p = 0.0036$). DCS did not differ between E3 and CEVIS ($p = 0.1121$) or E1 and E3 ($p = 0.1980$). Similarly, peak grade IV Doppler-detected bubbles were more frequent in E1 vs. CEVIS trials ($p = 0.0138$). Grade IV bubble peaks did not differ between E3 and CEVIS ($p = 0.1899$) or E1 and E3 ($p = 0.2110$). **DISCUSSION:** Decompression stress and sickness at spacesuit pressure is increased by mild ambulation conducted in both undersaturated and supersaturated states. However, preliminary data do not establish an increased risk with mild ambulation conducted in the undersaturated state alone.

Learning Objectives:

1. To understand how exercise can accelerate inert gas elimination during oxygen breathing.
2. To appreciate how exercise may promote bubble formation and increase decompression stress.
3. To comprehend how inert gas saturation may play a role in exercise-induced bubble formation.

[475] HYPOBARIC DECOMPRESSION SICKNESS TREATMENT MODEL

J. Conkin¹, A.F. Abercromby², J.P. Dervay³, A.H. Feiveson³, M.L. Gernhardt³, J. Norcross², R. Ploutz-Snyder¹, and J.H. Wessel²
¹Universities Space Research Association, Houston, TX; ²EVA Physiology Laboratory, Wyle Science, Technology and Engineering Group, League City, TX; ³NASA Johnson Space Center, Houston, TX

INTRODUCTION: The NASA Decompression Sickness (DCS) Treatment Model links a decrease in computed bubble volume from increased pressure (ΔP), increased oxygen (O_2) partial pressure, and passage of time during treatment to the probability of symptom resolution $P(SR)$. The decrease in offending volume is realized in 2 stages: a) during compression via Boyle's law and b) during subsequent dissolution of the gas phase by the O_2 window. **METHODS:** We established an empirical model for the $P(SR)$ while accounting for multiple symptoms within subjects. The data consisted of 154 cases of hypobaric DCS symptoms with ancillary information from tests on 56 men and 18 women. **RESULTS:** Our best estimated model is $P(SR) = 1 / (1 + \exp(-(\ln(\Delta P) - 1.510 + 0.795 \times AMB - 0.00308 \times T_e) / 0.478))$, where ΔP is pressure difference (psid); $AMB = 1$ if ambulation took place during part of the altitude exposure, otherwise $AMB = 0$; and T_e is elapsed time in minutes from the start of altitude exposure to recognition of a DCS symptom. To apply this model in future scenarios, values of ΔP as inputs to the model would be calculated from the Tissue Bubble Dynamics Model based on the effective treatment pressure: $\Delta P = P_2 - P_1 = P_1 \times V_1/V_2 - P_1$, where V_1 is the computed volume of a spherical bubble in a unit volume of tissue at low pressure P_1 , and V_2 is computed volume after a change to a higher pressure P_2 . If 100% ground-level O_2 were breathed in place of air, then V_2 continues to decrease through time at P_2 at a faster rate. The computed ΔP then represents the effective treatment pressure at any point in time. **DISCUSSION:** The ambulation status is an important variable in the regression, distinguishing between ambulation during EVA on a planetary surface or no ambulation during EVA in space. Given the low probability of DCS during EVA and the prompt treatment of a symptom with guidance from the model, the symptom and the gas phase are likely to resolve with minimal resources and minimal impact to astronaut health, safety, and productivity.

Learning Objectives:

1. Apply principles of physiology, physics, and statistics to create a probability model for hypobaric decompression sickness symptom resolution.
2. Define minimum resources to effectively treat hypobaric decompression sickness during spacewalks.

[476] SUBCORTICAL WHITE MATTER HYPERINTENSITY BURDEN IN ASTRONAUTS

P.M. Sherman¹ and S. McGuire²

¹Human Performance/Radiology, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH, and Wilford Hall ASC, Boerne, TX;

²U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: We postulated that subcortical white matter hyperintensities (WMH)/white matter injury without clinical symptoms might be occurring in astronauts exposed to hypobaric conditions. **METHODS:** We previously demonstrated the presence of increased WMH burden in U-2 pilots and altitude chamber personnel occurring in the absence of clinical symptoms. As part of this study we obtained routine clinical brain MRI sequences (5 mm slice thickness axial T2 FSE and FLAIR sequences on a Siemens 3 Tesla Verio scanner). NASA has previously acquired similar clinical brain MRI images on 41 astronauts. We propose to compare these two sets of MR scans by counting the number of WMHs. We will use nonparametric statistics for comparisons. **RESULTS:** Initial results will be presented. **DISCUSSION:** This study will determine whether or not astronauts have a similar subcortical WMH burden as demonstrated in U-2 pilots and altitude chamber personnel.

Learning Objectives:

1. Determine whether or not astronauts have an increased WMH burden compared to normal age matched controls.
2. Determine potential for future risk of brain white matter injury secondary to hypobaric exposure in deep space missions.

[477] HISTORICAL EVIDENCE FROM THE SHUTTLE ERA TOWARDS THE EXPLORATION ATMOSPHERE

J.H. Wessel, J.R. Norcross, and O.S. Bekdash

EVA Physiology Laboratory, Wyle Science, Technology and Engineering Group, Houston, TX

INTRODUCTION: The proposed exploration atmosphere of 8.2 psia and 34% oxygen (O_2) renders an atmosphere with a hypoxic dose nearly identical to the shuttle cabin condition while it was under the 10.2 staged prebreathe protocol [1]. Therefore, the 33 shuttle missions featuring this protocol provided information towards setting expectations of the suitability for future manned exploration missions. **METHODS:** The NASA Archive Data Retrieval Interface Tool was used to determine the in-flight values for ppO_2 and $ppCO_2$ over the course of each mission and the exact times that the cabin depressed to 10.2 psia and repressed to 14.7 psia on each shuttle flight. **RESULTS:** Cumulatively, crewmembers experienced 114 days under the staged 10.2 condition. The length of exposure to this environment varied by mission, with average time being ~3.5 days and the longest being just over 8 days. ppO_2 averaged 2.75 ± 0.07 psia (142.2 ± 3.6 mmHg) while depressed to 10.2 psia, and 3.16 ± 0.13 psia (163.4 ± 6.7 mmHg) at 14.7 psia before and after depress across all staged missions. The $ppCO_2$ varied among the 10.2 shuttle missions, the average was 1.95 ± 0.62 mmHg at 10.2 psia, and 2.10 ± 0.78 mmHg at 14.7 psia. The maximum recorded $ppCO_2$ was 11.02 mmHg. 24 staged 10.2 shuttle missions recorded $ppCO_2$ above 4 mmHg, and a notable 6 missions with $ppCO_2$ at or above 7.6 mmHg. Across all staged missions, 5.55% of all $ppCO_2$ values were above 4 mmHg, and 0.066% were above 7.6 mmHg. **DISCUSSION:** Data mining results from the Sleep Logs study (DSO 634), de-identified private medical conference logs and shuttle post flight debriefs should provide subjective and medical insight (headaches, lethargy, sleeplessness, etc.) from staged 10.2 missions that will be compared directly against non-depressed shuttle missions.

Learning Objectives:

1. The 10.2 Staged Prebreathe shuttle missions provide a rich source for data mining as background for the future Exploration Atmosphere.
2. The 10.2 Staged Prebreathe shuttle missions are nearly physiologically equivalent (PIO_2) to the Exploration Atmosphere.

Thursday, May 14
S. Hemisphere 4

3:30 P.M.

[XCIV.] SLIDE: SPATIAL ORIENTATION AND NEUROPHYSIOLOGIC MEASURES

Co-Chair: Frederick Bonato
 Montclair, NJ

Co-Chair: Eilis Boudreau
 Portland, OR

3:30 p.m.

[478] EEG FUNCTIONAL NETWORK PROPERTIES RELATED TO UNRECOGNIZED SPATIAL DISORIENTATION EVOKED BY VISION

Y. Chen², F. Pu², C. Hao¹, and Y. Li²

¹Bethune Hospital, Heibei, China; ²School of Biological Science and Medical Engineering, Beijing University of Aeronautics and Astronautics, Beijing, China

INTRODUCTION: Unrecognized spatial disorientation (SD) which is intimately linked with brain cognitive function is sometimes a fatal issue for the safety of pilots. To explore the effects of it on human brain cognitive function, we adopted graph theoretical tools to examine changes in electroencephalography (EEG) functional networks while experiencing unrecognized spatial disorientation. **METHODS:** Twelve male pilots participated in the study. They were subjected to two different SD scenes namely visual flow and visual rotation, which evoked unrecognized SD. For the main EEG frequency intervals, phase lag index (PLI) and normalized mutual information (NMI) were calculated to quantify the EEG data. Then weighted connectivity networks were created and their organizations were characterized in terms of an average clustering coefficient and global efficiency. Wilcoxon signed rank test was performed to compare PLI, NMI and network measures between SD group and non-SD group. **RESULTS:** We found a weak functional connectivity level in the theta band under unrecognized SD based on the significant decrease of mean PLI and mean NMI ($p < 0.05$). Meanwhile, both the average clustering coefficient and global efficiency in the theta band reduced under spatial disorientation. **DISCUSSION:** The decrease of global efficiency demonstrates a decline in processing efficiency of brain cognitive regions. On the other hand, all the experimental results show that SD may have a negative effect on brain functional networks in the theta band. The present study offers reference for further researches.

Learning Objectives:

1. The effects of unrecognized spatial disorientation on brain functional networks are analyzed and described.

3:45 p.m.

[479] THE ROLE OF VISUAL ATTENTION IN SIMULATOR SICKNESS

P. Trivelloni^{1,2}, F. Ferlazzo², P. Verde¹, M. Lucertini¹, and C. Guariglia²

¹Aerospace Medicine Department, Flight Experimental Center, Italian Air Force, Pratica di Mare AFB, Italy; ²Department of Psychology, Sapienza University of Roma, Roma, Italy

INTRODUCTION: The use of flight simulators for pilots' initial and recurrent training is increasingly widespread. Modern flight simulators offer high fidelity technology with full motion platforms and domes for visual information presentation. However, simulator sickness continues to affect pilots, mainly those who are in charge of the training sessions, causing discomfort or sickness during and/or after the simulated flights. **METHODS:** 42 pilots underwent three different tests: visual spatial ability (MRT, Mental Rotation Test); auditory covert spatial attention orienting test (acoustic cue Posner paradigm); visual search (letter & bell cancellation test) under eye-tracker monitoring. Tests were administered to the subjects (22) before and after a 1-hour training session in a spatial disorientation demonstrator (SDD), while to the controls (20) before and after a 1-hour lecture on SD; subjects answered a Pensacola SSQ before and after the SDD

training sessions. Data analysis was focused on response time and accuracy for MRT; difference between response time in valid and invalid trials for acoustic Posner paradigm; fixations total number, maximal excursion and mean duration for visual search task. **RESULTS:** MRT and Posner paradigm showed a statistically significant ($p < 0.05$) improvement in the second test due to training effect, in accordance with the scientific literature. The visual search task showed a change in visual search pattern after the SDD session, with significant statistical difference ($p < 0.05$) only in fixations mean duration which increased after the SDD session. We also found a change in visual scanning strategy with a higher number of fixations in the center of the visual pattern after the SDD session. **DISCUSSION:** The aim of this study was to analyze the incidence of simulator sickness in a spatial disorientation simulator, using cognitive psychology and psychophysiology experimental models, to provide evidence-based data about the role of visual attention in simulator sickness. Although few statistically significant data emerged, related to a critical visual attention impairment induced by the exposure to virtual reality, we found a trend in the visual scanning strategies that correlates with simulator sickness oculomotor cluster score.

Learning Objectives:

1. The relationship between visual attention, eye movements and simulator sickness oculomotor cluster.

4:00 p.m.

[480] ESTIMATION OF AN OPTIMAL STIMULUS AMPLITUDE FOR USING VESTIBULAR STOCHASTIC STIMULATION TO IMPROVE BALANCE FUNCTION

R. Goel¹, I. Kofman², Y. Dios², J. Jeevarajan³, V. Stepanyan², M. Nair⁴, S. Congdon⁴, M. Fregia⁴, B. Peters², H. Cohen⁴, S. Wood⁵, J. Bloomberg³, and A. Mulavara⁶

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INTRODUCTION: Sensorimotor changes such as postural and gait instabilities can affect the functional performance of astronauts when they transition across different gravity environments. We are developing a method, based on stochastic resonance (SR), to enhance information transfer by applying non-zero levels of external noise on the vestibular system (vestibular stochastic resonance, VSR). The goal of this project was to determine optimal levels of stimulation for SR applications by using a defined vestibular threshold of motion detection. **METHODS:** We compared perceptual threshold (using a joystick) with that obtained from six measures of body sway (medio-lateral shear forces and roll moments, accelerations of head and torso, and roll velocities of head and torso). We followed which subjects did a balance task in which they had to stand on 10 cm thick medium density foam and try to maintain balance, while they experienced stimulation from 20% to 400% of their perceptual threshold. Optimal stimulation amplitude was determined to be the one which showed the maximum improvement in balance performance when compared to the control (no stimulation). **RESULTS:** Comparisons of threshold of motion detection obtained from joystick data versus body sway suggests that perceptual thresholds were not different from body sway thresholds using force plate and head-mounted IMU, but were lower than that obtained from a torso-mounted IMU. But, body sway measures are affected more by systemic noise, or if the subject is stiff or fidgety. Results from the balance task shows that, in general, using stimulation amplitudes at 40% of perceptual-motion threshold significantly improved the balance performance. **DISCUSSION:** We hypothesize that VSR stimulation will act synergistically with sensorimotor adaptability (SA) training to improve adaptability by increasing utilization of vestibular information, and therefore will help us to optimize and personalize a SA countermeasure prescription to each crewmember. This combination may help to significantly reduce the number of days required to recover functional performance to preflight levels after long-duration spaceflight.

Learning Objectives:

1. Advancing the understanding of stochastic resonance mechanism in improving balance function.

4:15 p.m.

[481] TWO FREQUENTLY-MENTIONED CONTRIBUTORS TO MOTION SICKNESS SEVERITY THAT LACK SUFFICIENT PROOFB. Lawson¹, L.I. Thompson^{1,2}, J. Brill³, and A. Rupert¹¹U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL; ²Oak Ridge Institute for Science and Education, Oak Ridge, TN;³Old Dominion University, Norfolk, VA

INTRODUCTION: Motion sickness (MS) is a challenge to users of virtual environments and people engaged in actual/simulated travel via land, sea, air, or space vehicles. Understanding the factors that worsen MS is important to military and aerospace operations. Misconceptions exist regarding the most important stimulus or individual factors contributing to a person's MS severity. Many lay sources concerning MS are incorrect. Unfortunately, misunderstandings can arise from the scientific literature as well, e.g., when published assertions concerning "proven" MS contributors go beyond what the data can support. **METHODS:** Two problematic MS assertions were evaluated in this presentation. Assertion #1 is that the illusion of self-motion (vection) has been proven to be necessary to elicit visually-induced MS. Assertion #2 is that women have been proven to be more susceptible to MS than men (due to a primary sex difference). These assertions were evaluated via two narrative literature reviews using Google Scholar, PubMed, Defense Technical Information Center, and other sources to be discussed. The reviews identified 10 publications relevant to Assertion #1 (from 1950-2013) and 56 publications relevant to Assertion #2 (1940-2013). **RESULTS:** Regarding Assertion #1, a causal link from vection to MS has not yet been confirmed, and only 30% (3/10) of the identified studies observed a significant correlation between the two. Regarding Assertion #2, a greater number of studies have been identified than in any other review. However, only 50% (28/56) of the studies confirmed that women had significantly greater MS susceptibility, and the reasons for the difference (when observed) were not isolated. Adding one more relevant study in preparation by Brill would bring the estimate to 50.9% (29/57). Nevertheless, the argument for Assertion #2 is not quite as dubious as is implied by our "coin toss" findings, for reasons that will be discussed.) **DISCUSSION:** The literature findings to-date cannot support confident assertions that vection or sex are sufficiently proven MS factors. More confidence should be placed in better-established factors, such as MS response to a similar challenge and past history of MS susceptibility.

Learning Objectives:

1. To make listeners aware of existing misconceptions regarding the relation of vection and sex differences to motion sickness.

4:30 p.m.

[482] A NOVEL METHOD FOR DETECTING NECK DISEASE BY SURFACE ELECTROMYOGRAM AND WAVELET ANALYSIS

J. Schnaidt and D. Bron

Airforce, Fliegerärztliches Institut, Dübendorf, Switzerland

INTRODUCTION: Neck pain is a common health problem in Air Force pilots. Additional equipment on their helmet, G-forces, vibrations and a non-ergonomic sitting posture can provoke neck pain. The incidence of neck pain has increased in the last few years within Air Force pilots. Most of the time when neck pain is reported, an expensive course of treatment and loss of quality of life is the consequence. The purpose of this study is to describe a cost-effective and efficient testing procedure to accurately detect and prevent neck pain. **METHODS:** A group of 50 Swiss Air Force pilots with and without neck pain performed several mobility exercises. Simultaneously, a surface EMG recorded muscle activity. A Visual Analogue Scale (VAS) reported the subjective pain felt in real time and of the worst episode of pain in the last 3 months. A Wavelet analysis was applied on the EMG pattern. Muscle activity of those pilots with neck pain was compared to muscle activity of asymptomatic controls. **RESULTS:** The pattern of neck pain subjects showed a higher intensity level on the affected painful side. In addition, the frequency range of muscle activity was smaller compared to pain free subjects. Asymptomatic controls showed no difference in intensity level regarding right and left side of the upper body. Further analysis is being conducted and will be presented and discussed in due course. **DISCUSSION:** Preliminary results show the procedure of using EMG and Wavelet offers new possibilities to approach the problem of neck pain in pilots. The higher

intensity of muscle activity in subjects recording pain could be inferred as a cause of great tension and permanent muscle contraction. Moreover, movements are performed with only a few muscle fibers, resulting in a small frequency range. These could be the first indicators for detecting neuromuscular changes, which indicate neck disease. This novel method of using EMG and Wavelet analysis has shown to be useful in detecting neuromuscular abnormality in neck pain patients. The more, it provides practical treatment and training recommendations for the early prevention of neck pain. Further studies are needed to fully evaluate and validate this method.

Learning Objectives:

1. EMG and Wavelet Analysis is a useful method to detect neck pain.

4:45 p.m.

[483] SIMULATING THE APPEARANCE OF COLOR DISPLAYS AS VIEWED THROUGH LASER EYE PROTECTION

C.A. Williamson

711 Human Performance Wing, Optical Radiation Bioeffects Branch, San Antonio, TX

INTRODUCTION: Laser Eye Protection (LEP) imparts coloration to the wearer's vision which can make viewing of color displays problematic, either through misinterpretation of color cues or masking specific colors completely. This is of particular concern for aircrew wearing LEP in modern cockpit environments, where multi-function color display (MCFD's) are now commonplace. **METHODS:** A simple model has been created to allow the appearance of color displays to be simulated as if wearing LEP. The model is based upon an implementation of the CIECAM02 color appearance model and allows for chromatic adaptation. **RESULTS:** The model has been applied to a mock radar display image viewed through blue-blocking LEP. Simulated imagery for this specific case shows potential color confusion that occurs between green and blue symbols, and also between white and yellow symbols. **DISCUSSION:** This technique could aid the design of display symbology to maximize compatibility with existing LEP, or it could be utilized to inform the selection of appropriate LEP to permit viewing of existing display systems.

Learning Objectives:

1. A technique for simulating the appearance of color displays as viewed through laser eye protection is presented.

Thursday, May 14

S. Hemisphere 5

3:30 P.M.

[XCV.] PANEL: FULL SCALE HELICOPTER CRASH TESTING—PERFORMANCE OF CRASH INJURY MITIGATION TECHNOLOGIES

Sponsored by the Life Sciences and Biomedical Engineering Branch and AsMA's Science & Technology Committee

Chair: Barry Shender

Patuxent River, MD

PANEL OVERVIEW: This panel presents the results from the first of two full-scale crash tests of transport helicopters conducted at the NASA Langley Research Center Landing and Impact Research Facility (LandIR). A multi-facility effort measured the efficacy of multiple protection concepts using a variety of fully instrumented anthropomorphic test devices, airframe sensors, video and mechanical data. The first presentation, from LandIR, describes the experimental setup and overall study goals. The second presentation describes the crash pulse in detail, which varies depending upon location within the aircraft. This has obvious implications for crashworthy concept designs. During crash, some of the most at risk occupants are those not seated. A presentation by the Naval Air Systems Command (NAVAIR) describes the performance of a mobile Aircrew Restraint System as compared to the current restraint. However, the most vulnerable occupants are patients during evacuation. The US Army

Aeromedical Research Laboratory presents results of an effort to characterize the risks to patients transported in litters. Finally, the study also included measuring the response of civil aviation forward facing passenger seats as well as a comparison of sidewall-mounted troop seats and an investigation of a modification to the FAA Hybrid III ATD conducted by FAA CAML.

[484] OVERVIEW OF THE FIRST TRANSPORT ROTORCRAFT AIRFRAME CRASH TESTBED (TRACT) FULL SCALE CRASH TEST

M. Annett

NASA Langley Research Center, Hampton, VA

INTRODUCTION: The principal focus areas for the rotorcraft crashworthiness research task at NASA Langley Research Center are crash modeling and simulation to improve predictive capabilities for structural impact, evaluation of crashworthy concepts, including active restraints, energy absorbing seats and composite subfloor, and development of advanced anthropomorphic test device models for aerospace crashworthiness. Full-scale crash testing at NASA Langley Research Center's Landing and Impact Research Facility (LandIR) provides the capability to represent all the critical interactions between the airframe, seat, and occupant in a controlled environment. The Transport Rotorcraft Airframe Crash Testbed (TRACT) full-scale crash tests address transport category rotorcraft crash response under combined horizontal and vertical loading. **METHODS:** A CH-46E, categorized as a medium-lift rotorcraft with fuselage dimensions comparable to a regional jet or business jet, was outfitted with various crashworthy features such as pre-tensioning active restraints and energy absorbing seats. The first TRACT test (TRACT 1), conducted in August 2013, assessed improvements to occupant loads and flail envelope with crashworthy features, provided data for comparison to finite element analyses, and demonstrated novel techniques for photogrammetric data acquisition to measure occupant and airframe kinematics. A combination of Hybrid II, Hybrid III, and ES-2 Anthropomorphic Test Devices (ATDs) were placed in forward and side facing seats, in standing position, and in a patient litter, and occupant responses were compared against injury criteria. Crash test conditions for TRACT 1 were 33-ft/s forward and 25-ft/s vertical combined velocity onto soft soil, which represent a severe, but potentially survivable impact scenario. **RESULTS:** Loads from ATDs in energy absorbing seats and restraints were within injury limits. Severe injury was likely for ATDs in forward facing passenger seats, legacy troop bench seats, and a three-tiered patient litter. **DISCUSSION:** The loads throughout the airframe varied widely from tail to cockpit with just a slight pitch-up attitude. The terrain provided a unique kinematic response that changed the deceleration profiles.

Learning Objectives:

1. Assess airframe loads as they relate to seat and occupant loads, how difference in terrain, attitude, etc. drastically change the seat and occupant response.

[485] SLAM-DOWN CRASH PULSE CHARACTERISTICS AND THE EFFECTS ON CRASHWORTHY HARDWARE PERFORMANCE

L.W. Bark

Human Systems, Naval Air Warfare Center Aircraft Division, Hollywood, MD

INTRODUCTION: The TRACT-1 test was a full-scale crash test of a CH-46 airframe conducted at NASA-Langley Research Center by NASA, Navy, FAA, and the Army. This airframe was approximately 40 ft. long and was instrumented from nose to tail. Nominal test conditions were 35 ft/sec forward, 26 ft/sec sink and 2-deg nose-up pitch onto soil. The airframe was instrumented from nose to tail to identify how the crash pulse varies depending on location. The crash test article also contained numerous experiments regarding non-crashworthy and crashworthy hardware. Fifteen anthropomorphic test devices (ATD's) were included in the test to represent human occupants. **METHODS:** Data collection included 350 channels of instrumented data and 40 high speed video cameras. The test article was suspended by four swing cables and a pull-back cable. The pull-back cable was cut and the airframe swung toward the impact surface gaining both vertical and horizontal velocity. At impact, the swing cables were cut from the airframe so it was free from cable forces. **RESULTS:** The data clearly show the magnitude and direction of the crash pulse are remarkably different for

different longitudinal locations in the airframe. The longitudinal component of the crash pulse is roughly constant with respect to location at any given time. The vertical component is markedly different at different locations, ranging from a peak of 36 G at the aft-most floor to 120 G at the cockpit floor. Also notable is that the vertical acceleration reverses direction in the cockpit to create the slam-down condition. **DISCUSSION:** Helicopter seating systems stroke downward at a controlled load to limit the compressive force imparted to the occupant's lumbar spine. It was observed that the unique characteristics of the crash pulses noted in the cockpit region of the test airframe tend to initially throw the occupant up and forward relative to the seat. Upon fuselage contact under the cockpit, the occupant then moves down and violently re-contacts the seat pan. The kinematics of this dynamic sequence result in compressive lumbar spinal forces that are substantially in excess of accepted injury criteria. These findings illuminate potential causative factors behind presently unexplained spinal injuries in real world mishaps.

Learning Objectives:

1. Identify potential causative factors relating to injuries sustained in crash protective hardware, the condition of which would not necessarily indicate likelihood of injury.

[486] EVALUATION OF MOBILE AIRCREW RESTRAINT SYSTEMS IN A FULL-SCALE MILITARY AIRFRAME CRASH TEST

L.W. Bark

Human Systems, Naval Air Warfare Center Aircraft Division, Hollywood, MD

INTRODUCTION: In a typical utility, mission, or cargo helicopter, certain aircrew must be mobile to complete their missions. Such aircrew may be mobile for all phases of flight including takeoff and landing. In the event of a crash impact, a mobile aircrew is at substantial risk of serious or fatal injury as evidenced by mishap experience. To investigate these issues, two mobile aircrew experiments were included in the TRACT-1 crash test, the first time mobile aircrew have been included in such full-scale tests. **METHODS:** Two 5th percentile male Hybrid III ATDs were equipped with typical flight survival ensembles. One included traditional equipment and a gunner's belt representing a fixed-length tether between the mobile aircrew and the airframe. The other ATD had the newer Aircrew Endurance vest and the developed mobile aircrew restraint system (MARS) that has been designed to retract the tether between the airframe and mobile aircrew and automatically lock to prevent tether extension upon impact. The two ATDs were positioned symmetrically (Right/Left) in the airframe and secured in a standing position with an arrangement of cables and cords. Upon airframe impact with the terrain, the supports that positioned the ATDs were pyrotechnically severed so the ATDs represented free-to-move mobile aircrew. **RESULTS:** Data and video indicate that the ATD with the gunner's belt sustained a severe (certainly fatal) head strike and experienced chest accelerations that are substantially in excess of typical chest acceleration limits. The ATD with the MARS was 'caught' by the locking of the MARS and did not experience accelerations or loads that are indicative of serious injury. **DISCUSSION:** The side-by-side testing of the mobile aircrew in this crash test demonstrated that newer technologies can substantially mitigate the hazards facing mobile aircrew involved in aviation crashes. The results obtained in the TRACT-1 test are practically binary in conclusion. For an identical crash environment, one ATD represented lethal injury while the other would represent injuries that were mild based on assessment of recorded data. The results of the testing also allow assessment of how a mobile aircrew is loaded by the vests and restraint technologies.

Learning Objectives:

1. Understand the unique crash-protective challenges related to military helicopter aircrew that may be mobile during all phases of flight.

[487] PATIENT LITTER RESPONSE IN A FULL SCALE CH-46 CRASH TEST

J. McEntire, T. Rooks, and V. Fralish

Aeromedical Research Laboratory, U.S. Army, Fort Rucker, AL

INTRODUCTION: Current patient movement items, such as patient litters, are designed to meet static strength requirements at a component

level. While patient care during medical transportation is critical, the patient movement systems need to structurally withstand the dynamics of turbulent flight and "survivable" crash events. Patient litters and their supporting systems are critical, and often overlooked, infrastructure components of the medical transport environment. The inability to safely restrain patients in harsh environments and properly support patients on a litter during crash impact events could exacerbate existing injuries and create additional injuries to the patient. **METHODS:** During a planned crash test of a CH-46 helicopter, space was provided to install three litters stacked above each other with wall stanchions and ceiling hanging straps. The upper and lower litters were loaded with non-instrumented test dummies to produce representative dynamic loads. The center litter was loaded with an anthropometric test device (ATD), instrumented to collect the forces, moments, and accelerations. Additional accelerometers were installed to collect dynamic loads acting on the four support hooks of the middle litter. A high-speed video camera captured the dynamic response of the patient litter systems and occupants. **RESULTS:** Instrumented ATD data is being assessed against established injury assessment reference values for automotive testing. Review of the on-board video revealed the upper test dummy was partially ejected off the litter prior to impact. All litters collapsed during the event and separated from their support hooks. None of the test dummies were adequately restrained on their litters. **DISCUSSION:** The results suggest the structural integrity of the litter systems used in this test and the CH-46 litter support systems are insufficient to properly secure and restrain litter occupants during severe crash events. Patient safety during this crash loading environment was compromised and could introduce new or exacerbate existing injury.

Learning Objectives:

1. To introduce the audience members to the dynamics of crash events and to illustrate the hazards present during poor occupant restraint supporting structural failure.

[488] PASSENGER SEAT AND MODIFIED ANTHROPOMETRIC TEST DEVICE PERFORMANCE DURING TRACT TEST

J. Pelletiere and R. Deweese

Aviation Safety, Federal Aviation Administration, Dayton, OH

INTRODUCTION: The drop test of the TRACT CH-46 airframe provided an opportunity to conduct several experiments, two of which are described here. **METHODS:** The first was the inclusion of forward facing passenger seats that were certified to 14 CFR 25.562 aviation regulations. Their certification process consisted of testing with specific pulses and specific Anthropometric Test Devices (ATD). The TRACT testing provided the opportunity to compare the certification testing with the results of an actual impact. This included collecting the lumbar loads in the ATDs and the use of different sized ATDs. The second experiment was a comparison of sidewall-mounted troop seats and an investigation of a modification to the FAA Hybrid III ATD. For side-facing seats, the ES-2RE ATD is used in certification tests to evaluate the unique injury risks produced by lateral loading. That ATD was not designed to withstand vertical loading or measure injury risk during a vertical impact. For this test, the head and neck of the ES-2RE was fitted to the FAA Hybrid III. Vertical loading and flail can be assessed with the FAA Hybrid III and lateral neck loads could be measured with the ES-2RE head and neck. This ATD and a standard 50th percentile Aerospace Hybrid-III were seated side by side in identical, wall mounted, energy absorbing, seats. As a performance benchmark, two 50th percentile Hybrid-II ATDs were seated on a typical troop bench. **RESULTS:** The forward facing passenger seats remained attached to the floor structure; however, the lumbar loads measured were significantly higher than those in certification tests. Both of the energy absorbing seats stroked downward as designed during the impact. The modified ATD and the Aerospace ATD had similar, moderate level, lumbar load magnitudes, and the modified ATD neck loads were below established injury limits. The troop seats collapsed in a way that would tend to produce upper leg and abdominal injuries. **DISCUSSION:** As expected, the energy-absorbing seats provided a significantly higher level of safety than the certified passenger seats or the troop seats. The modified FAA Hybrid-III functioned as intended and produced useful data. A comparison with the results from the second TRACT test will be useful in determining its robustness.

Learning Objectives:

1. To understand the differences in ATD responses for lateral loading.
2. To understand how seats respond to real world impulses as compared with certification testing.

Thursday, May 14

3:30 P.M.

S. Hemisphere E3

[XCVI.] SLIDE: FABULOUS AEROMEDICAL RANDOM TOPICS

Chair: Patricia MacSparran

Edwards, CA

3:30 p.m.

[489] MORAL, ETHICAL AND LEGAL POSITION OF PHYSICIAN VOLUNTEERS PROACTIVELY IDENTIFIED ON COMMERCIAL FLIGHTS

C.A. Graham¹, B. Murphy^{2,1}, V. Lok², K. Hung¹, and R.A. Cocks¹

¹*Accident and Emergency Medicine Academic Unit, Chinese University of Hong Kong, Shatin, Hong Kong;* ²*Howse Williams Bowers, Hong Kong, Hong Kong*

INTRODUCTION: Recent personal experience suggests that some commercial airlines have a policy of proactively identifying physician passengers at or prior to departure. The physician is greeted warmly by the cabin crew and questioned along the lines of 'are you a medical doctor?' and if so, 'in what specialty do you practice?' After several similar episodes, we were concerned that the normal physician volunteer-airline relationship could be affected in some way by this practice. The key question here is whether the physician is truly a volunteer if they have been pre-emptively identified as a physician prior to any medical event occurring. **METHODS:** Good Samaritan laws and regulations were reviewed and this practice was critically appraised for its moral, ethical and legal aspects. In particular, the US Aviation Medical Assistance Act of 1998 and AsMA's advice were reviewed. **RESULTS:** Any physician has a moral obligation to provide assistance in an emergency consistent with their skills when assistance is requested. This applies on board an aircraft as much as in any other setting. Whether or not a physician responds to any request remains entirely their decision, whatever the moral imperative, and relies on their own judgement of fitness to practise at that particular time. However, if the cabin crew are aware that a passenger is a physician, they may specifically request that the physician acts in an emergency. In this situation, the physician is no longer a volunteer but has an ethical and moral (and probably, legal) obligation to respond. **DISCUSSION:** In these circumstances, it is likely that the Good Samaritan legislation would continue to apply as long as the physician truly volunteers their services when requested. The wider question of whether or not a physician's inflight behaviour may be modified by an airline's approach will be considered further.

Learning Objectives:

1. The relationship between airlines and 'volunteer' physicians will be analysed and evaluated from moral, ethical and legal standpoints.

3:45 p.m.

[490] PHYSICAL ADAPTATION DURING AN EXPEDITION IN ANTARTICA

A. Parent¹, S. Morales², and A. Comtois²

¹*Biology, University of Quebec in Montreal, Montréal, QC, Canada;*

²*Kinanthropology, University of Quebec in Montreal, Montreal, QC, Canada*

INTRODUCTION: Antarctica is a non-human land that challenges the human body whenever someone ventures there. It is an important analog environment mimicking certain aspects of an isolate crew in microgravity. **METHODS:** A group of 6 explorers (3 women and 3 men; 25 ± 4 years old) participated in an expedition in complete autonomy

for 30 days in Antarctica. The objective was to observe the physiological adaptation of the explorers in this extreme environment following physical preparation, high calorie input nutrition, and mineral supplements. Anthropometric measures (DXA), a specific aerobic test, grip strength and endurance tests (suspension bar) were conducted before and after the expedition in the laboratory at UQAM. An analysis by paired samples t-test was used to compare pre- and post expedition. **RESULTS:** Pre- VS post- expedition measurements were significantly [L1] different for %body fat (17.1 ± 7.9 VS 15.0 ± 10.5 and 25.7 ± 6.7 VS 24.6 ± 6.3 % fat for men and women, respectively; $t=3.9$), but not for lean mass (62.9 ± 4.8 VS 63.3 ± 4.6 and 45.4 ± 4.4 VS 53.3 ± 4.1 kg; $t=-0.3$ for men and women, respectively). Pre-post expedition were significantly different for the specific $\dot{V}O_{2peak}$ test (40 ± 3 VS 51 ± 9 ml/kg/min for men and 38 ± 2 VS 42 ± 4 ml/kg/min; $t=-2.89$ for women). The grip strength and suspension bar test did not change significantly and for the grip strength was 126 ± 8 VS 115 ± 14 kg for men and 78 ± 12 VS 75 ± 17 kg for women; $t=0.8$, while for the suspension bar test was 73 ± 10 VS 61 ± 20 seconds for men and 37 ± 17 VS 55 ± 47 seconds for women; $t=-0.8$, before and after the expedition, respectively. **DISCUSSION:** The nutrition and the physical preparation appear to be key aspects during an expedition in an extreme environment to countermeasure weight lost and physical ability decay.

Learning Objectives:

1. Identify different physiologic changes during an expedition in Antarctica.

4:00 p.m.

[491] AEROMEDICAL DECISION MAKING IN SPONDYLOARTHROPATHY

C. Chua

Republic of Singapore Air Force Medical Service, Singapore, Singapore

INTRODUCTION: Spondyloarthropathy refers to a family of rheumatic diseases that cause arthritis by involving the entheses. The onset of disease typically begins in teens and 20s, with a male preponderance. Besides affecting the joints, it is often associated with other conditions such as inflammatory bowel disease, psoriasis and uveitis. Medical treatment of spondyloarthropathy and associated conditions may involve disease modifying anti-rheumatic drugs (DMARDs) and TNF alpha blockers. The aeromedical disposition of military aviators who are stricken with this condition is dependent on the extensiveness of disease, presence of associated conditions, clinical assessment on physical impairment, and effects of pharmacological treatment. In this presentation, the aeromedical risk assessment and disposition of spondyloarthropathy cases will be discussed through the review of the management of two aircrew with peripheral spondyloarthritis.

Learning Objectives:

1. To provide an overview on spondyloarthropathy and its predominant treatment modalities.
2. To discuss the aeromedical risk assessment and disposition of spondyloarthropathy.

4:15 p.m.

[492] TRANSCRANIAL MAGNETIC STIMULATION IN TREATMENT OF ACTIVE DUTY MEMBERS WITH PTSD, DEPRESSION AND LOWER BACK PAIN

J. Zhang¹, Y. Jin², and G. Bates³

¹Aerospace Medicine, Tinker Air Force Base, Oklahoma City, OK;

²Brain Treatment Center, Newport Beach, CA; ³Mental Health, Tinker Air Force Base, Oklahoma City, OK

INTRODUCTION: Transcranial Magnetic Stimulation (TMS) has been recently FDA approved to treat patients with depression and migraine. Data from Air Force Research Library shows that a warrior's cognitive abilities can be enhanced through repetitive TMS. It is indicated that

members with PTSD may receive benefit from rTMS treatment. We treated airmen and families in Los Angeles area with rTMS that significantly improved outcomes in the following cases. 1) A 50 year old active duty male complained of chronic back pain and a moderate degree of anxiety from work-related stressors. After 30 TMS treatments, his back pain is now primarily gone. More importantly, he is far less anxious, sleeping better and can focus "in the now" better than he ever has. 2) A 17 year old female suffered from depression for two years with significant negative impact on her school performance. After 20 TMS treatments, her symptoms improved significantly. She has mood, sleep and energy improvement. As a result, her psychiatrist started tapering her antidepressant medications. 3) An active duty male Master Sergeant with 21 years of service suffered from PTSD following 6 deployments to Iraq/Afghanistan as an EOD technician between 2000 and 2011. After trying multiple other treatments with varied results, he agreed to give TMS a try. With only a week of treatment, his sleep quality improved. His anger subsided significantly and he started to enjoy things again. He has a significant reduction of his PCL-M score from baseline of 62 to 17 after one week of treatment. Importantly, he has become able to focus again and can concentrate on information much more efficiently. We are currently planning a pilot study to gather more information on the efficacy of TMS in PTSD, Depression, and LBP in our active duty population. Baseline EEG will be done on all subjects prior to undergoing two weeks of TMS treatment (30 min a session; 5 sessions/week). PCL-M scales will be used to monitor progress of members with PTSD, and PHQ-9 be used for members with depression. For back pain, the pain scale and number of days on profile will be used to monitor progress. The ultimate goal is to improve members' duty performance and therefore increase mission readiness.

Learning Objectives:

1. TMS through synchronization of brain wave (activity) may improve symptoms in people with PTSD, Depression, and LBP.

4:30 p.m.

[493] REASONS FOR MEDICAL DISQUALIFICATION OF IRANIAN COMMERCIAL PILOTS BETWEEN 2001-2013

K. soleimani

Air Medical Section, Civil Aviation Organization, Tehran, Iran

INTRODUCTION: A License holder is legally obliged to undergo regular health examination, performed by designated medical examiner in an aero medical center (AMC). The medical requirements for commercial pilots are issued by the ICAO, FAA, CAA, and JAA. In Iran the Aeromedical Section (AMS) of the Civil Aviation Authority evaluates and assesses medical reports submitted to the Licensing Authority by medical examiners whether pilots are medically fit to fly. This study presents the causes for medical disqualification among the Iranian commercial pilot population during a 13-yr period. **METHODS:** The categories of medical condition which have most often been responsible for permanent disqualification of flying personnel have been previously documented in some studies. In my country, the outcomes of all pilot medical examinations are gathered in the archive of the Aeromedical Section of the Iranian Civil Aviation Authority. The disqualifying conditions were reviewed, listed individually, and grouped by major disease categories and age factors related to these conditions were examined. **RESULTS:** In this study total population are 41480 pilots took the Iranian pilot's medical examination and pilot-years, and 164 pilots were permanently grounded, which gives a 13-yr average disqualification rate of 4.2 per 1,000 pilot-years. **DISCUSSION:** Cardiovascular disease, as a calcification, was found to be the commonest cause of disqualification in this population. Other causes, such as internal medical, neurological diseases, ENT problems, Endocrine disease, and psychiatric diseases, are frequently reasons for permanent disqualification. This fact is probably not attributed to more stringent health requirements, but possibly to the attitudes of the pilots, who have become more critical with respect to their subjective perception of their working environment and psychosocial factors.

Learning Objectives:

1. This study presents the causes for medical disqualification among the Iranian commercial pilot population during a 13-yr period.

4:45 p.m.

[494] RELATIONSHIP BETWEEN BODY MASS INDEX AND PERFORMANCER.C. Tontz¹, A.P. Tvaryanas¹, and M.J. Kinchen²¹U.S. Air Force School of Aerospace Medicine, U.S. Air Force, Wright-Patterson AFB, OH; ²Statistics and Operations Research, University of Northern Colorado, Wright-Patterson AFB, OH

INTRODUCTION: An extensive amount of medical literature suggests that people with a body mass index (BMI) in the category of overweight (BMI 25.0-29.9), obese (BMI 30.0-39.9), or morbidly obese (BMI >40.0) are at increased risk of developing chronic medical disease such as hypertension, cardiovascular disease, or diabetes. Current research suggests that the short-term impact of being overweight or obese has a negative impact on work performance as measured by days off work and injury rates. This study examines work days missed and physical fitness testing (PT) failures among aviators with elevated BMIs and abdominal circumferences. **METHODS:** In this retrospective study, the BMIs of 3.5 million aviators were identified using the Aeromedical Services Information Management Systems (ASIMS), a medical surveillance data collection system. These subjects were enrolled based on the inclusion criteria of being on U.S. Air Force (USAF) active duty status and taking a physical fitness assessment between years of 2006 and 2014. No electronic medical records will be examined. This study uses only preexisting data. Participants include only present or former USAF members enrolled in the ASIMS database. **RESULTS:** Preliminary results show there is a very strong relationship between increasing BMI and probability of PT failure. There is also a very significant relationship between increasing abdominal circumference and PT failure. The pass rate for PT testing is significantly higher for flying status members versus non-flying status members. Amongst flyers there is a significant relationship between increased abdominal circumference and days on duty not involving flying status, as well as increased BMI and increased duty not involving flying status days. Interestingly, members on flying status and officers have a significantly lower BMI than non-flyers and enlisted members. **DISCUSSION:** This presentation is focused on the relationship between elevated BMI and performance as measured by days off flying status/physical fitness failure rates among USAF aviators. Determining a relationship between BMI and performance could alter the USAF emphasis on the measurement of performance and the importance of maintaining a physically fit force.

Learning Objectives:

1. Examine relationship of BMI & decrement of performance.
2. Identify risk factors of those with elevated BMI, increased duty not including flying days, & physical fitness failures to include waist circumference, rank, gender & flying status.
3. Discuss the implications & impact of a "fit force" on mission accomplishment.

Thursday, May 14

3:30 P.M.

S. Hemisphere E4**[XCVII.] PANEL: AEROMEDICAL EXAMINATION IN GERMANY: CLINICAL CASE PRESENTATIONS (In English)***Sponsored by the German Society of Aviation and Space Medicine***Co-Chair: Carla Ledderhos***Fuerstenfeldbruck, Germany***Co-Chair: Claudia Stern***Cologne, Germany*

PANEL OVERVIEW: Concerning Germany, aeromedical examination and decision making is regulated by the EASA. This session is a clinical case presentation with several important and interesting cases. It is presented by members of the German Society of Aviation and Space

Medicine (DGLRM). During the session, presenters will ask some questions and discuss the answers with the audience. This session is presented in the English language and organized by the German Society of Aviation and Space Medicine (DGLRM).

[495] CASE REPORT: SUDDEN INCAPACITATION INFLIGHT OF AN AIR RESCUE SERVICE PILOT

U.L. Diestel

AME, Hamburg, Germany

INTRODUCTION: A 37 year old pilot is airborne with his helicopter, transporting a patient accompanied by a paramedic and an emergency doctor at the rear. Suddenly, he feels sick, dizzy and his heart is beating very fast. He reaches his destination, a special cardiology clinic. After landing, he is the next patient. His diagnosis: atrial flutter with a frequency of approximately 170 beats per minute. That evening a catheter ablation is performed successfully. Two weeks later, driving to my office, he feels sick again. His ecg now shows an atrial fibrillation and tachyarrhythmia absoluta. The indication for the isolation of the pulmonary veins is given and performed. Now the pilot is stable. According to medical guidelines he took phenprocoumarin for three months. Several long term electrocardiograms show - there are no pathological findings, particularly no signs for arrhythmia. In accordance to aviation regulations, initially, he may fly again, however, only with a safety pilot. Result: He develops massive anxieties, fear of another incident. His high responsibility for passengers and staff put too much pressure on him. Thus, in the end, he becomes permanently unfit to fly for psychological reasons.

Learning Objectives:

1. Sudden incapacitation inflight of an air rescue service pilot resulted in a psychological unfitness for flying.

[496] SEVERE NEUROCARDIOGENIC SYNCOPE WITHIN THE RECOVERY PERIOD OF A ROUTINE BICYCLE-STRESS-ELECTROCARDIOGRAPHY- A CARDIOLOGIC AND AEROMEDICAL CHALLENGE

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INTRODUCTION: According to the rules of the German Air Force, bicycle-stress-electrocardiography has to be performed annually during the flight physical for aircrews. Syncope is the number two cause (21%) of accidents due to losing consciousness. It happens to 3% of men and 3.5% of women. The frequency has increased in Germany within the last few years. Losing consciousness may cause sudden incapacitation and subsequent fatal accidents. Based on a severe case, the cardiologic challenge and the aeromedical consequences are demonstrated. **METHODS:** In July 2014 a 38 year old healthy male pilot of the German Navy performed his annually flight physical. In the recovery period of his stress ECG he got a seizure due to an asystole of 29 seconds without prodromal warning, followed by a spontaneous recovery of the sinus rhythm. The same cardiac event occurred again two minutes later. He was transferred to the ICU of a hospital for further diagnostics and therapy. **RESULTS:** In his medical history a vasovagal syncope during a medical procedure was found. All laboratory and other medical tests were normal, especially ECG, echocardiography, magnet resonance imaging (MRI), coronary angiography and an electrophysiological study. Severe neurocardiogenic syncope was proven by the same clinical event during a tilt table test. Tilt table training and a beta blocker therapy were started. Implantation of a pacemaker system might be necessary. The civil aeromedical regulations in Europe exclude a flying status after recurrent syncope. They are the minimal standard in the military aeromedical certification process of the German Air Force. **DISCUSSION:** This was our first resuscitation during routine stress ECG and the most severe neurocardiogenic syncope. Stress ECG is an integral part of the human performance enhancement project according to a "zero loss strategy". The present German Air Force policy might reveal aeromedical relevant findings early and prevent fatal accidents.

Learning Objectives:

1. The current German Air Force policy might reveal aeromedical relevant findings early and prevent fatal accidents.
2. Stress ECG is an integral part of the human performance enhancement.
3. The civil aeromedical regulations in Europe exclude a flying status after recurrent syncope.

[497] VESTIBULAR SCHWANNOMA - A CHALLENGE IN AEROMEDICAL DECISION MAKING

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INTRODUCTION: Vestibular schwannoma (VS) (acoustic neurinoma) is a benign tumor with its origin in schwann cells of the 8th cranial nerve. Mostly localisation is unilateral, except in special cases like neurofibromatosis. The auditive and vestibular fibres pass the bony internal ear canal. The growing tumor leads to early symptoms in the cochleavestibular system, like tinnitus, hearing loss, and disorders of the equilibrium. Most authors describe an incidence of 1:100,000. Various options of therapy are available like neurosurgery by different accesses (translabyrinthine, suboccipital...), radiosurgery (gamma knife), or "wait and scan". **METHODS:** By annual ENT medicals, signs and symptoms can be detected early. Following special signals like unilateral hearing loss in time examinations like MRI or neurootological tests (Brainstem-Evoked-Response-Audiometry =BERA) can be performed in the GAF Center of Aerospace Medicine. **RESULTS:** In the past 10 years we have observed 4 cases that are presented here, with different therapy approaches, who all returned into their cockpits under special restrictions. In about 2,000 examinations p.a. the incidence seems to be higher compared to the normal population. The main reasons might be the flight surgeon's the better "situational awareness", nearly unlimited availability of imaging and neurootological examinations, absence of economic pressure by the National Health Service. **DISCUSSION:** In general aircrew members with acoustic neurinomas are waiverable not earlier than 6 months after therapy under the following conditions: localization is unilateral, no relevant dysfunction of the equilibrium, tumor-diameter not more than 2.5 cm, no relevant facial nerve palsy, no psychomotoric disorders, MRI follow-up, OML, and clinical checks every 3 months

Learning Objectives:

1. Vestibular Schwannoma must not be a "no go" for aircrews.
2. Size of tumor determines the kind of therapy ceteris paribus.
3. Better solutions focussing the tumor in gamma knife therapy have been developed during the past 5 years.

[498] NOACS IN AVIATION MEDICINE: ACCEPTABLE OR NOT?

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INTRODUCTION: New oral anticoagulants (NOACs) are an alternative for vitamin K antagonists (VKAs) to prevent stroke in patients with non-valvular atrial fibrillation (AF). [Heidbuchel et. al. *Europace*, 2013 May, 15(5):625-51]. The FAA accepts VKAs in special cases, EASA differentiates between class 1 + 2 and LAPL. For class 1 + 2 medicals no anticoagulation is allowed. **METHODS:** Analysis of literature in order to clarify the risk of bleeding under a medication with NOACs. **RESULTS:** Meta-analysis

of large NOAC trials shows favourable risk/benefit ratio over warfarin.

[Ruff et. al. *The Lancet* 2013] **DISCUSSION:** Under certain conditions, the use of NOACs appears possible and safe in pilots. The new group of drugs should be discussed in aviation medicine.

Learning Objectives:

1. Patients with non-valvular atrial fibrillation (NVAF) are exposed to an increased risk for ischaemic stroke and systemic embolism. Learn about the role of NOACs in comparison with VKA.
2. Three studies used dose-adjusted warfarin as standard of care control, using a prospective open label blinded endpoint evaluation (RE-LY) or double blind, double-dummy study design (ROCKET AF, ARISTOTLE). Learn about the risk and safety profile of NOACs.
3. Know about possible role of NOACs in pilots.

[499] JOINT REPLACEMENT AND FITNESS FOR MILITARY FLYING DUTY

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INTRODUCTION: Joint replacement is a common and safe surgical procedure to treat joint failure due to osteoarthritis, rheumatoid arthritis, avascular necrosis, joint fracture, and tumor. The earliest recorded attempts of hip replacement were carried out in Germany by T. Gluck in 1891. Today, more and more joints are being replaced, and almost all large and small joints are replaceable, so joint replacement could be a therapeutic option for active pilots and crew members. **METHODS:** This case study includes 13 pilots and crew members with joint replacement (16 joints): 3 cases after knee replacement (4 joints) and 9 cases after hip replacement (12 joints). The indication for an artificial joint was a severe osteoarthritis in all cases. Different types of prosthetic implants and different materials were used, as well as different methods of fixation of the acetabular cup and femoral component. Our study summarizes indication, approach, implants, complications, rehabilitation and treatment outcome. **RESULTS:** All 13 pilots and crew members involved were examined as unfit for all military flying duties by German aeromedical regulations. After three months of surgical treatment (in case of one-side replacement) or after 6 months (in case of two-side replacement or after replacement of the artificial joint) a waiver procedure was initiated, and the decision-making was done on a case-by-case basis. In one specific case (helicopter pilot, 49 yrs, with early loosening of an insufficient artificial knee joint) the waiver was rejected, in all remaining cases the waiver was granted. The waiver was limited to five years. In these five years we did not see any complications in pilots or crew members caused by flying or military duty. **DISCUSSION:** Modern surgical techniques, implants and the correct indication reduce risks (vein thrombosis, dislocation, fracture, osteolysis, infection, metal sensitivity, metal toxicity, nerve palsy, chronic pain, leg length inequality) and the severe complication of an early loosening of the artificial joint, the main reason for replacement surgery. Joint replacement is a therapeutic option for military pilots and crew members; however, risk management in the waiver procedure is necessary.

Learning Objectives:

1. Indication for joint replacement.
2. Complications of joint replacement.
3. Military flying fitness after joint replacement.