

Learning Objectives: 1. The risk of post traumatic seizure post traumatic brain injury. 2. Aeromedical decision making post traumatic brain injury.

[152] SIGNIFICANCE OF CEREBRAL ARACHNOID CYSTS IN MILITARY AVIATION

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Introduction: Arachnoid cysts are intra-arachnoid CSF-filled sacs that do not communicate with the ventricular system. They are often asymptomatic but can present themselves clinically at all ages with signs of raised intracranial pressure, with focal cerebral signs or with cognitive deficits. Prevalence of arachnoid cysts is reported as about 0.3% or approximately 1% of all intracranial masses or 2% (2% incidental finding on imaging for seizures). Here we report frequency and clinical findings in a population screened for military aviation. **Methods:** Screening by cranial MRI. **Results:** In a population of 2,536 healthy applicants an arachnoid cyst was found in 43 cases (1.7%). 60% were in the middle cerebral fossa, only 3 of them had an abnormal EEG, neurological findings were otherwise normal (neurological history, neuropsychiatric examination, neuropsychological testing, VEP). Standardized neuropsychological testing revealed no differences between carriers of arachnoid cysts and applicants without cysts. All cysts were incidental. **Conclusion:** The ascertained prevalence of arachnoid cysts of 1.7% requires aeromedical attention. In carriers of arachnoid cysts, a thorough neurological and neuropsychological examination is recommended.

Learning Objectives: 1. Frequency and symptoms of cerebral arachnoid cysts in a "healthy" population are described. 2. The audience will learn the signs and symptoms of cerebral arachnoid cysts. 3. neurological aspects of pilot selection will be discussed.

[153] THE PROBLEM OF DISPLACED WISDOM TEETH AS VIEWED FROM AVIATION MEDICINE

M. E. DITTMER

None Given, Fuerstenfeldbruck, Germany

Introduction: Among the 32 human teeth, the 4 wisdom teeth are exceptional. They are the latest to form in the jawbone and are the latest to erupt. If the upper or lower jaw or both are too small, normal eruption is not possible, that means they remain (impacted, retained or displaced) inside the jawbone. This may cause acute or chronic inflammation, damage due to pressure on adjacent molars, the formation of gnathic cysts with ensuing bone destruction, neuralgia and tooth displacement. **Methods:** Each applicant undergoes an examination by a dentist along with a documentation of the diagnosis and an x-ray. Besides the assessment of the dental status, of the parodontium and of phonation, the sites of the wisdom teeth are given particular attention. In the event of displaced, partially and fully retained wisdom teeth, applicants for military flying duty in the GAF must have these teeth orthodontically removed prior to the beginning of flying training. **Results:** In the period 01 Jun 2007 - 31 Aug 2007 (= 3 months), 155 applicants were examined by the dental, mouth and jaw section including an orthopantomogram. In 54 applicants (=35%), the wisdom teeth had already been removed during adolescence, frequently as part of orthodontic treatment. No complications with an impact on the fitness to fly were observed. In 76 applicants (=49%) the extraction of wisdom teeth was indicated. In 25 applicants (=16%) no extraction was indicated. Prior to the beginning of flying training in the U.S., an OPG check is performed on principle. **Discussion/Conclusion:** The old proverb "Let sleeping dogs lie" does not apply to displaced wisdom teeth, because they not infrequently cause severe discomfort. Among the advantages of early removal (16th or 17th year of life) are incompletely developed dental roots, elastic bone and less neurologic complications (mandibular nerve!). Complications at a later stage of life are: jaw fractures, maxillary sinusitis, nerve injuries, larger surgical wound.

Learning Objectives: 1. dental fitness. 2. orthopantomogram. 3. wisdom teeth.

Monday, May 12

4:00PM

PANEL: Sleep Apnea: Too Tired to Work

[154] SLEEP APNEA: TOO TIRED TO WORK?

E. A. BOUDREAU¹, S. BANKS² and M. A. GARBER³

¹Oregon Health & Science University, Portland, OR; ²University of Pennsylvania, Philadelphia, PA; ³National Transportation Safety Board, Dunwoody, GA

The prevalence of sleep apnea is increasing in the general population and may go unrecognized for years before it is diagnosed and treated. One of the most common symptoms associated with sleep apnea is excessive daytime sleepiness. This daytime sleepiness is of special concern in individuals working in the transportation field, including commercial drivers, pilots and associated support personnel because it leads to an increased risk of accidents. This panel will review the latest information on the pathophysiology of sleep apnea and guidelines for diagnosis and treatment, with special emphasis on how these guidelines apply to transportation workers.

Learning Objectives: 1. The prevalence, clinical characteristics, and treatment of sleep apnea will be discussed with special emphasis on individuals working in transportation related areas. 2. The impact on performance of transportation workers (including pilots and aviation support personnel) of untreated sleep apnea will be explored.

[155] SLEEP APNEA: EPIDEMIOLOGY, PHYSIOLOGY, AND TREATMENT

E. A. BOUDREAU

Oregon Health & Science University, Portland, OR

Sleep apnea is seen with increasing frequency in all age groups and has significant short- and long-term health consequences. Practitioners in almost every area of medicine need to be able to recognize sleep apnea and its consequences. This talk will provide the latest information on the epidemiology, pathophysiology, and treatment options for sleep apnea with special focus on applications to individuals working in aviation and transportation fields.

Learning Objectives: 1. The epidemiology, physiology, and treatment options for sleep apnea will be discussed with special emphasis on individuals working in transportation related fields.

[156] THE EFFECTS OF APNEA ON FATIGUE AND PERFORMANCE

S. BANKS

University of Pennsylvania, Philadelphia, PA

This talk will review the effects of untreated sleep apnea and CPAP-treated sleep apnea on neurobehavioral functions, including fatigue, performance, subjective sleepiness and sleep propensity (measured physiologically). The relationship of apnea severity to these effects, and the role of CPAP adherence-nonadherences in these effects will be reviewed. Data from laboratory experiments, epidemiological studies and field / operational studies will be used to illustrate how sleep apnea can pose risks to performance and potentiate fatigue in real-world environments.

Learning Objectives: 1. The effects of untreated sleep apnea and CPAP-treated apnea will be reviewed.

[157] SLEEP APNEA IN TRANSPORTATION ACCIDENTS

M. A. GARBER

National Transportation Safety Board, Atlanta, GA

The NTSB has experience with accidents in all transportation modes in which sleep apnea was causal or contributory. The agency has made a number of recommendations with regard to the detection, evaluation, and treatment of sleep apnea in the transportation environment. Though a history of sleep apnea is not normally identified in an FAA or military aviation examination, the presence of such disease is a critical issue for transportation safety.

Learning Objectives: 1. To understand the role of sleep apnea in transportation accidents.

Tuesday, May 13

8:30 AM

PANEL: Lunar Surface Operational Challenges

(Sponsored by the Space Medicine Association)

[158] LUNAR SURFACE OPERATIONAL CHALLENGES

J. A. JONES and R. SCHEURING

NASA/JSC, Houston, TX

Lunar Surface Exploration will face many challenges to execute the mission of developing strategies to live on another planetary body. The challenges that face lunar explorers will come in many forms, some extrinsic and some intrinsic to the Moon itself. The challenges that will be discussed in this panel session include 1) lunar dust hazard, 2) habitation element design, especially in regard to extravehicular activity (EVA) interfaces between the habitat and the planetary surface, 3) radiation from galactic and solar sources, 4) design of surface transportation vehicles that allow surface exploration tasks, and 5) EVA consumable managements to support the physiological functions of the crewmember occupant. This panel will discuss each of the challenges and look at strategies for managing the risks and enabling surface operations within acceptable risk limits.

Learning Objectives: 1. To understand the hazards associated with lunar surface exploration. 2. Discuss strategies for exploration hazard management and risk mitigation. 3. To evaluate technologies to be developed to enable human exploration tasks.

[159] UNDERSTANDING LUNAR DUST HAZARD AND MITIGATION STRATEGIES VIA HABITAT AIRLOCK/SUITLOCK AND OTHER ENGINEERING APPROACHES

J. A. JONES, L. TOUPS, S. WAGNER, D. ALEXANDER, N. N. KHAN-MAYBERRY and K. KENNEDY

NASA-Johnson Space Center, Houston, TX

The Lunar Atmospheric Toxicity Advisory Group has been tasked by NASA with evaluating the hazards associated with crew exposure to lunar dust. The group is conducting toxicity research on murine and human subjects with both activated lunar dust stimulant and a small quantity lunar dust returned by Apollo, to determine expected acute and chronic exposure effects of lunar dust on future lunar inhabitants. The Lunar Architecture Team, Phase 2 developed potential design concepts for both airlocks and suitlocks attached to several possible variations of lunar outpost habitats. The habitat designs attempt to optimize an integrated life support system, thermal and power management, and crew functionality, while allowing interfaces for pressurized mobile rover transfer and for ambulatory suited EVA egress via airlock or suitlock. The Lunar Regolith Management Strategic Planning Team has been tasked with developing engineering strategies for dust management to include airlock/suitlock and habitat dust level monitoring hardware, suit materials development, suit cleaning techniques, as well as other techniques such as disposable coveralls, magnetic trapping and repulsing hardware, etc. By understanding the nature of the hazard, a reasonable health exposure standard for lunar dust can be established. Then by employing innovative engineering practices in habitat airlock/suitlock and interface design, as well as in the development of dust management hardware; the risk to the crew can be effectively mitigated, even for long stay lunar missions.

Learning Objectives: 1. Understand potential lunar dust risks to crew. 2. Evaluate possible design solutions to limit habitat contamination with lunar dust. 3. Understand possible engineering risk mitigation strategies for dust hazards.

[160] POST-MISSION SEQUELAE OF LONG-DURATION SPACE FLIGHT

D. WARMFLASH¹, Y. R. BARR², A. D. LEBLANC³, R. T. JENNINGS², Y. GARCIA⁴ and J. A. JONES⁵

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Exploration class missions will expose astronauts to prolonged periods of weightlessness, radiation, lunar dust, and a variety of physiological perturbations. In addition to affecting crew health and performance during the mission, these exposures may impact the long-term health of astronauts subsequent to returning to Earth. Possible perceived consequences of long duration exploration missions include: 1) Muscle deconditioning and bone loss resulting from weightlessness. Either of these

may require rehabilitation; the latter may result in permanent architectural changes and increased fracture risk. 2) Nephrolithiasis, resulting from weightlessness and increased urinary calcium excretion, may warrant medical and/or surgical intervention after completion of the mission. 3) Inhalation of lunar dust during lunar missions may predispose the exposed crew to a pneumoconiosis and potentially an increased risk of pulmonary malignancies. 4) Cataracts. 5) Fibrotic diseases. 6) Malignancy. 7) Transient or permanent reduction in fertility. The incidence of the latter four may increase because of exposure to space radiation. While it has yet to be determined whether the linear no threshold model is applicable to modest exposure levels (< 2 cG/day) and for all cancers, other factors (altered genetic repair mechanisms, immune system dysfunction resulting from weightlessness and psychosocial stress, and disruption of circadian release of melatonin) may affect cancer initiation and progression risk. None of these risks should be seen as an obstacle to human exploration of interplanetary space. Nevertheless, the use of primary prevention strategies in the form of countermeasures to reduce mission and post-mission risk should be integral to medical planning of the mission. Long-term monitoring of returning astronauts for early detection of conditions for which they are at particular risk is also justified for the purpose of providing a secondary prevention safety net.

Learning Objectives: 1. To understand the possible long-term post-mission health sequelae of interplanetary spaceflight. 2. To review the role of primary and secondary prevention strategies for mitigating these potential health concerns.

[161] OCCUPANT INJURY STUDIES FOR THE EARLY CONSTELLATION REFERENCE SUIT ARCHITECTURES

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¹NASA-Johnson Space Center EC5, Houston, TX; ²NASA-Johnson Space Center, Houston, TX

Introduction: The Orion crew will land in a recumbent seated position with nominal loads projected up to 10Gx (over 20Gx off-nominal). One of the concepts envisions has called for a rigid metallic disconnect which circles the lower waist area of the occupant to allow for alternate upper torso suit elements to be configured on a common lower suit body to allow for weight and logistics reductions. Concerns were raised regarding blunt impact injury potential due to the rigid metallic disconnect joint across the spine area. The objective of this study was to evaluate occupant protection strategies to mitigate occupant blunt force and flail within Constellation (Cx) reference suit configuration. **Methods:** To understand the implications of this suit design to occupant protection during impacts, a test series was conducted at the Air Force Research Laboratories by NASA and USAF personnel on the horizontal test sled using a Hybrid 3 manikin inside a representative spacesuit with spinal protuberances. The test buck seat was fully instrumented to resolve the loading characteristics of the suited occupant. The recorded lower spine x-axis loads were later transposed to cadaver subjects at The Ohio State University to gain understanding of the injury potential of spinal blunt impact. **Results:** Preliminary findings include Cx reference suit loading and dynamic response (DR) is unpredictable and mitigation strategies (internal padding, internal restraints, etc) resulted in minimal protection in some loading directions while causing no or decreased protection in other loading directions. Initial cadaveric results are still under investigation. **Discussion:** Impact events in space capsule landing environments provide unique challenges to occupant safety. These challenges stem not only from the volume and mass constraints of the space capsule, such as the Apollo or forthcoming Orion space capsules, but from the interface of the occupant's spacesuit to the seat requiring further investigations.

Learning Objectives: 1. Audience will understand how early constellation suit architectures are studied with respect to determining occupant injury patterns. 2. The participants will become familiar with how cadaveric testing can provide useful insight to injury patterns for living subjects.

[162] MANAGEMENT OF ACUTE RADIATION EXPOSURES ON THE LUNAR SURFACE FOR EXPLORATION

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Introduction: Constellation Program requirements for crewmember health and safety are driven by NASA's human spaceflight documents. However, NASA radiation standards for lunar surface operations have yet

to be defined. Using the Apollo program approaches and methods as a starting point, understanding both of the space radiation environment and the human risks incurred by crews has sufficiently evolved in the years since the first lunar sorties to allow for a more methodical approach to the issue of human radiation exposure. The objective was to assess available options in measurement and characterization, pro-action and reaction to an evolving, un-controlled environment, and subsequent medical intervention to ensure the continued health and safety of astronaut crews. **Methods:** To develop a consistent understanding between the medical operations, Space Radiation Analysis Group and Radiation Health Officer on what the health and mission risks are for lunar exploration crews in the event of exposure to a SPE, a team was formed from each of these disciplines to bring current research and operational radiation knowledge to develop a consensus statement for lunar surface operations. **Results:** The current effort identified areas related to acute radiation exposures on the lunar surface, including the timeframe for events to occur resulting in acute radiation sickness and the timeframe for loss of mission but not crew. The development of operational technologies for real-time remote and in situ space weather monitoring and prediction of SPE onset and prospective SPE time course with improved reliability were also identified. **Discussion:** A mission timeline for diagnosing, treating and monitoring crewmembers exposed to an intense SPE given the current mission architecture in which a substantial number of EVAs will be performed on the lunar surface is yet to be determined and is forward work. However, the team developed a consensus statement based on the best available current evidence to guide requirements and planning for acute exposures to radiation on the lunar surface.

Learning Objectives: 1. The audience will understand what the current understanding is of acute radiation exposures on the moon for crews performing lunar EVAs.

[163] HEALTH AND SAFETY BENEFITS OF SMALL PRESSURIZED SUITPORT ROVERS AS EVA SURFACE SUPPORT VEHICLES

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¹NASA, Houston, TX; ²Wyle, Houston, TX

Introduction: Lunar architecture designs typically include a single large pressurized rover (LPR) primarily intended to extend extravehicular activity (EVA) exploration range. A design study was conducted to evaluate the potential benefits of two small pressurized rovers weighing less than a single LPR. **Methods:** A multi-disciplinary team developed preliminary designs and operational concepts for a pair of Small Pressurized Suitport Rovers (SPSRs) with low mass, low volume, and low EVA overhead. Qualitative and quantitative analyses were performed to evaluate the preliminary designs in the context of the lunar architectures developed by the NASA Lunar Architecture Team Phase II study. **Results:** The preliminary SPSR design includes two suitports on each SPSR, which allow ingress and egress in 10 to 30 min. An ice-shielded lock provides solar particle event (SPE) radiation protection and also provides heat rejection, while a reconfigurable ergometer provides resistive and cardiovascular exercise capability. **Discussion:** Analysis indicates that SPSRs offer many potential operational, engineering and exploration benefits compared with a single LPR. With respect to health and safety, the ability to perform multiple EVAs with low overhead combined with visibility equal to or better than EVA suit visibility offers the possibility of reducing time spent in EVA suits by up to 50%. This will reduce suit-induced trauma and provide improved options for nutrition, hydration, and waste-management. Furthermore, analysis indicates that the intermittent recompression effect of performing multiple shorter EVAs versus single 8 hr EVAs has a protective effect that increases DCS safety and decreases prebreathe requirements. EVA astronauts will have a nearby pressurized safe-haven providing SPE protection and decompression sickness (DCS) treatment capabilities at all times and the low mass and volume enables delivery of two SPSRs, providing pressurized contingency return capability and improved exploration range and performance vs. a single LPR.

Learning Objectives: 1. Health and safety benefits of small pressurized suitport rovers as EVA Surface Support Vehicles will be discussed.

[164] INTEGRATED SOFTWARE SYSTEMS FOR CREW MANAGEMENT DURING EXTRAVEHICULAR ACTIVITY IN PLANETARY TERRAIN EXPLORATION

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¹NASA-Johnson Space Center, Houston, TX; ²SETI Institute/NASA-Ames Research Center, Moffett Field, CA; ³Virginia Commonwealth University, Richmond, VA

Background: Initial planetary explorations had a veritable ground support army monitoring safety and health of astronauts who performed lunar surface extravehicular activities (EVAs). A spacesuit for Mars must be smart enough to replace that army. The next generation suits can use 2 software systems, LEGACI (Life support, Exploration Guidance Algorithm and Consumable Interrogator) and VIOLET (Voice Initiated Operator for Life support and Exploration Tracking). In this study data inputs from a suite of sensors is routed to MIII suit's communications, avionics and informatics hardware for distribution to remote managers and data analysis. **Methods:** Field tests conducted at Johnson Space Center (JSC) and Mars and Lunar analog (Devon Island, Canada). LEGACI integrates data inputs from noninvasive biosensors (heart rate, suit inlet/outlet leg temperature and flowrate, suit outlet gas and dewpoint temperature, pCO₂, suit O₂ pressure, state vector (accelerometry) etc). In Devon Island tests satellite communication and informatics capabilities were test routing data to JSC in Houston, TX via secure servers at VCU in Richmond, VA. **Results:** The input from all the sensors enable LEGACI to compute multiple independent assessments of metabolic rate, from which a "best" met rate is chosen based on statistical methods. This rate can compute detailed information about the suit, crew and EVA performance using test-derived algorithms. VIOLET gives LEGACI voice activation capability, allowing the crew to query the suit, and receive feedback. LEGACI and VIOLET can also automatically control the astronaut's cooling and consumable use rate without crew input. **Discussion:** These findings suggest that non-invasive physiological and environmental sensors supported with data analysis can allow for more effective management of mission task performance during EVA. Integrated remote and local view of data metrics allow crewmember to receive real time feedback in synch with mission control in preventing performance shortcomings for EVA in exploration missions.

Learning Objectives: 1. The audience will learn about informatics capabilities. 2. The audience will learn about capability for use of non invasive sensors. 3. The capability of integrating wireless communication in vital data routing will be covered.

Tuesday, May 13

8:30AM

PANEL: Aviation Safety: 2007 Year in Review –I

[165] AVIATION SAFETY: 2007 YEAR IN REVIEW

N. L. WEBSTER and C. A. DEJOHN

FAA, Civil Aerospace Medical Institute, Oklahoma City, OK

Introduction: Representatives from the various international aeromedical agencies will present respective information on aviation safety and adverse aviation events during 2007. Discussion will center on mishap/accident analysis of both mechanical and human causal factors. Hazardous trends will be further discussed and compared with previous years. Updates will be presented on the progress of ongoing intervention strategies designed to help mitigate and eliminate identified hazards.

Learning Objectives: 1. Discuss the most significant hazard areas in aviation. 2. Provide insight into development of data driven intervention strategies based on analysis of mishaps during the past year and previous years.

[166] TURKISH CIVIL AVIATION IN 2007

A. SEN¹, A. AKIN¹ and H. F. TORE²

¹Gulhane Military Medical Academy, Eskisehir, Turkey; ²Ufuk University, Balgat, Ankara, Turkey

The Directorate General of Civil Aviation (DGCA) of Ministry of Transport is responsible for all civil aviation and related activities in Turkey. In recent years DGCA has established a series of changes in accordance with the Regulations of Joint Aviation Authorities (JAA) in aircrew flight licensing, aircrew medical licensing, aircraft maintenance procedures, and aviation safety measures. Flight training, Authorized Medical Examiner (AME) training, and flight operations are monitored closely, as well. Aviation Safety Department (ASD) of DGCA is in charge with the inspection and supervision of safety issues of all civil aviation companies and flight training schools. ASD is also conducting the aircraft accident investigations. In its activities, ASD is working in cooperation with national and international organizations. Aviation safety figures of Turkish civil aviation

for 2007 will be presented in comparison with previous years. Suggested countermeasures will be discussed.

Learning Objectives: 1. Aviation accidents that occurred in 2007 will be compared with previous years. Safety measures will be discussed.

[167] U.S. ARMY AVIATION SAFETY: FY 2007 IN REVIEW

J. CAMPBELL

U.S. Army Combat Readiness/Safety Center, Fort Rucker, AL

Purpose: Identify the primary causal factors of Army aircraft accidents for fiscal year 2007 using descriptive statistics. **Methods:** Causal factors from Class A flight mishap data were obtained from the Army Combat Readiness Center databases and were analyzed using standard safety metrics. **Results:** The Army experienced 33 Class A Flight Mishaps during fiscal year 2007 resulting in the destruction of ?? aircraft, the loss of 37 lives with a total dollar cost of approximately ???million. Human error was found to be a causal factor for approximately 80-85% of these accidents. The 33 class A flight accidents resulted in an accident rate of ??? accidents per 100,000 flight hours. Analysis of the human error causal factors reveals CRM, assumption of low risk missions, inadequate risk assessment, indiscipline and inadequate flight planning are the most prevalent latent conditions that preceded a majority of the decision and skill based errors. **Conclusions:** Army aviation accident rates have shown a general plateau over the past 10 years despite vigorous efforts to decrease them. While aviation fatalities over the last year are slightly increased compared to FY 2006, analysis indicates CRM, leadership involvement and leadership understanding of the risk management process are areas that need increased focus if we are to continue to drive down mishap rates. **Discussion:** As a result of this information, Army aviation leaders are working to provide commanders with tools and intervention strategies to attack the latent conditions leading to the human error. Specific intervention strategies will be discussed.

Learning Objectives: The audience will learn about Army efforts to utilize aviation accident data to develop proactive intervention strategies to prevent future accidents in an effort to improve readiness through the preservation human life and the red.

[168] AUSTRALIAN DEFENCE FORCE AVIATION SAFETY: 2007 YEAR IN REVIEW

G. D. PASCOE

RAAF Institute of Aviation Medicine, Edinburgh, South Australia, Australia

The Directorate of Defence Aviation and Air Force Safety (DDAADS) maintains a database on all Australian Defence Force (ADF) aircraft accidents and incidents, known as the Defence Aviation Hazard Reporting & Tracking System (DAHRTS). The 2007 statistics of ADF aircraft accidents and incidents will be presented, and a comparison made with previous years. The discussion will include an explanation of the ADF aviation Safety Management System. The human factors and safety equipment issues of a recent fatal accident will also be discussed.

Learning Objectives: 1. Understand the role of the Australian Defence Force aviation safety management system in preventing aircraft accidents. 2. Compare Defence accident rates of current financial year with previous years.

Tuesday, May 13

8:30AM

PANEL: Show Me the Evidence I: Aeromedical Certification Following Stroke

[169] "SHOW ME THE EVIDENCE!": AEROMEDICAL CERTIFICATION FOLLOWING STROKE

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"My bias is and always has been that strokes are very heterogeneous and that the risk of recurrent strokes and seizures after stroke and cardiac

risk varies with the etiology, nature, and location of the stroke in the individual. Your patient with pure sensory stroke really has little risk except if BP is not well controlled. My advice would be to write no firm general rule, but to evaluate each individual case—preferably by a panel of individuals who specialize in stroke" --Louis R. Caplan, Professor of Neurology, Harvard Medical School, Senior neurologist, Stroke Service, Beth Israel Deaconess Medical Center, Past Chairman, Stroke Council, American Heart Assn. (personal communication, Sept. 2002). FAA policy in reference to stroke is largely based on expert opinion. Many of today's aeromedical standards, protocols, and exemption (waiver/special issuance) policies have been based on arbitrary decision, tradition, case studies, and expert opinion. Expert opinion is the lowest form of evidence in medical evidence hierarchy. There is a need for a coordinated effort in the formation, review, revision, and application of aeromedical certification standards with the goal of an evidence based approach to aeromedical certification. Stakeholders include aeromedical regulatory entities, international organizations such as ICAO, aeromedical certification entities, aerospace medicine associations worldwide, and individual aviation medical examiners. Ultimately aeromedical disposition of an individual aviator involves a clinical decision. Evidence based medicine is the application of best research evidence and clinical expertise to aeromedical disposition of an individual aviator. The purpose of this panel is to call attention to the need for an internationally coordinated and harmonized evidence-based approach to medical certification.

Learning Objectives: 1. To foster evidence-based medical certification.

[170] UK POLICY FOR RECERTIFICATION AFTER TIA

S. A. EVANS

UK CAA, Gatwick Airport South, West Sussex, United Kingdom

The UK has adopted the European Joint Aviation Authorities' requirements for medical certification for flight crew. The requirements contain no reference to the certification of a pilot after a stroke or Transient Ischaemic Attack. A review of the stroke and TIA literature was undertaken in 2004 and guidance developed for certification after a TIA. The review concluded that a history of stroke was incompatible with certification because of the unacceptable risk of recurrence. Certain underlying conditions and factors were assessed as disqualifying because they were associated with a high recurrence rate. The review also highlighted the need for thorough assessment of the risk of a Major Adverse Cardiac Event as part of the protocol for certification after a TIA and the pre-requisite of demonstrating adequate control of cardiovascular risk factors. Extensive literature is available on stroke and TIAs in the general population, but the studies often have a high mean age, so the results have to be interpreted cautiously when applied to aircrew. One of the main issues is accuracy of diagnosis and lack of recognition of symptoms that are non-specific and may not be recognised as serious, leading to probable under reporting in community studies. Amaurosis fugax of unidentified cause is considered separately to other types of TIA as it has a much better prognosis. This paper will outline the UK CAA's guidance on certification after a TIA.

Learning Objectives: 1. Medical assessment after TIA will be discussed.

[171] TIA/STROKES IN CIVIL AVIATION PILOTS IN JAPAN

S. HARA¹, M. FUKUMOTO¹, I. TSUKUI¹, S. TAMURA², T. SHIMAZU² and H. TOMITA²

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²Ministry of Land, Infrastructure and Transport, Chiyoda-ku, Tokyo, Japan

During 1995-2007, 14 pilots with stroke and 1 pilot with transient ischemic attack of 12,000 civil aviation pilots in Japan have been applied for waiver; 7 cerebral infarction, 4 subarachnoid hemorrhage, and 3 intracerebral hemorrhage. 10 of them were professional (ICAO class1) and three were private (ICAO class 2) pilots. Only 2 of them were issued the medical certification. One of the two was a private pilot, who was assessed for his first recertification three years after his stroke. At assessment this pilot with cerebral infarction was found to have a mild left hemiparesis and to be tolerating his anti-platelet medication without side-effect. His previous obesity, hyperlipidemia, and impaired glucose tolerance had been well controlled in response to lifestyle modification. Despite his residual hemiparesis this pilot demonstrated the absence of any aviation safety relevant functional impairment during a medical flight test, and was subsequently issued a class 2 medical certificate with restrictions that prevented to fly as an instructor. Another applicant, who was a professional pilot, was assessed one year after transient ischemic attack. He previously had hypertension, which had been normalized with ARB and was taking

anti-platelet for the secondary prevention. A class 1 medical certificate with restriction that prevented flying with another waiver pilot was issued. The rest of those pilots were denied medical certification. In each case the basis for denial was their elevated risk of medical incapacitation due to either a further stroke, another cerebrovascular or cardiovascular event. This presentation provides the clinical details of each case, and the medical evidence basis for each decision, in the context of the Japanese medical certification system.

Learning Objectives: 1. stroke . 2. certification . 3. transient ischemic attack.

[172] BEST EVIDENCE IS BAD NEWS: AEROMEDICAL DISPOSITION 15 YEARS AFTER A STROKE

D. WATSON, C. G. PREITNER, P. D. NAVATHE and M. DRANE

Civil Aviation Authority of New Zealand, Wellington, New Zealand

This presentation describes the regulatory medical, and legal-ethical, dilemmas that are faced when an aging private pilot is 'discovered' to have suffered a cerebrovascular accident (CVA or stroke) fifteen years previously.

In a regulatory environment where numerical risk criteria (e.g. 1% per annum) are applied to medical incapacitation risk where possible, the medical literature was scoured to assist an evidence-based risk assessment. Initial risk assessment estimates suggested an incapacitation risk in the 3 – 7% per annum range, with cardiovascular incapacitation risk predominating over cerebrovascular incapacitation risk. Subsequently an absolutely normal exercise stressed echocardiogram was used to 'reason' the cardiovascular incapacitation risk component down to 1% per annum, leaving a residual risk of approximately 3 – 4% per annum. Based on this risk assessment the pilot was issued a class 2 medical certificate carrying conditions designed to reduce third party and operational risk – including no carriage of passengers unless accompanied by a safety pilot.

The ethical issues faced include: That the stroke was discovered after the pilot had been flying for a decade and a half without incident; and That the best medical evidence is imperfect and requires extrapolation to be applied to this case. The legal issues relate to the subsequent courtroom appeal against the regulatory decision.

Learning Objectives: 1. Best evidence assessment of incapacitation risk 15 years after a stroke. 2. Ethical and legal implications of delayed regulatory discovery of an aeromedical risk.

[173] PURE SENSORY LACUNAR STROKE

J. D. HASTINGS

Aerospace Medical Association, Tulsa, OK

This is a case presentation of a 47 year old First Officer for a major US air carrier who suffered a lacunar stroke while returning home as a non-flying pilot in a jump seat. The risk factor of hypertension was present. A lacunar stroke was present in the right thalamus. Clinical recovery occurred rapidly and nearly completely, with mild residual sensory deficit. Risk factors were idealized. U.S. FAA policy for certification following stroke generally dictates a two year observation period before consideration of recertification following stroke. The policy is subject to some exceptions. Currently available best research evidence for stroke recurrence risk does not provide sufficient numbers of individuals with one or few risk factors, nor does current literature address comparability in terms of compliance and idealization of risk factors. This case will be presented to illustrate the need for data collection, data review, and an evidence based approach to medical certification following stroke and transient ischemic attack.

Learning Objectives: 1. To emphasize the need for comprehensive individual assessment of aviators with stroke.

[174] CRYPTOGENIC STROKE IN A USAF AVIATOR

P. A. CORRIGAN

Aeromedical Consultation Service, Brooks City-Base, TX

Introduction: Over the past two years, the USAF Aeromedical Consultation Service (ACS) has evaluated several aviators with cryptogenic stroke. A case presentation will be used to launch a discussion concerning evaluation and aeromedical risk assessment for cryptogenic stroke in aircrew. **Discussion:** Neurologic deficits, risk of recurrence, and seizure risk are the major factors used in the aeromedical decision making process for cryptogenic stroke. Although there is a paucity of scientific studies concerning cryptogenic stroke in our patient population, the current literature suggests a relatively high post-stroke seizure incidence of 10% in

the first five years. Annual recurrence rates are varied in the literature, but are estimated at 3-4% per year in the first few years following stroke, dropping to ~1.7% in subsequent years. Based on this evidence and other factors, the ACS has not recommended return to flying for several aviators recently evaluated for cryptogenic stroke.

Learning Objectives: 1. Scientific literature concerning risk of post-stroke seizure and recurrence in young adults with cryptogenic stroke will be reviewed and applied to aeromedical decision making.

Tuesday, May 13

8:30AM

SLIDE: Gz Here, There, and Everywhere

[175] VARIABILITY IN SUSCEPTIBILITY TO REDUCTIONS IN FRONTAL CORTICAL OXYGENATION DURING GZ EXPOSURE: A NEAR-INFRARED SPATIALLY RESOLVED SPECTROSCOPIC STUDY

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Introduction: The recently developed NIR spatially-resolved spectroscopy (SRS-NIRS) has been confirmed to provide frontal cortical tissue hemoglobin saturation (Tissue Oxygenation Index, TOI). In this study, we monitored the TOI and the standard NIRS measured chromophore concentration changes of oxygenated hemoglobin (O₂Hb) and deoxygenated hemoglobin (HHb) to identify the differences between subjects who lose consciousness and those who do not during high Gz exposure. **Methods:** There were 141 healthy male pilots participated in JASDF centrifuge training and volunteered for the study. The centrifuge profiles include gradual onset run (GOR, onset rate of 0.1Gz / sec) with a maximum of up to 8 Gz, short-term repeated, and sustained exposures with Gz levels from 4 Gz to 8 Gz, a plateau from 8 s to 30 s and an onset rate from 1.0 to 6.0 Gz / sec (Rapid onset run, ROR). During the Gz exposures, O₂Hb, HHb, TOI and Gz levels were recorded using NIRO-300G near-infrared spectrophotometer by Hamamatsu Photonics K.K. Hamamatsu, Japan. **Results:** The TOI in the short term repeated exposure profiles was significantly lower in the terminating subjects both with (n=30, p < 0.01) and without G-LOC (n=36, p < 0.05) compared with the completed subjects (n=37). No significant difference was observed in NIRS variables between with and without G-LOC. The oxygenation variables decreased to the same levels in subjects with G-LOC and in subjects who completed a gradual onset run up to +8Gz. The SRS-NIRS revealed an approximate 15% decrease in the TOI in G-LOC. **Conclusion:** Although the G-LOC cases in the present study demonstrated this critical cerebral oxygenation level, there was scant difference in the oxygenation variables between those with and without G-LOC. Further studies which elucidate the mechanism(s) behind the wide variety of individual differences may be needed for a method of G-LOC prediction to be effectively realized.

Learning Objectives: 1. The audience will learn the large variability in susceptibility to reductions in cerebral oxygenation. 2. SRS-NIRS is useful to evaluate G induced cerebral oxygenation debt and the effect of the anti-G protection system.

[176] COMPARATIVE EVALUATION BETWEEN AIRCREW EQUIPMENT ASSEMBLY (AEA) AND LIBELLE G MULTIPLUS® – HUMAN FACTORS ASSESSMENT

M. STEIN

German Air Force Institute of Aviation Medicine, Manching, Germany

Introduction: Due to the demand of high performance fighter aircraft, such as high Gz onset and sustained Gz, new anti-G suits have to be developed. Therefore a comparative study between AEA and Libelle has been performed in the human centrifuge. The goal of the study was to assess medical, functional and ergonomic differences (multi method approach) of the two anti-G suits in an experimental setting. This study focuses on Human Factors Assessment. **Methods:** 17 Eurofighter pilots volunteered to be exposed to relaxed gradual onset runs (GOR) and rapid onset runs (ROR) stepwise from 5 to 9 Gz in a human centrifuge with both anti-G suits. Physiological measurements such as oxygen saturation, heart rate, and blood pressure were taken. A questionnaire was applied for the human factors assessment (72 items, i.e. Gz-protection, personal experienced safety of the anti-G suit, armpain, communication; five point rating

scale ranged from "optimum" to "not acceptable"). **Results:** There was a significant difference between the two anti-G suits in the range 7 to 9 Gz (F = 4,764; p = .042; Eta² = 0,200; testpower = 0,544). Under both conditions of the assessment AEA was rated near "optimum" in the mean value in the above mentioned profiles. In contrast Libelle was rated "acceptable" on the scale. Significant difference could also be shown for the passive Gz-tolerance (t = 5,064; p = .000; AEA: M = 6,6 Gz; SD = 1,070 and Libelle M = 5,7 Gz; SD = 0,598). The personal experienced safety was rated near "optimum" with AEA and near "acceptable" with Libelle. Armpain, G-measles, and haematoma occur with AEA only. The communication was rated "not acceptable" with AEA and "near optimum" with Libelle. **Discussion:** The results indicate functional and ergonomic advantages of AEA compared to Libelle but medical and communication disadvantages.

Learning Objectives: 1. Anti-G suit. 2. human factors assessments. 3. subjective measurements.

[177] HEMODYNAMIC MONITORING DURING GZ LOADS USING PHOTOPLETHYSMOGRAPHY

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Introduction: Conventional pulse oximeters require photoplethysmography (PPG) to determine oxygen saturation of arterial blood. Besides the SaO₂, this enables other physiologic functions such as peripheral pulse rate, changes in cardiac contractility and venous return etc. to be derived from the sensor signal. This explains why repeated attempts have been made to use PPG as a method for hemodynamic monitoring. As early as in the 1930s, PPG was developed by Hertzmann as an independent method for measuring changes in blood volume. **Objective:** This study was designed to clarify whether PPG is suitable for monitoring vital parameters in subjects exposed to Gz loads on the human-use centrifuge (HZF). During a comparative trial of various anti-G suits (AEA BAeS and Libelle G-Multiplus®), the issue was to be clarified whether a forehead-mounted reflectance sensor would be suitable for accessing the plethysmogram (PG) at the HZF control station and to record it for systematic evaluation. **Methods:** A conventional forehead-mounted pulse oximetry sensor was used on 19 subjects in order to record the PG during eight passive and/or active centrifuge profiles. For systematic evaluation the PG was split into the pulse-synchronous AC component and the so-called DC component. **Results:** In a total of 364 centrifuge runs, only one data transmission failure occurred at the end of a run due to the separation of the sensor. In all other cases, the sensor signals could be recorded and evaluated. Gz increases resulted in a rectified change of DC components due to Gz-induced volume shift towards the dependent body regions. The AC signal amplitude increases observed during Gz increase could, however, mirror changes of cardiac contractility, changes of the vascular tonus, of the blood volume or a combination thereof. **Conclusion:** The sensor working according to the reflectance principle passed the suitability test for monitoring subjects during HZF examination.

Learning Objectives: 1. noninvasive hemodynamic monitoring during Gz loads. 2. reflectance pulse oximetry. 3. photoplethysmography.

[178] NEW QUALITY OF ACCELERATION TRAINING IN THE GAF DYNAMIC FLIGHT SIMULATOR FOR EUROFIGHTER/ TYPHOON PILOTS

M. NEHRING and H. WELSCH
GAF IAM, Königsbrück, Germany

Introduction: The upgraded GAFIAM human centrifuge (HC) is now fully operational and ready for basic and interactive training. In addition to a conventional centrifuge training pilots are now able to use the HC as a dynamic flight simulator (DFS). Experiences and results of this realistic training will be presented. **Methods:** The use of the HC as a DFS is part of the high-g-training course in Königsbrück. Under a more realistic environment (120° x 40° wide-field-of-view collimated vision system, HUD, HDD, EF cockpit mock-up, rapid g-onset (6g/s), high sustained g (9gz), personal aircraft equipment assembly) the pilots perform operational basic fighter manoeuvres and interactive training profiles as part of a G-LOC awareness training programme. An instructor (fighter pilot) in the control room takes control of a target aircraft, which is monitored at the visual system in the HC. The task of the trainee in the HC is to chase this

target, to train SACM up to 9gz and to practice the g-tolerance techniques as an integrated part of the SACM-scenario. **Results:** The DFS training creates a more realistic flight experience and leads to improved pilot acceptance of the centrifuge training. GAF pilots can familiarize themselves with rapid g-onset, sustained high-g-forces and their new personal g-protection equipment within a realistic and safe environment. After qualification according to STANAG 3827 demands (9gz for 15 s, g-onset 6g/s) the target-chasing task in the free flight mode guides the pilots to operate like in an air combat scenario, integrated with the limiting factors "fatigue" and "G-LOC", the missing links of conventional full mission simulators. **Discussion:** The acceleration training in the DFS for EF pilots is now established in the GAF. The HC is an excellent training device which is now also used by several foreign airforces.

Learning Objectives: 1. Advantage of the interactive centrifuge training as an important factor of flight safety.

[179] HIGH-G TRAINING IN A DEVELOPING COUNTRY: THE ROYAL MALAYSIAN AIR FORCE EXPERIENCE

A. H. WEE, M. B. KAMARULZAMAN and Z. B. JUSOH
Institute of Aviation Medicine Royal Malaysia Air Force, Kuala Lumpur, Malaysia

Introduction: High-G Training has been established in most of the world's established Air Forces since the 1980's. In most developing countries, access to such training has been limited due to funding, priorities and lack of accessibility to such facilities. The Royal Malaysian Air Force has since addressed the gap in this particular type of training and had since procured it's first 3rd generation dynamic flight simulator at the end of 2005. High-G and Spatial Disorientation Training started in 2006 and is conducted at the G-Research & Training Centre (PULLS-G) of the RMAF Institute of Aviation Medicine. **Methods:** The experience and approach to starting a High-G training will be discussed along with its acceptability to the pilot community. The experience and approach to training in a dynamic flight simulator will also be addressed in this presentation. **Discussion:** High-G training has been found to be still relevant especially in a young air force such as the RMAF. Lessons learned in starting this programme is invaluable and can be used as an approach to training in a socioeconomic and culturally different environment of a developing country.

Learning Objectives: 1. The audience will learn about High-G Training Development from scratch in a developing country. 2. High-G Training Issues with regards to Dynamic Flight Simulation will be presented.

[180] DESIGN AND DEVELOPMENT OF A LOW COST ANTI G VALVE

M. KHAN¹, A. WITHDRAWN Reference Research
¹JMI Central WITHDRAWN and Development Organization, Dehra, India; Indian Institute of Technology, Kharagpur, West Bengal, India

Tuesday, May 13

8:30AM

PANEL: Human Performance Optimization

[181] HUMAN PERFORMANCE OPTIMIZATION: MODELS AND Methods

V. E. MARTINDALE
US Air Force, Silver Spring, MD

Introduction: Human performance (HP) has become a hot topic in many fields. New techniques and technologies continue to extend HP capabilities. How are we to integrate these disparate capabilities into something useful, cost effective, and coordinated? This panel presents a number of different frameworks and models for viewing and integrating human performance modifications into a coherent whole. **Methods & Results:** 1) The Human Performance Archetype concept is based on identification of key performance attributes verified by participant observation research. It has the advantage of a limited number of dimensions and a simple but powerful graphical representation. 2) A conceptual Human Performance Doctrine for the Air Force presents an overarching view. This model takes under itself Human Systems Integration (HSI) and the Human Factors Analysis and Classification System (HFACS). 3) The General Systems Performance Theory (GSPT) comes from engineering, and brings a generalizable mathematical construct to bear on HP. This model shows great promise for providing a manageable number

of variables and a simple but powerful mathematical construct to integrate them. 4) Related to GSPT is the Elemental Resource Model of the human, which provides a way to break down HP resources into meaningful, measurable entities. Combined, these models may allow optimization to be performed with limited knowledge of the factors to be integrated into the whole. 5) Finally, Human Performance Operator Optimization (HPO2) is a team approach at the operational level, centered on the customer. HPO2 is predictive, and derives its power from integrating the perspectives of its carefully chosen team members. **Discussion:** Comparing and contrasting these approaches provides a rich context for considering HP and how to optimize HP, both within a narrow context such as a specific task or mission, and in a broader sense, such as an occupation or career.

Learning Objectives: 1. Mathematical and graphical methods can be applied to optimization of human performance. 2. Human performance optimization is an integrative function that takes place at the operational level.

[182] ARCHETYPE CONSTRUCTS AS A BASIS FOR HUMAN PERFORMANCE OPTIMIZATION

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Scitor Corporation, Rosslyn, VA

Defining and measuring different kinds of human performance is a nearly universal challenge for teams, organizations, and industries. Biotechnological innovations show tremendous potential for modifying human physical, cognitive, and affective attributes, but current task-oriented analyses are poor tools to understand how these biotechnologies could affect military operator performance. We developed an alternate method for analyzing, representing, comparing, and potentially optimizing military human performances of different kinds. Key human performance attributes were identified that span the dimensions of physiology, cognition, and emotion. Participant-observation research was then conducted into human performance demands for different military units and personnel, and the Human Performance Archetype concept was developed from the findings. The Archetype graphically places different human attributes in relationship to each other and to the performance demands made on personnel by a unit's mission, its culture, and its operational environment. The Archetype also allows us to compare human performance differences across units, which would otherwise be unfeasible if using tasks to compare units. By graphically representing human performance as a simultaneously physical, cognitive, and socioemotional phenomenon, the Archetype suggests a more comprehensive battery of human performance metrics to be developed in order to optimize that performance, whether through personnel selection, training, or even the use of performance biotechnologies. Finally, the Archetype can also help clarify the notion of "Human Performance Capital", which refers to the physical, cognitive, and socioemotional resources that a person possesses to answer specific performance demands. Our presentation will briefly cover the development of the Archetypes, explore both the advantages and disadvantages an Archetype-like approach to human performance presents, and discuss the value of a more general notion of Human Performance Capital for future research into military HPO.

Learning Objectives: 1. To present alternative methods for analyzing military human performance needs.

[183] CONCEPTUAL VISION FOR AN AIR FORCE HUMAN PERFORMANCE DOCTRINE: PERFORMANCE OPTIMIZATION

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¹311th Human Systems Wing, San Antonio, TX; ²Naval Postgraduate School, Salinas, CA

Introduction: Human Performance (HP) is one of the core competencies which Health Service Support (HSS) personnel provide as a force enabler for both in-garrison and deployed military operations. Advocating for HP is challenging because of the immaturity of HP doctrine relative to other HSS competencies (e.g., preventive medicine, casualty management, etc.). Recent work has attempted to provide a conceptual blueprint for an overarching HP doctrine, and this paper presents the section specifically dealing with Human Performance Optimization (HPO). **Methods:** A panel of U.S. Air Force HP subject matter experts held a 2-day workshop in July 2007 at Langley AFB to develop a draft HP doctrine. Subsequently, inputs on the draft proposal were solicited from HSS command leadership. **Results & Discussion:** HPO was defined as those activities which seek to achieve the most efficient use of limited human resources by comprehensively integrating humans within larger socio-technical systems and Human Systems Integration (HSI) was identified

as the supporting process model. Additionally, a modified version of the traditional HSI model was adopted based on recent theoretical work by the Naval Postgraduate School. In this model, four domains (human factors engineering, personnel, training and manpower) are input domains, whereas the other three domains (Environment, Safety and Occupational Health (ESOH); habitability and survivability) are first order effects and HP is a second order effect of the input domains. Importantly, the latter three domains describe the HSS function of Force Health Protection (FHP), allowing FHP to be addressed through the systems engineering process. The proposed model also offers the potential for using data from FHP failures (i.e., HFACS databases) to define individualized HSI models for systems which could be the foundation for quantitative HSI cost-benefit analyses.

Learning Objectives: 1. Doctrinal solutions to human performance optimization will be discussed. 2. The audience will learn how the Human Systems Integration model can be used to optimize human performance.

[184] GENERAL SYSTEMS PERFORMANCE THEORY AND THE ELEMENTAL RESOURCE MODEL FOR HUMAN PERFORMANCE

G. V. KONDRASKE

Univ. of Texas at Arlington, Arlington, TX

Introduction: General Systems Performance Theory (GSPT), although applicable to any systems-task, was motivated by challenges in human performance. To gain insight into fundamental principles, human system complexity was set aside and focus was placed on simple hypothetical systems and tasks. GSPT thus provides a first principles, conceptual, quantitative, and hierarchical framework for modeling systems, tasks, and their interface using abstraction of these items that focuses on the notion of "performance". **Methods & Results:** With GSPT, systems (and/or subsystems) are modeled as possessing a set of "performance resources" that reflect the unique qualities that characterize "how well" a given system executes its function (e.g., accuracy, speed, strength, endurance, etc.). The nonlinear, threshold-oriented mathematics of resource economics are incorporated. In this model, Resource Availability must exceed Resource Demand for "success" of a given system in a given task. Tasks draw upon multiple system performance resources; this thus extends to the logical combination of resources, which may be written as "sufficiency" (an amount $\geq$ threshold) is required for Resource A AND B AND C, etc. The concept of a performance capacity envelope is derived from this representation, the volume of which represents the capacity of the system to perform tasks that make demands on performance resources that form the multi-dimensional performance space. This suggests a multiplicative computation to characterize a generic capacity to perform. Applying these concepts and that of monadology to the human system results in the Elemental Resource Model. **Discussion:** The redundancy present in the human system and the constructs of GSPT suggest a new approach to the problem of optimization; i.e., the system (human) is driven to accomplish the goal (task) in a manner that minimizes the stress on all performance resources involved in task execution (i.e., maximizing the margin between available resources and utilized resources).

Learning Objectives: 1. To understand the basic constructs of General Systems Performance Theory and application to human performance modeling and measurement. 2. How performance resources are defined and used to modeling any aspect of human and human subsystem performance. 3. Learn the structure of the Elemental Resource Model for human-task interfaces.

[185] GENERAL SYSTEMS PERFORMANCE THEORY AND HUMAN PERFORMANCE: SOME EXPERIMENTAL RESULTS

University of Texas at Arlington, Arlington, TX

Introduction: Concepts of General Systems Performance Theory (GSPT) and monadology were applied to the human system to realize the Elemental Resource Model (ERM). A task analysis, performance modeling and performance prediction methodology dubbed Nonlinear Causal Resource Analysis (NCRA) was also developed using GSPT. NCRA not only estimates the level of performance in a higher level task (HLT) supported by a set of lower level or basic performance resources (BPRs), but also identifies which BPRs limit HLT performance. **Methods & Results:** Overviews in applications where the HLT is a complex sport task, driving, and laparoscopic surgery are presented. In each context, an ERM-guided gross task analysis is first performed to identify a set of BPRs (i.e., specific performance capacities for specific human subsystems) involved in HLT execution. This initial set is prioritized and reduced, taking into account time allowable for performance capacity measurements. To build performance models, data is collected at the BPR and HLT levels. BPR

capacities are measured using a variety of objective maximal performance techniques that produce single number results reflecting “how much” of a given BPR is available. HLT performance is measured subjectively by one of more domain experts that observe subjects and rate integrated performance on a visual-analog scale. Custom NCRA software produces Resource Demand Functions (estimates of the amount each performance resource utilized to achieve a given level of HLT performance), uses these functions to predict HLT performance, and identifies limiting performance resources. Given the relatively small number of BPRs included in each model, experimental results have been encouraging; differences between predicted and expert-rated performance $\leq 15\%$ for a large fraction (e.g. 75-90%) of the study populations. **Discussion:** Where differences are large and predicted exceeds expert-rated performance, it is likely that the subject is limited by a BPR that was not included in the model.

Learning Objectives: 1. To learn about the logic behind Nonlinear Causal Resource Analysis. 2. To learn how to apply Nonlinear Causal Resource Analysis and the Elemental Resource Model to develop performance models for specific contexts.

[186] HUMAN PERFORMANCE OPTIMIZATION AT THE BASE LEVEL

P. NELSON

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Columbus AFB, MS

The Human Performance Operator Optimization (HPO2) Team is a base level cross functional team of Line and Medical assets, answering the operator's need for performance enhancement expertise for our next generation warfighter. The team solicits and prioritizes opportunities to enhance both individual and system performance, and recommends action through ad hoc Tiger Team formation. The HPO2 team supports these individual Tiger Teams with performance enhancement expertise, and forwards a vetted capability gap analysis through leadership to the MAJCOM for broader consideration. Discussing the HPO2 organizational structure and information flow provides an opportunity to identify possible solutions to base level integration of line and medical human performance assets with MAJCOM and Air Force human performance assets. The views presented are those of Dr Nelson and do not reflect the views of the United States Air Force.

Learning Objectives: 1. Understand challenges and possible solutions to local implementation of integrated human performance teams.

Tuesday, May 13

8:30AM

SLIDE: Human Error in Aviation

[187] COGNITIVE PROCESSES ASSOCIATED WITH THE LOSS OF SITUATION AWARENESS

L. L. BAILEY, J. POUNDS and A. L. SCARBOROUGH
FAA-CAMI, Oklahoma City, OK

Purpose: The loss of situational awareness (SA) is the most common human error identified by en route air traffic control (ATC) quality assurance (QA) personnel charged with investigating ATC operational errors (OEs). The SA construct involves integrating several cognitive processes, and therefore, it is not always clear what is meant when an ATC OE investigator identifies a loss of SA as an OE causal factor. We attempt to elucidate the operational meaning of a loss of SA by using an OE investigation tool called JANUS-ATC. **Method:** Two OE investigation techniques were simultaneously conducted by separate OE investigators for 67 en route OEs that occurred during 2002. The first technique used the current OE investigation process that assesses three components of SA: (a) detection, (b) comprehension, and (c) projection of future status. The second technique used a human factors diagnostic tool called JANUS-ATC, which classified human errors as: (a) perception and vigilance, (b) memory, and (c) planning and decision making. The results of the two techniques were used to construct a 3x3 contingency table to determine the degree to which a given SA component was associated with a given JANUS-ATC category. **Results:** Planning and decision making was the most common JANUS-ATC category associated with each of the three respective SA components (63%, 63%, & 65%). Next was perception and vigilance (32%, 31%, & 20%) and last was memory (26%, 13%, & 16%). **Discussion:** The results suggest that when ATC OE investigators attribute an OE to a lack of SA, they are implying that the controller more than likely demonstrated poor planning and decision making. However, it remains unclear whether

the lack of planning and decision making was associated with poor tactical or poor strategic decisions. Thus it appears that a temporal dimension of SA is needed to better capture what is meant by a lack of SA.

Learning Objectives: 1. to learn a new air traffic control taxonomy of human error. 2. to understand how to customize training based on cognitive processes.

[188] LOGISTIC REGRESSION ANALYSIS OF OPERATIONAL ERRORS AND ROUTINE OPERATIONS IN EN ROUTE AIR TRAFFIC CONTROL

E. PFLEIDERER and C. SCROGGINS

FAA CAMI, Oklahoma City, OK

Purpose: Numerous studies have examined environmental elements contributing to operational error (OE) occurrence. Most have been done without reference to routine operations (ROs). Yet, for every OE that occurs in a sector, there are hundreds (possibly thousands) of hours in which an OE did not occur. To truly understand the contextual factors that contribute to OEs, it is necessary to identify what was different about the sector environment at the time. The Number of Aircraft with Lateral Distances <10 nm, Transitioning Aircraft, Heading Changes, Handoffs, Point Outs, Average Vertical Distance, and Average Control Duration were submitted as predictors in a backward stepwise logistic regression analysis to determine how well dynamic traffic characteristics could discriminate between OE and RO traffic samples. **Method:** OE traffic samples were derived from SATORI (Systematic Air Traffic Operations Research Initiative; Rodgers & Duke, 1993) re-creations of OEs occurring at the Indianapolis Air Route Traffic Control Center (ARTCC) between 1/5/2003 and 12/10/2003. Sector characteristic variables were computed in 5-minute intervals for each OE (i.e., 4 minutes prior, 1 minute after) and summarized (averaged) for each sector. RO traffic samples were extracted from System Analysis Recordings (SARs) taped between 5/8/2003 and 5/10/2003, and sector characteristics variables were computed in 5-minute intervals and summarized (averaged) for each sector. This produced a total of 65 observations (28 OEs and 37 ROs). **Results:** Variables included in the final model (Number of Aircraft with Lateral Distance <10 nm, Number of Transitioning Aircraft, Number of Handoffs, and Average Control Duration) accurately classified OE and RO samples for 91% of the traffic samples. **Conclusions:** Although the results of the logistic regression analyses cannot be used to determine causation, they effectively identified variables that distinguished between OE and RO traffic samples. Further research is required to test how well these results generalize to other facilities.

Learning Objectives: 1. The relationship between sector characteristics and the occurrence of operational errors in en route airspace is described.

[189] A LONGITUDINAL EXAMINATION OF THE RELATIONSHIP BETWEEN OPERATIONAL ERRORS AND TRAFFIC VOLUME

S. E. LOWE¹ and L. BAILEY¹

¹FAA-CAMI, Oklahoma City, OK

Introduction: Human factors analyses have established strong and fairly consistent positive relationships between the number of aircraft operations and the number of Air Route Traffic Control Center (ARTCC) operational errors (OEs). Given that aircraft operations are expected to increase by 33% by the year 2015, there should be a corresponding increase in the number of OEs. However, it remains unclear if the expected increase would occur across all ARTCCs or within a restricted few. To help answer this question, we conducted a longitudinal study of OEs at the ARTCCs. **Method:** Number of aircraft operations and OEs were compared across 21 ARTCCs from the year 1995 through 2006. Scatter plots and regression lines for each year were examined. R2 values were compared across years. **Results:** R2 values across all ARTCCs ranged from .44 in 1996 to .81 in 2003, which produced an average R2 of .61. However, six ARTCCs consistently appeared as outliers on the scatter plots. This suggested the existence of two populations, those above (n=6) and those below (n=15) 2,100,000 annual aircraft operations. The average R2 for the higher operations ARTCCs was .19 and the average R2 for the lower operations ARTCCs was .47. **Discussion:** If the increase in operations is uniform across centers, some ARTCCs will likely experience a corresponding increase in OEs and others will not. We can expect to see an increase in OEs at the lower operations ARTCCs as the number of operations increase. However, since the higher operations ARTCCs fall into a different population, it is uncertain how an increase in aircraft operations would affect their OEs. Perhaps for the latter, sector characteristics (i.e.

number of airports, number of intercepting flight paths, and amount climbing and descending traffic) have more of an effect on the number of OEs than just traffic volume.

Learning Objectives: 1. To understand the spurious nature of correlations. 2. To understand the problems associated with bimodal distributions. 3. To understand the factors affecting air traffic control operational errors.

[190] ENGLISH LANGUAGE PROFICIENCY (ELP) AND THE PREVALENCE OF COMMUNICATION PROBLEMS AT FIVE UNITED STATES AIR ROUTE TRAFFIC CONTROL CENTERS (ARTCCS)

V. PRINZO

FAA, Oklahoma City, OK

Introduction: Air traffic control (ATC) voice communication is built upon redundancy: Controllers send messages to pilots who listen then recite back their contents. Successful communication requires the participants to conduct and understand ATC radiotelephony in the same language. Since inadequate language proficiency was involved in some aviation accidents (e.g., 1996 Charkhi Dadri, 1995 Cali, 1977 Tenerife), the International Civil Aviation Organization (ICAO) requires its Contracting States ensure that ATC personnel and flight crews are proficient communicators of the English language when operating in airspace where the English language is required. Within the US, data are lacking concerning the prevalence of communication problems attributable to the production and comprehension of English. The communication problems presented here involve readback errors (RBE), breakdowns in communication (BIC), and requests for repetition (RFR) by commercial airline pilots. **Method:** Fifty-one hrs were analyzed of air-ground transmissions. Each controller transmission was paired with its readback and scored for accuracy. Aircraft call signs were used to classify transmissions by aircraft registry (US, Foreign) and language (English, Other). **Results:** Communications were analyzed from 832 aircraft (77% US, 23% Foreign) for 4816 pilot transmissions (80% English, 20% Other) of which 5.8% contained problems (120 RBE, 122 RFR, 48 BIC). When English was the primary language or pilots flew US aircraft, there were fewer communication problems, less time was spent on frequency, and fewer messages were transmitted than when pilots flew foreign aircraft or the primary language was not English [all $F_s(1,830) > 4.65$, $p < .05$]. ELP was a factor for 66/90 (73%) communication problems among foreign aircraft and for 56/191 (29%) involving US aircraft [$X^2 = 48.24$, $p < .05$]. **Conclusions:** ICAO requires ELP standards be implemented in March 2008. These standards are designed to improve the pilot-controller communication process and will likely reduce the incidence of miscommunications.

Learning Objectives: 1. The relationship between English Language Proficiency and the prevalence of communication problems is described.

[191] RADIO SPEECH COMMUNICATION IN MILITARY AVIATION – SURVEY RESULTS FROM FINNISH DEFENCE FORCE PILOTS

T. M. LAHTINEN¹, M. SORRI¹, K. HUTTUNEN¹, P. O. KURONEN² and T. K. LEINO³

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Introduction: Radio speech communication is still an important safety factor in military aviation as effective radio communication is necessary for, e.g., good team situation awareness. Problems in communication tend to emerge especially during air combat exercises with high information load and multiple speakers on the same frequency band. In addition to overlapping messages and too fast speech, also neglecting of acknowledgements, and technical problems in radio equipment often negatively affect radio communication. In spite of the crucial role of radio communication in military aviation, most of the previous research has been done in experimental conditions. Little information is available on the prevalence and nature of radio communication problems in everyday working environments. **Methods:** Prevalence of radio speech communication problems was surveyed among Finnish Defence Force personnel. **Results:** 169 pilots (75%, of them 138 fixed wing pilots and 31 helicopter pilots) responded to a questionnaire. The respondents announced radio communication problems to occur, on average, in 14% of all flight time. The most prevalent problems were: 1 multiple competing speakers on the same radio frequency causing overlapping speech, 2. poor technical quality of the radio and the mask microphone especially in F-18

Hornet, and 3. high background noise especially during helicopter operations. Of the respondents, 31 pilots (18%) reported that they had encountered at least one danger situation caused by problems in radio communication. Fixed wing pilots had more often problems due to unintelligible speech than helicopter pilots. If the employer would offer extra hearing protection, i.e., custom-made ear plugs, 93 % of the pilots would use it. **Discussion:** Technical improvements and better flight training are the key factors for better communication. Especially during intense air combat exercises, the speakers should concentrate on transmitting only the most essential information. The pilots seem to understand the importance of hearing protection.

Learning Objectives: 1. To get acquainted with the prevalence and nature of problems in radio speech communication of military aviation and possibilities to overcome the problems.

[192] PREDIPOSING FACTORS TO HUMAN ERROR IN GENERAL AVIATION

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Introduction: Accident investigations frequently focus on the active failures of pilots rather than attempting to identify the factors that predispose the operators to specific types of failures. With this in mind, if one is attempting to understand human error, then those states which may predispose an individual to failure should be an integral part of any investigation and analyses as well. The focus of this investigation was to identify the role these factors play in general aviation (GA) accidents. **Method:** All of the GA accidents from 1990 to 2003 were gathered from databases maintained by the National Transportation and Safety Board (NTSB) and the Federal Aviation Administration (FAA). Six expert pilot raters coded the accidents according to the preconditions in the HFACS taxonomy. These preconditions include: environmental factors (e.g., physical and technical environment), conditions of the operators (e.g., adverse mental and physiological states, and physical/mental limitations), and personnel factors (e.g., crew resource management and personnel readiness). **Results:** Eighty percent of the accidents were found to have an associated precondition. Personal readiness (PR), adverse mental states, and adverse physiological states were associated with the highest percentage of accidents (28%, 20%, and 11% respectively). Physical environment (PhE), physical mental limitations (PML), crew resource management (CRM), and technical environment (TE) collectively were associated with 20% of the accidents. Additional analyses were conducted revealing that over 75% of the accidents involving APS were associated with fatalities, whereas PR and AMS were associated with 45% of the fatal accidents. **Discussion:** The current investigation used HFACS to identify the role the preconditions for unsafe acts played in GA accidents. The high percentage of fatalities associated with APS, PR and AMS underscores the necessity for understanding how these mitigating factors relate to safety in GA.

Learning Objectives: 1. To investigate the relationship between underlying psychological, physical, and behavioral factors in general aviation accidents in order to pave the way for better safety management programs.

Tuesday, May 13

9:30AM

POSTER: Aeromedical Transport/Air Evacuation

[193] AIR EVACUATION UNDER BIOSAFETY CONTAINMENT OF PATIENTS WITH HIGHLY CONTAGIOUS INFECTIOUS DISEASES

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Every year we have epidemics due to new-emerging or re-emerging highly contagious infectious diseases, such as SARS, Marburg fever, pandemic avian flu, etc.. Aeromedical Isolation Team is a rapid response team that can deploy to any area of the world, foreign or domestic, to transport and provide medical care under high containment to a limited number of patients exposed to, or infected with highly contagious, potentially lethal pathogens. For this duty, AIT includes two teams, each comprised of ten people (three physicians and seven nurses) and two Aircraft Transit Isolator (ATI) systems. This isolator completely separates the patient in a negative pressure envelope that protecting the accompanying medical team and the surrounding environment. Half suits and gloved sleeves incorporated in the envelope walls enable the

attendants to examine and care for the patient. A battery powered air supply unit draws air through two inlet microbiological (HEPA) filters into the envelope and exhausts it through a similar filter at the foot end. In January 2006 Italian Air Force AIT carried out its first transportation of a contagious patient using an isolator system. The patient suffered from multidrug resistant (MDR) Tuberculosis, an infectious disease transmitted by air way, more severe for the high resistance at medical treatment, and was transferred from Alghero Airport, in Sardinia Island, to Linate Airport, in Milan, by Lockheed C-130J aircraft. The flight lasted one hour in comparison with estimated twelve hours by ambulance and boat. The organization of Italian Air Force AIT is basically founded on the model of U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) AIT. At the present, Italian and US teams are using the same procedures, training and equipments, and this similar capability is a good starting point for a future collaboration in operational scenarios. In 2007 Italian Air Force AIT carried two transportation of a contagious patient using an isolator system about suspected HF fever and MDR Tuberculosis.

Learning Objectives: 1. aeromedical management of patients with high infectious disease.

[194] REALIGNMENT OF PATIENT SAFETY REPORTING WITH USAF SAFETY INVESTIGATION CRITERIA: ONE EXPERIENCE

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Background: Patient Safety has long been stigmatized by the connotations of medical error. Incident reporting at the 35th Medical Group (35 MDG) was complex, requiring significant input from the reporting individual. The Transformation Team felt administrative burdens inhibited the effectiveness of the Patient Safety program. **Methods:** To improve error identification, we developed a data categorization plan based on US Air Force Safety investigation procedures and Joint Commission sentinel event criteria. The Patient Safety Matrix classified patient risk based on specific criteria and simplified reporting requirements. Having a Safety Analyst perform the investigation ensured a standardized report. Readily available incident summaries give senior leadership insight into incident trends. A robust database provides tracking and allows searching for possible trends in the available data. **Results:** While the 35 MDG Patient Safety Transformation is evolving, there are already notable results. Our incident investigation is congruent with other mishap reporting using USAF criteria. The new process has minimized work while maintaining accuracy. Rapidly accessible information empowers decision-makers to address issues. Local database trends will be discussed, but the small sample size prevents quantitative analysis. **Conclusions:** This program has strong potential to increase mishap reporting. Aligning medical reporting with standard safety reporting ensures medics can speak similarly with non-medical personnel, making Patient Safety more transparent to the military customer. Using available safety concepts can decrease the stigma of error by focusing on preventing recurrences. A simpler reporting process and anonymous reporting improves the likelihood personnel will provide mishap data. Finally, database development provides better information on common errors and trends.

Learning Objectives: 1. understand one method for aligning patient safety with other DoD safety programs. 2. learn common hinderances to reporting in patient safety programs.

[195] TRIAL TO ESTABLISH AN AERO-MEDICAL EVACUATION TROOP IN JAPAN AIR SELF DEFENSE FORCE

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On October 1 2006, Japan Air Self Defense Force (JASDF) established first Aero-Medical Evacuation Squadron (AMES) for air-transporting critical patients under sophisticated and strict medical interventions. This squadron consists of administrative and operative branch and several task forces (Right now, just 1.). Then, the task force is composed of one medical team equipped with one newly-devised ICU-style medical module called "Kido-eisei Unit". This "Unit" was originally constructed in order to immediately convert the milieu of our ordinary carrier aircraft into ICU-level medical milieu normally provided by dedicated medical aircraft. Just loading this "Unit" can make a cabin of C-130H more useful and comfortable for intensive medical care by decreasing a loud noise on cruising, by avoiding the electro-magnetic interference (EMI) between the aviation and the medical devices, by brightening with some kinds of light system and so forth. Two "Units" can be loaded into a cabin of C-130H. One "Unit" can

hold three persons simultaneously, and can be operated by one medical team including a medical doctor, a nurse and a paramedic. Now we are performing several tests required for operating the first "Unit" appropriately. So here we will show you our trial to establish the readiness of AMES and some of the instructions of "Kido-eisei Unit" for your reference.

Learning Objectives: 1. Understand AMES and the "Kido-eisei Unit" in JASDF.

[196] RISK ANALYSIS FOR EMERGENCY MISSIONS WITH PHYSICIAN-STAFFED AMBULANCES COMPARED TO RESCUE HELICOPTERS

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Background: In Germany, annually approx. 2 million ground-rescue missions with physician-staffed ambulances (PSA) are carried out. In addition approx. 80.000 helicopter emergency medical services (HEMS) air-missions are accomplished [1]. National and international data [2, 3] revealed 10.8 accidents/100,000 flight-hours (0.54 accidents/10,000 air-missions). Data for the risk during PSA ground-missions are not available. The aim of the present study was to compare the accident risk of PSA to HEMS in a 10-year period. **Materials and Methods:** A retrospective analysis ranging from 1996 to 2005 was carried out using published accident data from the BAST (Federal Highway Research Institute of Germany) for PSA and flight accident reports from the BFU (German Federal Agency for Flight Accident Investigation) for HEMS. Additional data (operating hours, missions, accident characteristics) were gathered and compared to published data [2, 3, 4]. Fisher's exact test was used for statistical analysis; P<0.05 was considered statistically significant. **Results and Discussions:** In the period analyzed, 1,245 PSA and 75 helicopters were at service per year (1.74 million vs. 36,775 operating hours). Each year 90 vs. 4 accidents occurred. On the basis of 10,000 missions, data were comparable (0.43 vs. 0.5 accidents, n.s.). A significant difference was found per 100,000 hours (5.17 vs. 10.87, P<0.05). International data were partially discrepant [3, 4]. **Conclusion(s):** The risk for accidents is comparable for PSA and HEMS on the basis of missions, but significantly higher for HEMS on the basis of operating hours. For Germany, published studies on this topic are not available and denominator data are not published sufficiently. Denominator data are often inhomogeneous and discrepant making direct comparisons difficult or nearly impossible.

References: [1] Behrendt H et al. Handbook of emergency rescue, 2003. [2] Viergutz T et al. Notarzt 2006; 22:186-92. [3] Rhee KJ et al. Aviat Space Environ Med 1990;61:750-2. [4] Biggers WA Jr et al. Prehospital Disaster Med. 1996;11:195-201.

Learning Objectives: 1. Accident risk may differ between air- and ground-rescue.

Tuesday, May 13

9:30AM

POSTER: Occupational and Environmental Medicine-- Occupational Exposures

[197] NECK AND BACK-RELATED DISABILITY AMONG US ARMY AVIATORS

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Introduction: Neck and back injuries exact a significant human and economic toll on the health and readiness of the U.S. Army. Occupational exposures that increase risk of neck and back injury may include activities such as heavy lifting, twisting, and exposure to vibration, g-loading forces, or use of equipment that increases head supported mass, such as helmets and head-mounted displays. **Methods:** Using data from the Total Army Injury and Health Outcomes Database (TAIHOD), including demographic, occupational and health outcomes data, we tested the hypothesis that Army pilots will be at greater risk for neck and back problems relative to officers who do not fly. Four separate outcomes were tested including disability discharges, outpatient encounters, hospitalizations, and accident

reports. Standardized Morbidity Ratios and (95% CIs) were calculated for both acute injuries and chronic neck and back problems (musculoskeletal conditions) controlling for age and gender. **Results:** During the 1985-2002 study period 10,268 officers drew flight pay and were part of the comparison group. Aviators had significantly greater risk for chronic back and neck hospitalization (SMR= 1.25 (1.11-1.39) and 1.46 (1.17-1.81), respectively) as well as back-related disability (SMR = 1.49 (1.14-1.92)), acute back-related accident reports (SMR = 1.94 (1.43-2.57)) and outpatient visits for chronic back and neck problems (SMR = 1.25 (1.23-1.28) and 1.07 (1.02-1.12), respectively). The only outcome that was significantly lower for flyers was outpatient visits for acute back injury 0.89 (.82-.97). **Discussion:** Officers in flying status appear to be at significantly greater risk for chronic back and neck morbidity as well as accidents resulting in back injury compared to their non-flying counterparts. The specific etiology of these differences and the fact that the risk varies by measured outcome warrants further investigation.

Learning Objectives: 1. Injuries and musculoskeletal conditions of the back and neck are a significant problem for Army servicemembers. 2. The audience will learn the relative risk of head and neck problems among Army aviators relative to non-flyers. 3. The audience will gain an understanding of the differences between morbidity measurements from safety reports, disability boards, and in and outpatient encounters.

[198] EDUCATIONAL OPPORTUNITIES IN OCCUPATIONAL MEDICINE

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Background: Occupational medicine has traditionally been the province of specialist occupational physicians or general practitioners with an interest in occupational health, leaving a gap in between. Part of this arises from a lack of accessible occupational medicine educational opportunities for practitioners unable to take time away from work.

Methodology: A cohort of part-time occupational physicians were identified by membership of a non-specialist medical society, and a group of specialist occupational physicians through their Fellowship status. Postal survey questionnaires were administered to both groups, seeking to identify costs and benefits of education. **Results:** Significant differences in responses were noted between the two groups. **Discussion:** Barriers to uptake of educational opportunities were identified. Suggestions for a range of strategies to identify the current apparent training gaps are put forward.

Learning Objectives: 1. To raise awareness of occupational physicians that alternatives to face to face programs for higher qualifications in occupational medicine exist.

[199] HEARING STATUS AMONG CABIN CREW IN COMMERCIAL AIRLINE

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Introduction: Cabin crew (CC) is exposed to noise, both during cruise, and other occasions, but there are few studies on hearing loss in commercial CC. **Methods:** Totally 155 male and 781 female CC (N=936) in one Swedish airline company have undergone repeated audiological tests 1974-2005. The last test was used to study hearing loss. The age group values for the hearing test at 3000 Hz, 4000 Hz, and 6000 Hz were used for the ear with worst hearing loss. Data was compared with a Swedish normal population (N=603) not occupationally exposed to noise. Equivalent noise levels gate to gate (Leq) were measured in the cabin of different aircraft. **Results:** Leq in the cabin was 78-84 dB (A), peak exposures were 114 dB (A) when closing bins. There was no indication of impaired hearing in CC at any age, neither in males nor in females. Median values for all ages were close to the reference group with a trend for better hearing than normal in subjects above 50 y. There was no association between years of employment and hearing loss, when adjusting for age and gender by multiple logistic regressions analysis. **Discussion:** Cabin crew are exposed to equivalent noise levels just below the current Swedish occupational standard of 85 dB (A), with peak exposures well above the standard. Despite this noise exposure, we found no indications of impaired hearing loss in cabin crew. One explanation could be use of hearing protection devices at peak exposures outside the cabin.

Learning Objectives: 1. Hearing impairment among cabin crew in relation to sex, age and years of employment, compared with a Swedish normal population will be presented.

[200] EFFECTS OF FEMALE ANTHROPOMETRIC VARIABILITY ON SIMULATED THERMAL RESPONSES

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Introduction: We previously evaluated the effects of anthropometric variability on predicted physiological responses to heat stress in U.S. Army male soldiers (AsMA2007). Here we extend this line of research by examining the effects of anthropometric variability on thermoregulatory responses in female soldiers. **Methods:** Anthropometric data (height, weight, % body fat) from U.S. Army female soldiers (n = 1244) were analyzed using principal component (PC) analysis. Key anthropometric characteristics were identified and applied to model simulations of individuals wearing battle dress uniform and body armor and walking at metabolic rates of 250-530W for 120 min in 30°C air temperature and 25% relative humidity conditions. The predicted physiological responses were compared to previous results from male soldiers. **Results:** The first PC, explaining 63% of the total variation, represent all positive loading effects associated with overall body size. The second PC, explaining 32% of the total variation, was associated with dichotomous body shape variables. The five prime somatotypes identified in women (i.e., average, "tall-fat," "tall-lean," "short-fat," "short-lean") were the same as those identified for men, though the anthropometric values for each somatotype differed by gender (p < 0.05). For the specific conditions simulated, the thermal model simulations indicated that "lean" women were more tolerant of heat stress and able to work 50% longer than "fat" women. Within-gender differences in physiological responses across the somatotypes were more pronounced than the differences between gender. **Conclusion:** Female as well as male U.S. Army soldiers fall into five major somatotype categories; the predicted physiological responses to physical work and thermal stress varies by somatotype. These findings may lead to better ways of identifying and managing soldiers at risk of heat illness by virtue of their somatotype.

Learning Objectives: 1. Discuss use of principal component analysis to understand major body types of female soldiers. 2. Discuss the predicted impact of body types on thermal strain.

Tuesday, May 13

9:30AM

POSTER: Occupational and Environmental Medicine--Environmental Exposures

[201] IMPACT ON HEAT STRAIN OF MEASURES TO REDUCE LOCAL COLD DISCOMFORT USING AN ACTIVE ICE-BASED PERSONAL COOLING SYSTEM

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Introduction: To mitigate heat strain during hot-weather military operations, UK rotary-wing aircrew currently use a personal cooling system (PCS) based on the circulation of melted ice through a liquid-conditioning vest (LCV). There is concern that the degree of surface torso cooling may be too intense when the flow rate is high, and the aim of this study was to assess the impact on heat strain of measures to reduce this risk. **Methods:** Six men (age, 27.2 ± 1 SD, 6.9 y; body mass, 70.9 ± 8.3 kg) undertook a work-in-heat test designed to simulate a hot-weather flight scenario on three occasions: 1) 'High' flow rate (HIGH); 2) 'Low' flow rate (LOW); and 3) LCV worn over a combat shirt with a 'High' flow rate (OS). The work profile consisted of treadmill walking (~400 W, 20 min) followed by leg-press exercise (~200 W, 80 min). Wet-bulb-globe temperature was maintained at 34°C, and the subjects wore a summer Aircrew Equipment Assembly (a vest was worn under the LCV in all conditions). Heat strain was assessed via physiological (including rectal temperature, Tre; front torso skin temperature, Ttorso; heart rate, *fc*; rate of water loss, *mwl*), and subjective measurements. **Results:** Ttorso at the end of HIGH (28.8 ± 2.0°C) was lower than in LOW (32.3 ± 1.2°C) and OS (33.0 ± 1.2°C), although torso cooling was only perceived as 'slightly cool' in HIGH, compared with 'neutral' in LOW and 'slightly warm' in OS. There were no differences in overall thermal comfort. Tre, *fc*, and *mwl*, which was 37.4 ± 0.1°C, 81.8 ± 14.1 b·min⁻¹, and 299 ± 75 ml·h⁻¹, respectively, at the end of HIGH, were not different from the values in LOW and OS. The ice-melt rate was reduced by 30% in LOW. **Discussion:** The measures evaluated to reduce local cold discomfort did not impact on whole body thermal balance and cardiac strain, although operating the pump at a lower flow rate offers logistical advantages.

Learning Objectives: 1. The impact of measures to reduce the risk of local cold discomfort on heat strain using an active ice-based personal cooling system will be described.

[202] HIGH ALTIUDE PULMONARY EDEMA IN WORKERS AT ALTITUDE: A RETURN-TO-WORK PROTOCOL

C. LOWRY

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Introduction: Research, construction, and military operations at altitude place unacclimatized workers at risk of altitude illness. At a scientific research station above 9,300 feet, work-rest protocols are enforced for new workers. Despite preventive efforts, acute mountain sickness and high altitude pulmonary edema (HAPE) occur. Treatment of HAPE requires medical evacuation by air to a small sea level clinic. Some workers want to return to work at altitude after treatment. An objective measure of readiness to return to work after HAPE was needed. No return-to-work protocols were available in relevant literature. **Methods:** Over a three-week period, seven workers at the high altitude station developed HAPE. Initial evacuation and treatment was standardized. Patients were evaluated for return to work when chest x-rays showed resolution of pulmonary edema, physical exam was normal, and oxygen saturation was at least 98%. When able to tolerate walking 400 feet without shortness of breath, maintaining oxygen saturation above 95%, they were ready for a more strenuous test. Vital signs were obtained at rest. Patients then walked on a treadmill at 3.2 mph with 10% incline for 3 minutes. Vital signs were checked at 3 minutes of exertion and again after 3 minutes rest. Patients were considered ready to return to altitude if able to maintain oxygen saturation greater than 95% without significant fatigue or shortness of breath, and with normal cardiovascular response to exertion and recovery. **Results:** Four of seven patients were eventually able to pass this objective test and return to altitude. All four remained at altitude without recurrence of HAPE. Two were unable to pass the treadmill test after recovery and remained at sea level. One patient was not tested due to an underlying medical condition. **Discussion:** This simple protocol was an effective way to objectively determine which workers were ready to return to work at altitude following descent and treatment for HAPE.

Learning Objectives: 1. Recognize the occupational risks to workers at altitude. 2. Determine workers' ability to return to work at altitude after recovery from high altitude pulmonary edema.

[203] ACUTE COLD EXPOSURE INCREASES AUTONOMIC NERVOUS ACTIVITY

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Introduction: The aim of the study was to examine cardiovascular autonomic nervous system responses to whole body cold exposure. **Methods:** Ten young male subjects were exposed to cold (10 °C) for 2 h. Autonomic function was assessed in supine position first at 25 °C temperature and thereafter during cold exposure. RR intervals, systolic (SBP) and diastolic blood pressure (DBP) were measured, as well as time (root mean square of successive differences in RR interval, RMSSD) and frequency domain heart rate variability (HRV) were determined from a 5 minute controlled breathing test. Power spectral analysis based on Fast Fourier Transformation was used to calculate high frequency (HF), low frequency (LF) and total power (TP) of HRV. Venous plasma norepinephrine (NE) concentrations were determined. **Results:** Acute cold exposure increased significantly SBP, DBP, TP, LF, RMSSD as well as venous NE (Table 1: ns = not significant, * = p < 0.05, *** = p < 0.001). **Discussion:** Acute whole body cold exposure leads to sympathetic activation as shown by the elevations in venous NE and blood pressure. It seems that at the sinus node level the sympathetic activation is balanced by vagal activation as the RR interval slightly but insignificantly increased together with HF.

Learning Objectives: 1. The audience will learn the effects of acute cold exposure on autonomic nervous activity.

Table 1.

	25 °C		10 °C		Significance
	Mean	SE	Mean	SE	
TP (ms ²)	5893	2892	9210	1678	*
LF (ms ²)	1518	774	1813	349	*
HF (ms ²)	2998	1748	3982	1197	ns
LF/HF (%)	101	28	87	24	ns
RMSSD (ms)	77	22	117	21	*
RR interval (ms)	882	24	962	51	ns
SBP (mmHg)	128	4	144	4	*
DBP (mmHg)	74	3	85	2	*
NE (ng/ml)	0.8	0.1	1.7	0.1	***

[204] THE EFFECT OF SHORT-TERM HYPOBARIC HYPOXIC EXPOSURE ON INTRAOCULAR PRESSURE AND CENTRAL CORNEAL THICKNESS

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Introduction: The aim of the study was to evaluate the effect of short-term hypobaric hypoxic condition on intraocular pressure (IOP) and central corneal thickness (CCT) in healthy subjects. **Methods:** The study group was comprised of 40 healthy subjects with a median age of 24.8 (range, 21–39) years. IOP and CCT were measured with a Tono-Pen XL tonometer and ultrasound pachymetry at the ground level, which is 2414 ft (792 m) above sea level (prehypoxic), during short-term hypobaric hypoxic exposure at a simulated altitude of 30000 ft (9144 m), and at the ground level after the hypobaric hypoxic exposure (posthypoxic). The changes in the IOP and CCT were appraised. The mean of 3 consecutive measurements of IOP and 10 consecutive measurements of CCT were calculated. The results were analyzed statistically by means of repeated-measures ANOVA. **Results:** The IOP level at hypobaric hypoxic condition (18.26 ± 3.01 mmHg) was significantly greater than both prehypoxic level (16.3 ± 2.98 mmHg) ($P < 0.001$) and posthypoxic level (17.02 ± 2.85 mmHg) ($P < 0.01$). The CCT value at hypobaric hypoxic condition (559.9 ± 33.7 μ m) was significantly greater than both prehypoxic value (554.1 ± 34.5 μ m) ($P < 0.001$) and posthypoxic value (553.6 ± 33.6 μ m) ($P < 0.001$). There was no significant difference in IOP and CCT between prehypoxic and posthypoxic levels. The changes in CCT and IOP at hypobaric hypoxic condition showed no correlation ($P > 0.05$). **Conclusion:** Short-term hypobaric hypoxic condition caused a significant increase in CCT and IOP in healthy subjects. But, there was no significant relation between them.

Learning Objectives: 1. The relation between intraocular pressure and central corneal thickness changes under hypobaric hypoxic conditions will be discussed.

[205] WBGT INDEX ALTERNATIVE?

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Background: Guidance to prevent heat injury often uses the Wet Bulb Globe Temperature index (WBGT) as a metric. During recent deployments, concerns regarding WBGT have arisen. Often required inputs - dry-bulb temperature (T_{db}), natural wet-bulb temperature (T_{nwb}), and black globe temperature (T_{bg}) - are unavailable. One proposal is to use of an alternative method to calculate WBGT (AWBGT) which requires only air temperature and relative humidity (RH). Radiation and wind effects are thus not incorporated into AWBGT. The apparent advantage of AWBGT is that WBGT based guidance would still be applicable. Is AWBGT an acceptable WBGT replacement? **Methods:** An automated WBGT monitor measured T_{db} , T_{nwb} , T_{bg} and RH in Griffin, GA, June to August 2007. WBGT and AWBGT were calculated using those inputs. **Results:** As a general trend, AWBGT values were higher than WBGT

values, but differences decreased during daylight. For the 13:00-14:00 interval, mean WBGT = $28.8 \pm 3.0^\circ\text{C}$, and range = 19.6 to 39.7°C versus $29.7 \pm 2.3^\circ\text{C}$, and 24.4 to 35.2°C for AWBGT. For the 5:00-6:00 interval, mean WBGT = $20.2 \pm 2.1^\circ\text{C}$, range = 13.3 to 24.3°C versus $25.7 \pm 2.4^\circ\text{C}$, and 18.0 to 31.3°C . Flag colors were assigned numbers representing the corresponding WBGT range: Green = 1, Yellow = 2, Red=4, Black=4, no flag ($<27.7^\circ\text{C}$) = 0. Twenty-five data subsets were evaluated using t-tests. In virtually all subsets, WBGT (24/25) and flags (25/25) were significantly different. For daylight hours, cases were removed when both flag levels = 0, leaving $n=8264$. In 6220 cases (72%), the flags differed by at least one level. When absolute values were compared, the mean change in levels was 1.4 ± 0.7 . As flag interval for Yellow is 29.4 to 31.1°C and for Red 31.1 to 32.2°C , an average difference of even 1°C can be important. **Conclusion:** The general bias and wide range of differences between WBGT and AWBGT values indicate that AWBGT cannot be substituted for WBGT.

Learning Objectives: 1. The alternative method of calculating WBGT does not always provide equivalent values. 2. Solar and wind effects should be included in WBGT.

Tuesday, May 13

9:30AM

POSTER: Medical Standards/Aircrew Health

[206] DOES DIABETES OR DIABETIC NEUROPATHY HINDER PERFORMANCE OF SUPRA-POSTURAL TASKS?

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Diabetes Mellitus is a metabolic disorder becoming more and more problematic in industrial societies. Diabetes Mellitus causes an economic burden for both patients and the health care system, especially when it is accompanied by neuropathy (i.e., damage to sensory, motor, and autonomic nerves). Of importance for the aeronautic industry are the task-performance consequences of diabetes-associated postural instability. Is instability a problem before diabetic neuropathy emerges (typically affecting more than 25 % of diabetic patients within 10 years of diagnosis)? In the 28 existing experimental articles, researchers agree that diabetes per se does not lead to instability. The authors all conclude that postural instability results from neuropathy or as a consequence of neuropathy. In particular, Symmetrical (left-right) peripheral sensory neuropathy has been proposed as the cause of instability (Cavanagh, Simoneau, & Ulbrecht, 1993). We consider evidence for additional hypotheses: information processing (changes in the information and/or postural strategy used for postural control), biomechanical (the consequences of neuropathy for the dynamics of postural motion), and autonomic (issues at the heart rate level). Finally, we also propose a hypothesis from the ecological approach to perception-action. Whereas instability in the antero-posterior axis could effectively result from the disorder, exploration—a functional means of picking up information relative to the limits of stability—could explain the greater variability in the medio-lateral axis for diabetic neuropathy patients than for healthy controls. This possibility is explained and discussed.

References: [1] Cavanagh, P. R., Simoneau, G. G., Ulbrecht, J. S. Ulceration, unsteadiness, and uncertainty: The biomechanical consequences of diabetes mellitus. *J Biomech*, 1993;26 (Suppl. 1):23-40.

Learning Objectives: 1. What is the cause of instability in patients affected by diabetes mellitus: is it the disease itself or any consequence of the disease?

[207] SIDENAFIL CITRATE & VARDENAFIL HCL USE FOR NAVAL AVIATION PERSONNEL

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Introduction: Erectile dysfunction (ED) affects 10-20 million American men. The current U.S. Navy Aeromedical Reference and Waiver Guide (ARWG) formally prohibit the use of Sildenafil by any aircrew. However, there is anecdotal evidence of use by naval aircrew after authorization by local flight surgeons and a period of grounding. This use is without official guidance from the Naval Aerospace Medical Institute (NAMI). We describe an aeromedical-policy revision process through the Aeromedical Advisory Council (AAC). AAC is composed of clinical aviation specialists and flight surgeons at NAMI. **Methods:** We researched

the literature for clinical information on PDE-5 inhibitors. We surveyed waiver guidelines of other U.S. Armed Services and the Federal Aviation Administration (FAA). We sought out opinions of NAMI clinical specialists. Utilizing Operational Risk Management principles and practices, AAC members discussed and voted on the merit of revising ARWG. Approved recommendations were forwarded to the Bureau of Medicine for review and inclusion into the ARWG. **Results:** The blue tinged vision associated with PDE-5 inhibitor use is temporary and reversible within 3 hours. There is no causal relationship between PDE-5 inhibitor use and NAION (Non-arteritic Anterior Ischemic Optic Neuropathy). Events such as MI and stroke are not associated with PDE-5 inhibitor use. The most common side effects are headache, facial flushing and dyspepsia. The half-life is 3-5 hours. The USAF has a verbal "Duty Not Involving Flying" policy with a 72-hour grounding period. The US Army requires a workup with 8-12 hour grounding. FAA requires a 6-hour observation. **Discussion:** The AAC approved Sildenafil and Vardenafil as a treatment option for ED with a 12-hour grounding period. An exercise stress test should be strongly considered prior to waiver submission. Collaboration and standardization among the U.S. Armed Services may reduce variation and increase the quality of aeromedical policies regardless of the aviator's service affiliation.

Learning Objectives: 1. The description of the U.S. Navy aeromedical-policy revision process on PDE-5 inhibitors will be discussed.

[208] STUDY OF HEALTH RISK FACTORS IN ROKAF'S PILOTS

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Introduction : Recently, habitual diseases such as hyperlipemia, hypertension are increasing due to the rapid westernization of the foods and life style, and they are attributed to develop ischemic heart disease and cerebral vascular disease in Korea. We think the Military have similar trends. Pilots in Air Force are precious human resources who are cost 10 billion dollar, but If they have habitual diseases and secondary complications, It is will be risk that threaten life as well as hard to maintain flight qualification. Therefore, Interests about active health promotion program are increasing and efforts of early detection and prevention for health risk factors and diseases are progressing. This research is planned for basic data to built health promotion programs which are progressing and planning in Korea Air Force. **Method :** We studied question survey with 203 pilots who examined at Aerospace Medical Center from June, 2006 to December, 2006. Each questionnaire composed smoking, drinking, dietary life habit, exercise, Insight of weight himself by 6 field of 57 questions including personal history. **Results:** All subjects are all men, and average age was 32.2-year-old (25 - 55 years old), and high performance including F-16 is 82.6%, and Air cargo including CN-235 is 15.4%, and helicopter is 2.1%. flying hour examined by Average 1104.9 Hours(30 hours - 4000 hours). Smoking rate was 42.1%, and smoking beginning reason is that stress(37.6%) and curiosity(26.3%). 74.4% was taking 3 meals regularly. second was 23.6% doing 2 meals.also we evaluate several items. **Discussion:** this data will be important to make health promotion policy and good chance to carare with civilian and foreign county's pilots

Learning Objectives: 1. The status of health risk factors in Korea Air Force.

[209] INFERIOR VESTIBULAR NEURITIS IN A CHINESE FIGHTER PILOT

X. SU JIANG

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Introduction: Pilot spatial disorientation is a leading factor contributing to many fatal flying accidents. Spatial orientation is the product of integrative inputs from the proprioceptive, vestibular, and visual systems. The importance of normal function of all organs involved in orientation is mentioned in the aviation medical literature as being a prerequisite for flying. Acute vestibular neuritis (aVN) might lead to sudden pilot incapacitation in flight. In ordinary clinical practice vestibular integrity is tested by caloric irrigation, which only test the horizontal semicircular canal. Cases of selective loss of inferior vestibular nerve, i.e. inferior vestibular neuritis, will not be identified as such if vestibular tests are restricted to calorics. The introduction of the vestibular evoked myogenic potential (VEMP) allows examination of saccular function, innervated by the inferior part of the nerve. **Case report:** A 45-year-old male, Chinese military command pilot with close to 2000 flying hours presented with

rotatory vertigo associated with nausea and vomiting. He had normal caloric ,but unilateral loss of VEMP. **Discussion:** In patients with aVN, lateral semicircular canal (SCC) function as shown by caloric testing is, by classical definition, abolished or severely reduced on the affected side. But aVN sometimes affect only the inferior vestibular nerve. Normally the superior vestibular nerve innervates the SCC, the anterior SCC, and the utricle, whereas the inferior vestibular nerve innervates the posterior SCC and the saccule. We can't evaluate inferior vestibular nerve system function for military pilots before the introduction of VEMP. Here we report on one pilot with acute vertigo attacks ,who had just such deficits of vestibular function demonstrated by caloric testing and VEMP evaluation and suggest that he did indeed have a selective inferior vestibular neuritis. **Conclusion:** We believe that the pilot suffer from pure inferior nerve vestibular neuritis. VEMP plays a major role in the diagnosis of inferior nerve vestibular neuritis.

Learning Objectives: 1. The audience will learn the diagnosis of Inferior vestibular neuritis in military pilots. 2. To apply vestibular evoked myogenic potential test to vestibular function evaluation of military pilots.

[210] FACTORS INFLUENCING PILOT SATISFACTION WITH AVIATION MEDICAL EXAMINATIONS CONDUCTED BY AVIATION MEDICAL EXAMINERS: RESULTS OF THE 2006 SURVEY OF PILOTS

D. M. BROACH and M. DENNIS
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Introduction: The Government Performance and Results Act, Executive Order 12862, and performance standards for the Senior Executive Service require executive departments and agencies to monitor and evaluate service quality and customer satisfaction. Therefore, the Office of Aerospace Medicine (OAM) conducted a survey of pilots to assess their satisfaction with aeromedical certification services. This analysis focuses on pilot satisfaction with the examination as conducted by an Aviation Medical Examiner (AME). **Method:** The 2006 survey of pilots was developed on the basis of (a) the 2000 survey content and (b) the scientific literature on customer satisfaction. The instrument was distributed to a national random sample of 16,000 U.S. pilots, stratified by pilot certificate and medical class; the return rate was 41%. Stepwise multiple regression analysis was used to identify aspects of the AME examination that influenced pilot satisfaction with the examination. **Results:** Overall, pilots were satisfied with the AME examination ($m=4.37$, $sd=0.97$) on a 5-point scale, where 1=Not at all satisfied to 5=Satisfied to a great extent. Seven factors accounted for about 18% of the variance in pilot satisfaction (Adjusted $R^2_{(7,3519)}=.184$, $p<.001$): delay in issuance ($\beta=-1.09$), providing the pilot with requested information ($\beta=.15$), treating the pilot with courtesy and respect ($\beta=.111$), providing accurate information ($\beta=.08$), conducting the exam in a professional setting ($\beta=.06$), explaining the pilot's responsibilities in the certification process ($\beta=.05$), and performing a thorough examination ($\beta=.04$; all β s significant at $p<.05$ or better). Cost of the examination was unrelated to pilot satisfaction. **Discussion:** Overall, the simple adages of "Customer Service 101" appear to apply to the aeromedical certification examination: Treat the pilot with respect and courtesy, administer a thorough examination in a professional setting, and provide accurate and timely information to the pilot, especially if issuance of the medical certificate will be delayed.

Learning Objectives: 1. Factors influencing satisfaction with aviation medical examinations in practice.

[211] CARDIAC AND VASCULAR CHARACTERISTICS IN YOUNG PREHYPERTENSIVE PILOTS AND IN NORMOTENSIVES WITH OR WITHOUT FAMILY HISTORY OF HYPERTENSION

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²Medical General, Sanitary Department Head, Italian Air Force, Rome, Lazio, Italy

Introduction: The purpose of our study was to examine the association of cardiac hypertrophy with carotid thickness in a group of young prehypertensives, compared to normotensives with or without parental history of hypertension. **Methods:** We examined 150 Italian Air Force pilots, aged between 19 and 29 years, who showed no evidence of cardiac disease at the physical exam and had a normal ECG. The subjects enrolled were divided in three subgroups as follows: 1) Prehypertensives (25 subjects); 2) Normotensives having one or both parents with hypertension (50 subjects); 3) Normotensives without family history of

hypertension (75 Subjects). All subjects underwent an echocardiographic exam in which left ventricular mass, as well as early and late ventricular filling velocity were evaluated. We also performed on each subject a carotid ultrasonographic exam, in which the intima-media thickness of both common carotid arteries and of their bifurcation were recorded, together with carotid diameters. **Results:** The echocardiographic exam showed significant differences between the group of prehypertensives and the two other groups, regarding left ventricular mass index and left ventricular filling velocity. The comparison between normotensives with or without family history of hypertension showed only a slightly significant difference concerning early and late left ventricular filling velocity. These results are correlated with vascular sonography. In fact we noticed no difference in carotid diameters among the three subgroups, but a significant difference in carotid intima-media thickness between group A and group C and a difference in thickness between group B and group C that hardly reached significance, but should be probably better evaluated on a larger group of subjects. **Discussion:** Our results, consistent with previous reports, seem to confirm the evidence that target organ damage of heart and cardiovascular system starts in a very early stage of hypertension and a slight difference might be detected even in normotensive subjects coming from hypertensive family.

Learning Objectives: 1. The relation between prehypertension and early target organ damage in a population of young pilots is examined. 2. The audience will learn to focus on target organ damage even in young prehypertensives when evaluating medical standards in air crew.

[212] USAF AVIATION SPECTACLE FRAME OF CHOICE: NEW DEVELOPMENTS

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In FY 2000, the Air Force replaced a 42 year-old standard-issue aircrew spectacle standard addressing key aircrew-identified operational issues. Standardization of eyewear in the cockpit is integral to instrument, headgear, aided vision, and protective device development and aircraft/human integration. As the new Air Force spectacle standard matured additional improvements were identified and implemented as a result of coordinated efforts to balance operational vision functionality with critical space constraints of newly designed Joint Service Chem/Bio protection (JSAM), head mounted cueing systems (JHMCS) and Joint Strike Fighter (JSF) headgear. Additional frame options were incorporated into the AF Aviation Spectacle Frame of Choice Program. Historical perspective and rationale of spectacle frame development for the aviator will be presented. This presentation will highlight key features, requirements, new developments, integration issues, and the scope of options available to Air Force aircrew through this program. Current and future mission impact resulting from this program will also be discussed

Learning Objectives: 1. Describe the rationale and history of aircrew spectacle standardization. 2. Identify key issue leading to implementation of this program. 3. Outline current and future mission impact resulting from the program.

[213] RELEVANCE OF METABOLIC SYNDROME IN GAF AIRCREW MEMBERS

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Introduction: According to the NCEP ATP III criteria the metabolic syndrome with obesity, dyslipoproteinemia, hyperglycemia and hypertonemia has a prevalence of 7,1% in general German population (age 16 -34 yrs) and of 21,7% (age 35-59 yrs). Besides general natural endpoints of MS like organic manifestations of diabetes, hypertensive heart disease or CAD mainly obesity related cardiocorporal and orthopedic handicaps implicate reduced operational readiness of military flying personnel with MS.

Methods: The actual prevalence of MS and risk constellation in the GAF in comparison with the general population, specific clinical and operational consequences of the MS in the GAF as well as the difficulties towards an effective therapeutic approach are demonstrated.

RESULTS: According to PROCAM-CVR-study-data GAF airmen (age 40-59 yrs) show a significantly lower 10 - year risk for cardiac events (3,5 - 6,5 %) compared with general male population (5 - 11,5 %), possibly because of higher health standards, specific motivation and a consecutive aeromedical care within this subpopulation. Prevalence of metabolic syndrome in this group is equally lower (5 /16 %) whereas the individual outcome concerning the longterm consequences of MS doesn't differ from general population.(30%). Considering operational readiness, we

experienced obesity to be of most important concern, mostly resulting in insufficient physical fitness and secondary orthopedic disabilities (> 50%), causing themselves a circulus vitiosus towards MS by immobilisation and uncalculable restrictions for demanding deployments.

Conclusion: The metabolic syndrome is implicating complex short-term and longterm risks for a reliable operational readiness under actual conditions. From all known risks obesity seems to be of most important concern and has to be prevented by all means. That includes participation in professional anti - obesity- programs which have been introduced in the GAF, stringent guidance by the flight surgeon and finally a specific risk awareness and sense of responsibility in our airmen with MS.

Learning Objectives: 1. Awareness of essential impacts of MS for operational readiness of military flying personnel.

Tuesday, May 13

9:30AM

POSTER: Health Promotion & Wellness

[214] IMPACT OF HEALTHY LIVING PROGRAM ON MISAWA AIR BASE AIRMEN

J. A. STRYD

USAF, APO, AP

Individual level of fitness has a direct link to duty performance in garrison or at a deployed location. The Misawa Health and Wellness Center uses the Air Force Healthy Living Program (HLP) to teach fitness. The goal is to analyze and benchmark the length of time Air Force members who initially did not pass the fitness assessment took to receive a passing score after attending the HLP. A statistical analysis was performed on the data documented in the Air Force Fitness Management System database. As per the 2004 Air Force fitness assessment standard, a member is considered not passing if they score below 70 points out of 100 and passing if they score 70 points or greater. This study tracked 127 Airmen that did not pass the Air Force fitness assessment from November 2004 to April 2005 for 24 months or until they passed the fitness assessment, which ever came sooner. The results suggest that 94% were able to raise their score to 70 points or greater after attending HLP. Further analysis of the 94% of the members who passed suggests that 82% were able to pass within 12 or fewer months while 18% took over 12 months. In summary, the majority of Air Force members in this study who were not passing the fitness assessment passed within twelve months after attending the HLP. However, there is a significant number of members that either required more than 12 months to pass the fitness assessment or did not pass. It is recommended this study be repeated because in September 2007 the Air Force raised the passing fitness score to 75 points. This change may affect the rate of members passing the fitness assessment. Additionally, a further study of those members who have difficulty passing the fitness assessment is recommended.

Learning Objectives: 1. The impact of the healthy living program on passing the Air Force Fitness assessment of Airmen that initially could not pass.

[215] THE EFFECTS OF OBESITY ON FIGHTER'S AND TRANSPORTATION PILOTS EFFICIENCY

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K. M. KHALIL⁴

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Introduction: The physiological influence that facing pilot in the air; force us to study how to maintain pilot physical & medical fitness to make him efficiently accomplish the required missions. We must handle obesity as any other disease regarding its effect to the body that might lead to a very serious illness that can directly affect some of the important body organs such as heart, bones, veins & arteries. The main objective of this paper is to discuss the optimum methods to avoid obesity & its harmful diseases. Obesity is a very important subject that will influence people's lives & their attitudes, how they live, act & eat specially for pilot. **Methods:** This study was prepared during a period of five (5) years from October (2001) to September (2006) by reviewing and analyzing the records of flight surgeons in different Air force bases affiliated to the Jordan Air Force.

Results: A total number of (192) pilots of our selected group aged (25-45) years with main age of (40) years mainly the transportation pilots, evaluated physically and psychiatrically and found that (30) persons (15.7%) of them to have mild fatigue and increased in the risk factors of Hypertension, and IHD due to obesity. **Conclusion:** The over weight does not worry us as some other diseases but we agree that this over weight must be defeated to avoid the undetermined consequences affecting the human body. Loosing weight now is a science with basics, rules and principles, so we can early get rid of the over weight easily by avoiding certain types of food and enhance the physical and mental activities.

Learning Objectives: 1. Pilots job requires great effort physically & mentally so medical recommendation to eat well balanced diet. 2. In order to do hard physical exercises he should eat a lot of proteins helping him endure these hard exercises.

Tuesday, May 13

10:30AM

PANEL: ISS Research Results

(Sponsored by the Space Medicine Association)

[216] ISS RESEARCH RESULTS AND APPLICATION TO MEDICAL OPERATIONS

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³Wyle, Houston, TX

In May of 2008, we will have just finished Increment 16 of International Space Station Operations. Analysis of results from the Human Research program will be completed through Increment 14. This panel will be the first of an annual panel to share and discuss the scientific results of investigations completed on ISS. An overview of the scientific plan will be presented followed by a presentation of specific results from a selection of PI teams. The presentations will also include an overview of the results from all of the investigations and how those results may effect the conduct of Medical Operations for continued ISS flights and Explorations missions. An ISS astronaut will present the challenges of conducting experiments on ISS and the opportunities of "Discovery Science"

Learning Objectives: 1. Share scientific results of investigations completed on ISS.

[217] HUMAN RESEARCH ON THE INTERNATIONAL SPACE STATION: ENABLING EXPLORATION BEYOND LOW EARTH ORBIT

J. CHARLES

NASA, Houston, TX

The International Space Station (ISS) provides unique capabilities for investigations into the biological, physiological, psychological and medical effects of long-duration space flight on humans. These effects are associated with prolonged microgravity, exposure to space radiation, drastically altered circadian stimuli, variable atmospheric pressure and the necessity for crew autonomy in challenging operations in an unforgiving environment. The potential for new discoveries into basic physical and biological processes in this environment has led the U.S. Congress to declare a portion of the ISS as a National Laboratory. The prospects afforded by a virtually gravity-free environment in which the cellular and molecular mechanisms that underlie human diseases can be explored led the National Institutes of Health (NIH) and NASA to agree to work together in space-related health research for improving human health. In keeping with President Bush's announcement of the Vision for Space Exploration in 2004, NASA's use of the ISS became focused on understanding and mitigating the risks to astronauts' health, safety and efficiency during exploration missions beyond low Earth orbit, to the Moon and then to Mars. The NASA Human Research Program (HRP) first evaluated the known and anticipated risks of such space missions, then selected a set of about 30 high-priority risks across all areas of health and fitness, and is now using the ISS to acquire the necessary information from space flight to understand those risks, and where appropriate, to test possible countermeasures to the deleterious effects of long-duration space flight. This presentation will describe the steps involved in this effort, including internal reviews of the evidence acquired to date, assessments of the anticipated requirements of future space exploration missions, and external vetting of NASA's risks and the processes used to select them.

Learning Objectives: 1. Discussion of the steps involved in the efforts of long-duration spaceflight risks using countermeasures. 2. Review of evidence acquired and assessments of the anticipated requirements for future human space flight.

[218] EFFECT OF LONG-DURATION SPACEFLIGHT ON PROXIMAL FEMORAL DENSITY, GEOMETRY AND WHOLE-BONE STRENGTH

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Introduction: The proximal femur is the skeletal site showing the highest rate of bone density loss in long-duration spaceflight. Until recently, however, there has been no information on the effect of long-duration spaceflight and re-introduction to Earth gravity on the structure and strength of the hip. **Methods:** 16 subjects were imaged in the hip with a helical vQCT protocol and with DXA at three time points: pre-flight, post-flight, and 12 months after mission completion. At each time point we measured the mean value of areal integral hip BMD by DXA and QCT, hip trabecular volumetric BMD, proximal femoral cortical BMD and cortical tissue volume. To assess loss of whole bone hip strength, we used QCT-based patient-specific finite element modeling to compute pre-post flight difference in hip failure load in simulated fall and single-legged stance loading conditions. **Results:** Measures of hip integral and trabecular volumetric density declined during the mission by 6 and 16% respectively on average. Hip cortical BMD showed a marginal decrease of a few per cent ($p < 0.05$), whereas hip cortical tissue volume declined by 9% on average. Hip areal integral BMD and cortical tissue volume recovered to within a few per cent of baseline values within a year of the mission, but volumetric trabecular and integral BMD recovered about half of the loss by one year after spaceflight. Cortical vBMD did not change in the year after mission completion, but tended to increase in the longer term. The recovery of areal but not volumetric BMD measures was explained by an expansion of the hip periosteal area after return. Whole bone strength declined by 13-14%, depending on loading condition. **Discussion:** Our study of ISS astronauts shows substantial loss of density and strength at the hip, and that re-adaptation of the hip to Earth gravity involves geometric expansion.

Learning Objectives: 1. Will discuss the effect of long-duration microgravity exposure to hip bone density, structure and strength. 2. Discuss the geometric changes in the hip associated with re-exposure to Earth gravity.

[219] SPACE NUTRITION: LESSONS FROM THE INTERNATIONAL SPACE STATION

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Throughout history, many explorers have learned the hard way that adequate nutrition is crucial for a successful expedition. Ensuring the health and safety of astronauts is critical, and nutrition contributes in several ways to that end. Nutritional assessment of International Space Station (ISS) crew members allows us to evaluate the nutritional health of individuals and also to gain a better understanding of how space flight affects nutritional requirements, and can mitigate the negative effects of weightlessness on humans. Available data suggest that the nutritional status of astronauts is compromised during and after flight. Inadequate dietary intake and subsequent weight loss are often considered hallmarks of space flight, although exceptions have occurred. Beyond energy intake, issues also exist with specific nutrients, indicating that the problem is not simply inadequate consumption. Decrements have been noted in blood concentrations of vitamins, including vitamin D and folate. Hematological and antioxidant defense systems are also affected: iron storage and markers of oxidative damage are typically increased after flight. Bone loss during space flight remains a critical challenge. Ground-based studies have established that nutrition is a potent modulator of the bone response to simulated weightlessness. During studies of simulated weightlessness, protein and sodium are two nutrients that tend to exacerbate bone resorption and subsequent calcium loss, likely through alterations in acid-base balance. Unfortunately, the current space food system generally provides an abundance of protein and sodium, even when the total number of calories consumed is inadequate. Defining nutrient requirements and being able to provide and maintain the required amounts of nutrients on exploration missions will be critical for maintaining crew health. Ongoing research

on the ISS will allow a better understanding of the role of nutrition during space flight, which will enable exploration missions and expand our knowledge of the role of nutrition in the health of humans on Earth.

Learning Objectives: 1. Review and discuss nutritional assessments towards the health of crew members pre and post flight.

[220] STABILITY OF PHARMACEUTICALS IN OPERATIONAL MEDICAL KITS ABOARD THE INTERNATIONAL SPACE STATION

L. PUTCHA

NASA, Houston, TX

Introduction: Environmental conditions encountered during space flights may adversely affect stability of pharmaceuticals contained in the Space Operational Medical System (SOMS) aboard the shuttle and International Space Station (ISS). The purpose of this study is to estimate physical/chemical stability and dissolution/diffusion characteristics of select pharmaceutical preparations (11) flown on the shuttle and/or the ISS. **Methods:** Eleven pharmaceuticals dispensed as different dosage forms were selected based on their physical-chemical characteristics and susceptibility to environmental factors such as, temperature, humidity and light sensitivity. When available, ground-controls of the study medications with matching brand and lot numbers were used for comparison. Physical and chemical analyses of the pharmaceuticals were conducted using validated United States Pharmacopeia (USP) methods. Temperature, humidity, and radiation data from shuttle and ISS were retrieved from onboard HOB0® U12 Temp/RH Data Loggers, and from passive dosimeters. **Results:** Results indicated degradation of 5 of the 11 formulations returned from space flights. Amoxicillin / Clavulanate, promethazine, sulfamethoxazole / trimethoprim, and ciprofloxacin tablets depicted discoloration after flight. Chemical content analyses using High or Ultra Performance Liquid Chromatography (HPLC / UPLC) methods revealed that dosage forms of Amoxicillin / Clavulanate, promethazine, sulfamethoxazole / trimethoprim, lidocaine, ciprofloxacin and mupirocin had less than 95% of label claim of active ingredient required by FDA for shelf-life assurance. Results suggest that Shuttle and ISS environments affect stability and shelf life of certain medications flown on these missions.

Learning Objectives: 1. Review stability indicating variables of select pharmaceutical formulations flown on Shuttle or ISS. 2. Learn FDA shelf-life criteria and industry standard tests.

[221] BIOMEDICAL RESULTS OF ISS EXPEDITIONS 1-14

C. SAMS and J. FOGERTY

NASA, Houston, TX

This presentation is the product of on-going work by The NASA, Johnson Space Center, Space Life Sciences Directorate (SLSD). Laboratories, researchers, clinicians, and analysts from each division, Habitability and Environmental Factors Division; Human Adaptation and Countermeasures Division; and Space Medicine Division have contributed to the work presented here. The purpose is to highlight biomedical data captured during expeditions 1 through 14 on the International Space Station (ISS) via medical requirements testing and to attempt interpretation of the results thus far. Included are graphic assessments of physiological, performance, environmental, and clinical data. Physiological parameters assessed include skeletal, cardiovascular, and neurovestibular. In addition, an assessment of radiation exposure based on current models is included for discussion. Performance parameters assessed include aerobic capacity, strength, flexibility, and endurance measurements. Alterations in physiological and performance parameters reflect the affect of microgravity exposure in the face of current countermeasure protocols such as aerobic and resistance exercise. Environmental monitoring and analysis of air and water quality are summarized. This data provides an overview of the continuous station environment and examples of contamination and the subsequent remediation accomplished by the environmental control and life support system. In-flight lab testing, pre- and post-audiometry results, operational psychology and behavior indices, and in-flight medical events are reviewed and summarized in the clinical assessment. It is hoped that this presentation and its continuous updating will facilitate documentation of the physiological, performance, environmental, and clinical data generated during expeditions on the ISS as well as an understanding of the effects on the human body of long term microgravity exposure.

Learning Objectives: 1. describe microgravity associated changes in skeletal, cardiovascular, neurovestibular, aerobic capacity, strength, flexibility, and endurance measurements. 2. describe the general

characteristics of the ISS' environment. 3. cite which clinical concerns have been established on the ISS.

[222] ASTRONAUT PARTICIPATION IN MEDICAL EXPERIMENTS ABOARD ISS

S. WILLIAMS

NASA, Houston, TX

Sunita Williams, Commander, USN was selected by NASA in June 1998 for the astronaut program. She began her record-setting flight when she launched to the ISS with the crew of STS-116 in December 2006. She remained onboard the station as a member of the Expedition 14 crew and then joined the Expedition 15 crew in April, returning in June of 2007. Williams became the record-holder for most hours outside a spacecraft by a female by completing four spacewalks during Expedition 14. She also set a new record for the longest duration spaceflight by a woman, 195 days. Commander Williams will describe her experiences participating in life sciences experiments leading to medical operational results. She participated in the following experiments: Nutritional Status Assessment, Sleep-Wake Actigraphy and Light Exposure During Spaceflight, A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft Environment, Behavioral Issues Associated with Long Duration Space Missions: Review of Astronaut Journals, Renal Stone Risk During Space Flight: Assessment and Countermeasure Validation, Space Flight Induced Reactivation of Epstein-Barr Virus, and Stability of Pharmacotherapeutics and Nutrition Compounds. In addition, as part of "Saturday Science" she and her crewmates filmed several video demonstrations of the importance of exercise onboard ISS. These videos are now distributed to educators across the US to teach youth about importance of exercise.

Learning Objectives: 1. Participants will understand some of the challenges inherent in the execution of scientific experiments on ISS.

Tuesday, May 13

10:30AM

PANEL: Aviation Safety: 2007 Year in Review--II

[223] U.S. NAVAL AVIATION SAFETY: FY 2007 IN REVIEW

J. LEE¹, J. ALTON¹, K. BROOKS¹, D. DELOREY¹ and D. WHITE²

¹Naval Safety Center, Norfolk, VA; ²USFF, Norfolk, VA

Purpose: Identify the primary human factors associated with fiscal year 2007 Naval class A flight mishaps. **Methods:** Causal Factors from 16 Naval Class A flight mishaps were obtained from the Naval Safety Center database and analyzed using the DoD's Human Factors Analysis and Classification System (HFACS). **Results:** The overall Naval aviation mishap rate for FY 07 was 1.24 mishaps per 100,000 flight hours, down from last year's rate of 1.48. In FY 07, the Navy had a decrease in their mishap rate (0.98 vs. 1.44), while the Marines have an increase (1.89 vs. 1.59). Human error was found to be a causal factor in 81% of these mishaps; an increase from last year's 70%. The rate of material failures for the Navy has decreased and the Marines rate of material failures have remained constant compared to FY 06. **Discussion:** FY 07 finds the Naval rate 1.24 mishaps per 100,000 flight hours to be below the 10 year running average of 1.85. In FY07, the USN rate is half of the Naval ten year running average, and the USMC rate is at the Naval ten year running average. **Conclusions:** The trend of Naval aviation mishap rates continue to show a steady decline particular in the last 3 years.

Learning Objectives: 1. The audience will learn about Naval efforts to utilize aviation mishap data to develop proactive intervention strategies to prevent future mishaps.

[224] CANADIAN FORCES: AIRCRAFT ACCIDENT REVIEW FOR 2007

T. M. SARDANA¹ and M. CLAVET²

¹Canadian Armed Forces, Ottawa, Ontario, Canada; ²Canadian Forces, Chicoutimi, Quebec, Canada

The Canadian Forces Directorate of Flight Safety (DFS) maintains an extensive database on all CF aircraft accidents and incidents. As part of this growing international panel, the status of CF aircraft accident and incidents will be presented. Specifically, the CF experienced an air accident rate of 1.24 per 10000 flying hours in 2007. The CF experienced one fatality in 2007, 1 very serious injury, 2 serious injuries and 47 minor ones. If only

CF aircraft are taken into account then, the CF experienced a total of 2252 occurrences including 11 accidents and 2241 incidents. If we include UAV's and Air Cadet organization flying statistics then these numbers would increase to a total of 2393 occurrences including 20 accidents and 2373 incidents. As part of the presentation, significant accidents and incidents will be presented, and data driven analysis and intervention strategies will be described from a CF-HFACS perspective.

Learning Objectives: 1. CF aviation accident rates. 2. Data driven analysis of aviation accidents and incidents and intervention strategies.

[225] U.S. AIR FORCE AVIATION SAFETY: FY 2007 YEAR IN REVIEW

K. A. HEUPEL, B. T. MUSSELMAN, T. G. HUGHES and

E. R. DOPSLAF

U.S. Air Force Safety Center, Kirtland AFB, NM

Introduction: Discuss fiscal year (FY) 2007 statistics and analyses for USAF Class A Aviation mishaps including classification with DoD Human Factor Analysis and Classification System (DOD-HFACS). **Methods:** FY 2007 data was obtained from the USAF Safety Center database for Class A Aviation mishaps and reviewed for human factors as determined by the Safety Investigation Boards (SIB). The human factors present were categorized for the present year and the preceding 4 years. **Results:** The US Air Force experienced 26 Class A rate-producing Aviation mishaps during FY07 (a rate of 1.28 per 100,000 flight hours) with 14 destroyed aircraft. There were a of 35 total Class A Aviation mishaps and of these, Procedural Guidance/ Publications, Acquisition Policies/Design Processes and Organizational Training Issues were the most prevalent. Cognitive Factors and codes for fatigue and perceptual factors were the most prevalent preconditions with judgment and/or decision making errors as the most prevalent acts. **Discussion:** Overall, the number and rate of Class A Aviation mishaps increased from FY06, however the majority of human factors identified as contributing to these mishaps has remained consistent in proportion and type.

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

[226] U.S. CIVIL AVIATION IN 2007

C. A. DEJOHN, N. L. WEBSTER and J. LARCHER

FAA-CAMI, Oklahoma City, OK

The Civil Aerospace Medical Institute's, Medical Research Team supports Federal Aviation Administration (FAA) safety programs. The Team provides aviation safety research findings to the FAA, National Transportation Safety Board, industry, other government agencies, academia, and the media. In addition, the team works with other safety elements within the FAA such as the Office of Accident Investigation, Office of System Safety, and the Office of Aviation Research to promote safe and efficient aviation operations worldwide. Safety statistics for 2007 will be presented and compared with previous years as well as a detailed review of a high profile 2007 aircraft accident. In addition, an update on the progress of current aviation safety intervention strategies and initiatives, contained in the Administrator's Flight Plan for 2008 – 2012, will be discussed. These initiatives include the Agency's NextGen progress and a briefing on the implementation of the Automatic Dependent Surveillance - Broadcast (ADS-B), Traffic Information System – Broadcast (TIS-B) and Flight Information System – Broadcast (FIS-B) systems.

Learning Objectives: 1. Safety statistics for 2007 will be presented and compared with previous years as well as a detailed review of a high profile 2007 aircraft accident.

Tuesday, May 13

10:30AM

PANEL: Show Me the Evidence II: Regulatory Risk Management

[227] "SHOW ME THE EVIDENCE!": REGULATORY RISK-MANAGEMENT, DECISION-MAKING, AND PHILOSOPHY

D. WATSON¹ and A. D. EVANS²

¹Civil Aviation Authority, Wellington, New Zealand; ²International Civil Aviation Organization, Montreal, Quebec, Canada

This panel is a continuation of the "Show me the evidence!" series. Our underlying premise is that making reasonable, replicable, and reviewable aeromedical decisions requires the "conscientious, explicit and judicious use of current best evidence" in conjunction with the assessment and 'management' of the risks that are identified. In this panel we explore the theory, philosophy, and underlying reasoning behind evidence-based aeromedical risk-management. In this panel our explorations include: the underlying risk criteria that are applied to aeromedical risk management; the abuse of evidence and logic in an aeromedical context; the suitability of formalised Safety Management Systems for aeromedical application; and the application of evidence and risk management to determining the safety suitability of operational tools.

Learning Objectives: 1. An understanding of some of the limitations and underlying principles that apply to evidence-based aeromedical risk management.

[228] THE UK EXPERIENCE OF CERTIFICATING PILOTS AFTER TIA

S. A. EVANS and P. C. HOWGILL

UK CAA, Gatwick Airport South, West Sussex, United Kingdom

The application of the UK CAA certification policy concerning TIA in pilots will be discussed, utilising 3 sample cases. The aeromedical interpretation of the investigative data will be demonstrated. The progress of the pilots that are returned to flying duties after TIA will be presented.

Learning Objectives: 1. To understand the risk stratification technique in assessing pilot's fitness to fly after TIA.

[229] TRANSIENT ISCHEMIC ATTACKS IN CIVILIAN AVIATORS

R. BISSON

FAA-CAMI, Oklahoma City, OK

Background: Transient ischemic attack (TIA) is a common neurological problem in aviators. The reported incidence in various populations ranges from 10 to 56 per 100,000 per year. Potential safety hazards include sudden incapacitation, high risk of recurrence, and completion of a cerebral vascular accident with persistent neurological deficits. Generally, the Civil Aerospace Medical Institute (CAMI) requires a two (2) year recovery period following TIA for consideration of issuing an airman medical certificate. If a cause can be determined and corrected, (e.g. atrial fibrillation, carotid atherosclerotic lesion, basilar artery dissection) an applicant may be considered in less than the two (2) year recovery period. Carotid ultrasound and a cardiovascular evaluation including echocardiogram and stress testing are required. **Methods:** This presentation reviews the aeromedical disposition of over 25 cases of TIA evaluated for certification or re-certification at CAMI over a two-year period ending in October 2007. The case series illustrates common presentations, complications, and co-morbidities of TIA in civilian aviators seeking certification. **Results:** Most airmen presenting with a history of TIA are certified after a two year waiting period. Those not certified have recurrent attacks, develop a persistent deficit during the waiting period, present with other disqualifying diagnoses, or are waiting to satisfy the two year interval requirement. The case series includes airman with TIAs due to large artery-low flow sources of emboli (e.g. carotid stenosis); embolic TIAs from extracranial sources (e.g. atrial fibrillation); and lacunar TIAs (e.g. stenosis of the middle cerebral, basilar or vertebral intracerebral penetrating vessels). Cases presenting for re-certification and cases denied certification provide some evidence for risk management and aeromedical disposition. **Discussion:** Demographics of the case series will be presented. The criteria for return to flying, limited follow-up experience, and suggestions for future surveillance will be discussed.

Learning Objectives: 1. The demographics and common presentations of TIA in civilian aviators is described. 2. The audience will learn the criteria used to issue an airman medical certificate to a pilot with history of TIA. 3. Evidence for risk management of the aeromedical disposition of TIA and suggestions for future surveillance will be discussed.

[230] SAFETY MANAGEMENT AND AVIATION MEDICINE

A. D. EVANS

International Civil Aviation Organization, Montreal, Quebec, Canada

The International Civil Aviation Organization (ICAO) requires air traffic service providers and aerodrome operators to have in place a

safety management system. From January 2009, this is also required of aircraft operators. Safety management involves the management of safety in a similar manner to managing other aspects of an organization, such as finance, marketing, personnel etc. It requires high level management commitment, including commitment of resources, and a positive organizational culture. The underlying principle is to identify hazards early, and then proactively implement appropriate risk mitigation strategies. It is a fundamentally different approach from the traditional method of retroactively reducing risks after investigation of an accident or serious incident. Whilst many States have adopted safety management as a system for improving flight safety, few have done so in the field of aviation medicine. This presentation will describe safety management principles, and show how such a system may be utilised in regulatory aviation medicine.

Learning Objectives: 1. Knowledge of safety management. 2. Application of safety management principles to aviation medicine.

[231] PILOTS IN PERIL: PITFALLS OF PULSE OXIMETRY

D. M. CONNOLLY

QinetiQ plc, Farnborough, Hampshire, United Kingdom

Modern unpressurised, turbocharged, single-engine aircraft are used increasingly for flight at altitudes up to 25,000 ft and a plethora of portable oxygen system components are available to augment on-board systems for protection against hypobaric hypoxia. Additionally, pulse oximetry is marketed widely and enthusiastically for in-flight monitoring of oxygenation, but with little clear guidance on its use or interpretation while its limitations go unrecognised. The hazard is highlighted by a recent fatal accident in a twin-engine Beech 56TC that is attributable to hypoxic incapacitation of the pilot at 27,000 ft, despite having an aircraft oxygen system, an improvised portable system and a pulse oximeter. This presentation questions the validity of the premise underpinning the use of oximetry in general aviation from practical, physiological and procedural perspectives. First, some simple ergonomic concerns will be identified. Next, with regard to reliable detection of hypoxia, the issues of sensitivity (false negatives) and specificity (false positives) will be highlighted, respectively, by reviewing the influences of hyperventilation and motion artefact. Finally, in-flight oximetry demands a rigorous procedural approach encompassing monitoring frequency, unambiguous acceptable minimum 'action' limits, and responses that may be initiated easily under presumed hypoxic conditions. At best, oximetry may have an adjunctive contribution to make to flight safety in unpressurised light aircraft at altitude, but it cannot substitute for effective regulation and licensing, the appropriate use of well maintained oxygen systems that are fit for purpose, approved pilot instruction/training, and good airmanship. At worst, inappropriate reliance on oximetry might even increase the risk of mishap in the event of hypoxic challenge. It is concluded that casual or unquestioning reliance on oximetry is inappropriate and users should be informed of the current limitations of peripheral pulse oximetry in general aviation.

Learning Objectives: 1. Limitations of oximetry at altitude. 2. The nature of hypobaric hypoxia.

[232] FURTHER DEVELOPMENT OF INCAPACITATION RISK CRITERIA CONCEPTS

S. J. MITCHELL

UK Civil Aviation Authority, UK, United Kingdom

What is considered acceptable medical incapacitation risk for aircrew in the UK and other states, for the past 20 years, has been based on a mathematical construct known as the '1% rule'. To meet an all cause target accidental risk of 1 in 10 Million flying hours, a target risk of any subsystem failure (pilot incapacitation) is postulated to be 1 in 1000 Million. If the first and last 3 minutes (i.e. 10%) of a 1 hour flight are considered critical (i.e. when an incapacitation can result in a crash) and there is a 1 in 100 chance of the 2nd pilot not safely taking over control, then a pilot in a 2-crew operation can meet the target risk by having a 1% medical risk per calendar year (10,000 hours). The mathematical basis for the 1% rule can be challenged on two counts. Firstly, the average flight duration is now over double that assumed in the original derivation. Secondly, that the way modern aircraft are operated, with increased automation and improved CRM techniques and training, has substantially reduced the chances of incapacitation of one of the flight crew resulting in an accident during the flight. Hence the proportion of the flight that is considered "critical" requires updating. This presentation introduces the concept of critical sub-phases of flight where the risk and consequences of failed transfer of control vary with time, rather than being the constant that is assumed in

the original derivation of the 1% rule. This points to a more operationally relevant method of assessing what might be considered acceptable medical incapacitation risk.

Learning Objectives: 1. Understand and apply more advanced risk assessment concepts for determining medical standards for pilots.

[233] GOOD EVIDENCE, BAD DECISIONS: THE USE AND ABUSE OF EVIDENCE IN AEROMEDICAL DECISIONS AND DEBATES

D. WATSON, P. D. NAVATHE and C. G. PREITNER
Civil Aviation Authority (New Zealand), Wellington, New Zealand

"Lies, damn lies, and ". Apologies to Disraeli and Twain, but figures do often beguile us, and we are all familiar with the abuse of statistical information. Most of us have witnessed a master, having had the "arranging" of the figures to themselves, meticulously disassemble a body of evidence and turn it on its head and many of us, while quietly discomfited by the result, will be unable to recognise the fallacies and abuses of evidence that littered the path to the alternative conclusion. Evidence-based aeromedicine is not simply gathering the current best evidence, we must also apply it conscientiously, explicitly, and judiciously to our decisions. Our application of that best evidence will be doubly tested when we are faced with passionately argued or seductively reasoned counter-arguments, or simple conundrums in logic or ethics. In reaching our decisions, and in analysing some counter-arguments, we must exercise care that our evidence is appropriate, our logic is sound, and that our conclusions are those that should be reached from that evidence and logic. In this presentation we discuss some of the more common fallacies, abuses, and conundrums of evidence that engage us, including:

- The relationship between the absence of evidence and evidence of absence;
- The fact that no-one has a 1% per annum chance of an incapacitating event;
- Arguments that population statistics should not, and cannot, be applied to individuals;
- Abuses of Bayes theorem and conditional probabilities; and
- The straw man and argumentum ad populum fallacies.

Samuel Johnson clearly was not aware of the global reach and importance of future aeromedical decision making when he observed that "The mind is seldom quickened to very vigorous operations but by pain, or the dread of pain. We do not disturb ourselves with the detection of fallacies which do us no harm."

Learning Objectives: 1. The recognition of common abuses of evidence and fallacies of logic.

[234] OPERATIONAL VS MEDICAL RISK IN COMMERCIAL OPERATIONS

S. J. MITCHELL and S. A. EVANS
UK Civil Aviation Authority, Gatwick Airport South, United Kingdom

For many years in the UK, within Europe and elsewhere, acceptable medical incapacitation risk limit criteria have been developed from a concept of anticipated fatal accident risks in large public transport jet aircraft using an engineering approach to human system failure. Although large jet public transport forms the significant majority of professional flying hours undertaken, smaller undertakings of commercial air transport, public transport and aerial work have differing exposures to operational risk and a similar approach may be difficult to justify. The medical risks of pilots undertaking the vast majority of public transport operations are mitigated by having a 2-pilot crew. The single pilot situation poses an increased challenge as the potential outcome of partial or complete medical incapacitation is more likely to be an accident. This presentation explores the variety of operations from both fixed-wing and rotary worlds, and attempts to compare operational risks and consequences of medical incapacitation between the different operations so as to inform policy-makers on a more consistent approach to regulation of individuals with potentially incapacitating conditions.

Learning Objectives: 1. To understand the contribution of medical risk to a wide range of commercial operations and how it informs fitness assessment.

Tuesday, May 13

10:30AM

SLIDE: Motion Sickness and Things That Affect It

[235] THE EFFECTS OF SMOKING NICOTINE TOBACCO VERSUS SMOKING DEPRIVATION ON MOTION SICKNESS

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Background: Habitual smokers use "puff-by-puff self-dosing" to render the nauseating effects of nicotine overdose sub-threshold for conscious experience. It is postulated that there is a varying "dynamic threshold for nausea" whose level can be probed objectively by motion sickness susceptibility, and without involving additional chemical challenges. Our opposing hypotheses were: (i) nicotine promotes motion sickness whereas deprivation protects; (ii) pleasurable effects of nicotine protect against motion sickness whereas adverse effects of withdrawal have the opposite effect. **Methods:** Twenty six healthy male (n=9) & female (n=17), habitual cigarette smokers (mean +/- SD) 15.3 +/- 7.6 cigs/day, age 29.9 +/- 9.4 years, were exposed to a provocative cross-coupled (coriolis) motion continued to the point of moderate nausea. The motion stimulus was whole body rotation on a turntable during which subjects executed a set of eight head tilts of approximately 45° during each 30s period. Rotational velocity commenced from stationary and incremented as a staircase profile in steps of 3°/s step every 30 s. Subjects were tested after either ad-lib normal smoking (SMOKE) or after overnight deprivation (DEPRIV), according to a repeated measures design counter-balanced for order with 1-week interval between tests. **Results:** Deprivation from recent smoking was confirmed by objective measures: exhaled carbon monoxide CO was lower (p<0.001) for DEPRIV (8.5 +/- 5.6 ppm) versus SMOKE (16.0 +/- 6.3 ppm); resting heart rate was lower (p<0.001) for DEPRIV (67.9 +/- 8.4 bpm) versus SMOKE (74.3 +/- 9.5 bpm). Mean +/- SD sequences of head movements tolerated to achieve moderate nausea were more (p=0.014) for DEPRIV (21.3 +/- 9.9°) versus SMOKE (18.3 +/- 8.5°). **Conclusions:** Tolerance to motion sickness susceptibility was aided by short-term smoking deprivation, supporting Hypothesis (i) but not Hypothesis (ii). The effect was approximately equivalent to half of the effect of an anti-motion sickness drug.

Learning Objectives: 1. The acute aversive and rewarding effects of nicotine are briefly reviewed. 2. The influence that nicotine and nicotine deprivation may have on tolerance to motion sickness is explained.

[236] EFFECT OF SLEEP ON THE ADAPTATION TO THE CROSS-COUPLED STIMULUS

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Introduction: Artificial gravity (AG) is a promising comprehensive countermeasure for spaceflight physiological deconditioning. A potential problem with AG is the negative effects associated with head rotations about axes other than the axis of centrifuge rotation. These head rotations result in a cross-coupled stimulus (CCS) to the vestibular system that elicits inappropriate vestibular-ocular reflex (VOR) eye movements, a perceived tumbling sensation, disorientation, and motion sickness. Previous studies have shown that, given an adequate training protocol and enough time, subjects can adapt to this stimulus. This study examines the effect of sleep on the adaptation to the CCS. **Methods:** Subjects were split into two groups. Each group attended three experimental sessions over a two-day period in which they performed a series of head turns while spinning at 23rpm. Group A attended *morning-evening-morning* sessions and Group B attended *evening-morning-evening* sessions. A total of 33 subjects participated in the experiment. Subjective reports of tumbling intensity and motion sickness were recorded together with eye movement data. Adaptation is quantified as a decrease in any of the recorded measures. **Results:** Based on the tumbling intensity, the difference in adaptation between the first two sessions of groups A and B suggests a positive effect of sleep in the adaptation to the CCS (p=0.027). Time of day does not have an effect on the tumbling intensity, yet there is a significant effect on motion sickness susceptibility (p=0.024), with motion sickness being lower in the evening sessions. **Discussion:** The results suggest that sleep accelerates the rate at which adaptation to AG is consolidated. Arranging two spinning sessions without a sleep interval between them is not efficient. Evening training sessions may be preferable to morning ones in order to decrease motion sickness incidence.

This research was supported by the National Space Biomedical Research Institute (NSBRI) grant NA00406.

Learning Objectives: 1. To understand some of the potential problems associated with artificial gravity. 2. Some of the factors that affect the adaptation to the cross-coupled stimulus will be discussed.

[237] CONSIDERATIONS OVER SENSORIAL DISCRIMINATION DURING YAW ROTATION ON 60 MILITARY SUBJECTS

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Introduction: This experiment does not aim at challenging current paradigms, but instead we focused on a more practical problem: to see if there is a difference between vestibular sensorial discrimination among various groups of military pilots as we observed that certain SD profiles work more efficient for some pilots. **Methods:** We employed 60 subjects. The subjects were screened for motion sickness sensitivity. We formed 6 groups, coded HEL for rotary wing, MIG for supersonic combat, SUB for subsonic combat, TRA for transport pilots, PAR for paratroopers and ZER for ground military. We created a custom profile for a SD trainer, allowing progressive angular acceleration. The subjects, blindfolded, were required to mark the first perceived sensation (coded aprimar) and also the threshold of positive motion identification (accurate direction) (coded areal), measured in dgr/sec^2 . **Results:** First, the values of areal were more uniform both between groups and inside each group, although closed to the maximum threshold (around 2.4 of 3 max). Also, a number of subjects (21 of 60) were unable to get a definite perception until the end so we had to attribute the maximum value to them. For aprimar discrimination, SUB had a good sensitivity (60% of them under 1) and for areal SUB and MIG pilots had a better discrimination. The statistical significance of groups differences were $p=0.0304$ (ANOVA) with 0.005 (Chi sq) for areal and $p=0.15$ (ANOVA) with $p=0.44$ (Chi sq) for aprimar. Possible reasons for statistical differences are discussed in detail. **Discussion:** For the majority of the subjects (78.33%), the primary threshold was higher than the literature limit (0.6), experimental setup and the specific training of the subject being accountable for that. We do not aim to challenge the standard value, but we want to underline that there is a variance between individuals and more, that variance could be attributed within certain limits to their aviation background. Further tuning of SD demonstration profiles according to such variations could be benefic for proficient training.

Learning Objectives: 1. Not all pilots may have the same response to a certain SD profile. Fine tuning them to individual or at least group needs may pay off.

[238] HEART RATE AND BLOOD PRESSURE VARIABILITY DURING MOTION SICKNESS

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Introduction: Motion sickness (MS) may be associated with altered hemodynamics. Low frequency oscillations (LF; 0.04-0.15 Hz) may represent sympathetic outflow and high frequency oscillations (HF, 0.15-0.4 Hz) may represent parasympathetic and respiratory influences. We hypothesized that increased HR and BP during MS would be associated with changes in the occurrence of LF and HF in R-to-R intervals (RR_i) and mean arterial pressure (MAP). **Methods:** Eighteen healthy human volunteers were instrumented for RR_i (ECG) and blood pressure (PortapresTM). After 5 minutes of baseline, subjects were exposed to OVAR (15 revolutions/minute, 12° tilt) to induce MS. MS symptoms were rated from '1' (none) to '5' (severe) with '3' as moderate (ModMS). OVAR was terminated when symptoms became severe or after 15 minutes. Subjects fell into 2 groups; 1) OVAR-sensitive (ModMS; n=9) and 2) OVAR-resistant (non-ModMS; n=9). **Results:** OVAR-sensitive, but not OVAR-resistant subjects had significant decreases in RR_i from baseline ($-16.8 \pm 2.2\%$ vs. $-2.7 \pm 2.6\%$). Neither group had changes in RR_i-LF or RR_i-HF. OVAR-sensitive had RR_i-LF and RR_i-HF changes of $54.2 \pm 44.2\%$ and $170.5 \pm 164.4\%$ while OVAR-resistant had RR_i-LF and RR_i-HF changes of $26.7 \pm 29.6\%$ and $-19.9 \pm 22.5\%$ from baseline. OVAR-sensitive, but not OVAR-resistant subjects had significant increases in MAP from baseline ($19.2 \pm 3.3\%$ vs. $5.4 \pm 3.0\%$). Both groups had significant changes in MAP-HF but not MAP-LF oscillations. OVAR-sensitive had MAP-LF and MAP-HF changes of $104.1 \pm 64.4\%$

and $1386.5 \pm 562.7\%$ * while OVAR-resistant had MAP-LF and MAP-HF changes of $28.2 \pm 28.9\%$ and $857.6 \pm 176.4\%$ * from baseline. **Conclusions:** OVAR-sensitive subjects, despite reduced RR_i, had insignificant changes in RR_i-HF and RR_i-LF suggesting that changes in RR_i may be independent of RR_i-LF and RR_i-HF oscillations during MS. OVAR-sensitive subjects had a significant increase in MAP, however both groups had significant increases in MAP-HF suggesting that OVAR may alter MAP-HF independent of MS-induced increases in MAP. Asterisks denote a significant change from baseline ($p>0.05$).

Learning Objectives: 1. To explore the relationship motion sickness and changes in hemodynamics.

[238] SIMULATOR SICKNESS IN HELICOPTER TRAINER

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Introduction: Flight simulators are safe and cost-effective training tools, however they may be associated with motion sickness-like symptoms (Simulator Sickness "SS"). These symptoms have been reported to persist for hours to days following the training experience. The objectives of this study were to characterize the prevalence and degree of SS in a new simulator. **Methods:** The simulator is a Helicopter Aircraft Weapon System Trainer (HAWST). Participants were experienced helicopter pilots. They filled out a pre-exposure SS questionnaire and a motion sickness history questionnaire. Training protocols included 3 sequential flights (1. low altitude daylight flight, 2. low altitude night-time flight, 3. instrument only flight). Questionnaires were filled after each training session and 12 and 24 hours following the training session. **Results:** 98 subjects participated in this study. The average score after each session was 14-20.6 with high variability (maximal score 101). The highest scores were associated with a low altitude night time flight. Previous complaints of motion sickness during ship cruise, aircraft flight, simulator flight and theme park attractions ride, as well as general motion sickness sensitivity were associated with higher score of SS ($p<0.05$). We found that subjects with pre-exposure severity score $7.48 \leq$ (two mild or one moderate/severe symptom at least) were more likely to experience severe SS ($p<0.05$). 50 and 48 subjects (with scores similar to the total group) were followed respectively 12 and 24 hours after training. Twelve hours after training 5 (10%) subjects reported significant symptoms (score ≥ 10). **Conclusion:** Relatively high scores of SS were reported when training with this simulator, which may be partly due to the specific flight patterns which accentuate the visual limitations of the simulator. SS prevalence after 12 hours is not negligible and may cause safety problems during driving or flying after training. SS score ($7.48 \leq$) before the training and history of motion sickness may predict higher severity of SS.

Learning Objectives: 1. Evaluating simulator sickness symptoms and the implications on safety and efficacy of simulator trainings.

[240]-FLIGHT SUCCESS RATE OF AIRSICKNESS DESENSITIZATION PROGRAM

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Introduction: Motion Sickness (MS) occurs when the body sensors send conflicting signals to the brain and affects aircrews, especially at the beginning of their flight career. According to the international statistics, in the ITAF about 35% of student pilot/navigator suffer airsickness during the initial flying activity. However, airsickness can affect also operational aircrew during a continuous flying status and/or after a layoff period. **Methods:** 27 individuals underwent to desensitization programs in the period Sept 2000 - Sept 2007. The ITAF experimental program is a 10-day schedule: in day 1 a CST (Coriolis Stress Test) is performed to evaluate MS severity; each day, 4 provocative sessions are performed at increasing rotational speeds; in day 10 the final CST is performed to evaluate the adaptation to be occurred. During all the desensitization program days, a psychological support is provided by an aviation psychologist, through Autogenic Therapy (AT) techniques (by Schultz). **Results:** 32 programs were conducted in 27 individuals, due to 5 airsickness relapses during flying activity. 18 were student pilots, 4 were operational pilots and 5

were operational navigators. 2 of the subjects, both student pilots, did not achieve the goal of the desensitization program, showing at the final CST a rate of 6 (nausea) over 10. Further 6 individuals did not graduate at the flight school (3) or at the operational conversion unit (3) due to MS.

Discussion: A preliminary personality examination should be administered to pre-evaluate the potential benefits of the desensitization program: subjects affected by airsickness related to psychological conflicts or fear of flying and not to a physiological mismatch could show a less consistent success rate, and a final assignment to low performance aircrafts.

Learning Objectives: 1. To understand the psycho-physiological mechanisms involved in the airsickness desensitization program. 2. To understand the role of physiological adaptation versus personality models in airsickness occurrence.

Tuesday, May 13

10:30AM

PANEL: Physiology in the Extreme Environment

(Sponsored by the Aerospace Physiology society)

[241] PHYSIOLOGY IN THE EXTREME ENVIRONMENT: OPERATIONAL CONSIDERATIONS

J. B. ESSEX¹ and J. SUNDSTROM²

¹Naval Air Systems Command, California, MD; ²USAF, Beale AFB, CA

An increased operational tempo coupled with a diverse range of challenging environmental extremes creates challenges for mission planners and the operational forces who are asked to carry out the mission. It is incumbent upon the aeromedical professionals who provide operational commanders with a wide range of clinical, training and safety related support to have an understanding of the various environments, and their unique aeromedical issues, so they can provide sound recommendations to mitigate detrimental physiological risks and enhance performance. This panel will provide an overview of Extreme Operational Environments and present information on Altitude, Circadian Dysfunction, Sustained Operations, Thermal Stress and Nutritional considerations.

Learning Objectives: 1. Participants will gain an understanding of physiology in the extreme operational environment.

[242] HELICOPTER IN-FLIGHT ENVIRONMENTAL CONDITIONS DURING SUMMER DESERT MISSIONS

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¹NAVAIR, Patuxent River, MD; ²NSAWC, Fallon, NV

Introduction: While three reports from USMC and USN helicopter squadrons over the last two years have indicated ambient temperatures during Operational Iraqi Freedom are extreme, little objective data have been collected to provide guidance to develop mitigation technologies. **Methods:** Temperature and humidity (RH) data were collected during ten H-53 helicopter missions in central and western Iraq from 24-31 August 2006 as the aircraft transited between various ground locations over the course of several hours. Twenty pilots and 29 crewmembers wore TRH-1000 temperature and relative humidity data loggers (ACR Systems, Inc) placed in custom made mesh pockets and attached to the front of their survival vests. Cabin vs. cockpit and ground vs. in-flight conditions were compared using ANOVA with a Tukey-Kramer Multiple-Comparison Post-Hoc Test (significance set at $p < 0.05$). **Results:** Cockpit measurements reached as high as 53.8°C/21.1%RH and cabin conditions peaked at 65.7°C/13.5%RH. As an example, on 26 Aug the cockpit was significantly warmer ($p < 0.001$) and drier than the cabin ($p < 0.01$) throughout a 5.5 hr mission. Mean cockpit conditions were: 43.85±4.16°C (range 36.55 to 50.04°C), 7.93±3.13%RH (range 1.8 to 16.93%RH); mean cabin conditions were: 41.38±5.40°C (range 32.27 to 48.57°C), 9.81±3.92%RH (range 2.36 to 21.08%RH). **Discussion:** Given the lack of physiologic data and therefore little objective evidence of physiologic heat stress, the degree of risk naval aircrew face during routine desert missions is unknown. Using these and additional data collected during 2007, a project is currently underway that simulates the physical workload, clothing, mission duration, and aircraft thermal conditions in the NAVAIR environmental chamber. Cognitive and physiologic responses from twelve volunteers will be measured. Through this simulation, it will be possible to determine the

physiologic and performance consequences of conducting operations under these conditions.

Project sponsors: MAG-16, NAVAIR 4.6T, NAVAIR 4.6.5.6, PMA202

Learning Objectives: 1. To understand the actual mission environmental conditions helicopter crews are exposed to during summer desert operations.

[243] PERFORMANCE AND ALTITUDE ILLNESS ASPECTS OF MILITARY OPERATIONS IN HIGH MOUNTAINOUS REGIONS

S. R. MUZA

US Army Research Institute of Environmental Medicine, Natick, MA

As seen in Central and West Asia, the Balkans and South America, mountainous terrain provides sanctuary for hostile forces. This harsh environment lessens U.S. military technological superiority by limiting use of air support and crew-served combat vehicles. This places the burden of combat on dismounted warfighters. U.S. military operations emphasize the rapid deployment and mobility of troops to conduct operations for sustained periods without relief. However, rapid deployment of unacclimatized troops to high mountainous environments causes debilitating effects on fighting capabilities and force health. All unacclimatized warfighters experience marked decreases in physical and cognitive performance at elevations above 1,500 m. Between 2,000 to 4,000 m the incidence and severity of Acute Mountain Sickness (AMS) in unacclimatized soldiers rapidly increases from ~20% to ~70%. Altitude acclimatization effectively decreases susceptibility to AMS and improves work performance, but acclimatization can take 6-14 days of continuous exposure to high altitude. In lieu of acclimatization, available medications that reduce AMS also impair work performance and have other adverse responses. This presentation will: 1) review the relationship between altitude and arterial oxygen transport, 2) describe key physiologic adaptations comprising altitude acclimatization, 3) describe the effect of increasing altitude on physical and cognitive work performance capacity and susceptibility to altitude illness, and, 4) highlight current R&D efforts to sustain warfighter health and performance in high mountainous environments.

Learning Objectives: 1. Describe the principal adaptations responsible for Altitude Acclimatization. 2. Describe the effect of Increasing Altitude on Maximal and Endurance Aerobic Exercise Performance. 3. Describe the Three Main Types of High Altitude Sickness.

[244] CIRCADIAN DESYNCHRONY IN MILITARY OPERATIONS AND COUNTERMEASURES TO SUSTAIN OPERATIONAL READINESS

M. PAUL

Defence R&D Canada Toronto, Toronto, Ontario, Canada

Modern military operations often occur on a 24/7 basis (causing shift lag), and may involve rapid deployments across multiple time zones (causing jetlag). Each of these stressors (jetlag and shiftlag) results in circadian desynchrony. Personnel suffering from circadian desynchrony may have impaired performance and compromised operational readiness. DRDC Toronto has carried out a series of laboratory and field studies over the past five years to find solutions to optimize performance in circadian stress brought about by shift lag or jet lag. Melatonin is the master hormone which regulates circadian rhythms, and is secreted by the pineal gland in the absence of daylight (i.e. at night). Melatonin is particularly effective as a sleep aid at off nominal circadian sleep times, and also can facilitate circadian phase shifts when taken at appropriate times. Circadian rhythms can also be manipulated by nocturnal phototherapy which transforms physiologic night into physiologic day by stopping the pineal gland from secreting melatonin. Examples of circadian desynchrony in air transport aircrews (jetlag) and submarine crews (shiftlag) will be illustrated in FAST (Fatigue Avoidance Scheduling Tools) models. Examples of countermeasures based on chronobiological intervention with appropriately timed intervention of supplementary melatonin, and/or appropriately timed phototherapy to advance or retard circadian rhythms (to reduce or eliminate circadian desynchrony) will be presented.

Learning Objectives: 1. Examples of circadian desynchrony in military operations including countermeasures to reduce circadian desynchrony and sustain operational readiness will be discussed.

[245] COGNITIVE PERFORMANCE DURING FIELD AND LABORATORY SIMULATIONS OF MILITARY OPERATIONS

H. R. LIEBERMAN

U.S. Army Institute of Environmental Medicine, Natick, MA

There is substantial anecdotal information that severe degradation in cognitive performance occurs during military, including aviation, operations. However, little objective data are available to substantiate these observations. Factors believed responsible for degrading cognitive function on the battlefield include: sleep loss, adverse environmental conditions, such as heat, cold, and high altitude, and inadequate nutrition and hydration. Psychological stressors in combat, including fear, anxiety and confusion, also degrade cognitive performance. Since the study of cognitive function in combat is not practical, studies of simulated military operations provide the best approximation. We have conducted field and laboratory studies to examine effects of multiple stressors on cognition, including studies of simulated aviation missions. Stressors in these studies always include sleep loss and often, environmental extremes and inadequate nutrition. We have consistently observed substantial degradation in all aspects of cognitive function, from simple, such as reaction time, to complex, like logical reasoning. When results of multistressor studies are compared to studies with single stressors, qualitative estimates of the contribution of different stressors to operational stress can be derived. Sleep deprivation is a particularly potent stressor, degrading cognitive performance in a "dose-related" manner. The adverse effects of climatic extremes and nutritional inadequacies are more difficult to capture, probably because studies are not typically conducted at the extreme levels of these stressors required to degrade cognitive performance. Unfortunately, limited information on effects of severe psychological stress is available. Studies assessing the effects of the various stressors on cognitive function will be reviewed and compared, and when possible, stressors ranked with regard to the magnitude of their effects. The ability of selected nutritional interventions to prevent degradation in cognitive performance in both infantry and aviation operations will be discussed.

Learning Objectives: 1. To understand how environmental and operational stress impair cognitive performance.

[246] USE OF CAFFEINE TO MAINTAIN PHYSICAL AND COGNITIVE PERFORMANCE DURING SUSTAINED OPERATIONS

T. M. MCLELLAN¹, G. H. KAMIMORI² and D. M. VOSS³¹Defence R&D Canada - Toronto, Toronto, Ontario, Canada;²Walter Reed Army Institute of Research, Silver Spring, MD; ³New Zealand Defence Force, Auckland, New Zealand

Elite combat personnel are often required to engage in continuous operations that demand peak cognitive and physical performance. Reconnaissance and intelligence gathering missions often are conducted under the cover of darkness and, as such, provide little opportunity for sleep. It is well documented that inadequate sleep degrades cognitive function, and physical tasks that require self-pacing and motivation are also degraded by sleep loss. Thus, under conditions where adequate sleep is not an option other strategies should be considered that prevent or minimize the extent of the degradation in cognitive and physical function and, thereby, extend the period of operational effectiveness. A recent series of studies has examined the effectiveness of caffeine in a military context to counter the cognitive and physical degradation associated with an overnight period of sustained wakefulness. These studies revealed that a total dose of 600 mg of caffeine provided throughout a night without sleep was effective in maintaining vigilance, during either an urban operations or reconnaissance task, and in restoring or enhancing physical performance compared to the rested state. Current military engagements, however, often involve more extended periods of sleep restriction and the physical and cognitive impairments associated with these prolonged scenarios of inadequate sleep are well-documented. Our recent collaborative efforts have also confirmed that the use of caffeine is an effective countermeasure strategy to extend the period of operational effectiveness under such conditions for elite combat personnel. Taken collectively, our findings would support the recommendation for the use of caffeine to extend the period of operational effectiveness during the conduct of military operations that involve unavoidable periods of sleep loss over a 3-4 day period.

Learning Objectives: 1. To understand the extent of physical and cognitive degradation associated with periods of sleep loss. 2. To understand the advantages and efficacy of the use of caffeine as a countermeasure strategy during periods of restricted sleep.

Tuesday, May 13

10:30AM

PANEL: Human Performance Factors (Sleep)

[247] HUMAN PERFORMANCE FACTORS, SLEEP AND CHRONOBIOLOGY IN SPACE EXPLORATION

E. B. KLIERMAN

Brigham and Women's Hospital/Harvard Medical School, Boston, MA

The success of human space missions depends on astronauts remaining alert and vigilant while operating sophisticated equipment and following complex procedures. During earth-orbit and exploration class space missions, the space environment affects a number of physiological systems critical to human performance. It is vital to mission success to understand the biological limits of human performance under space flight conditions. Mission tasks may be scheduled at habitual sleep times depending on mission requirements. On Earth, crew members travel rapidly across multiple time zones as they train in the U.S., Russia, Canada, and Japan. Multiple studies have shown that the sleep and circadian systems can overcome even strong motivation to succeed, causing errors and accidents. Our work focuses on the altered circadian organization, sleep disruption and cumulative sleep loss, and associated neurobehavioral decrements occurring during space flight. The knowledge required to aid crew members in space and on Earth includes: (1) Characterizing and quantifying the adverse effects of space flight on sleep and circadian rhythms; (2) Characterizing and quantifying the effect of sleep loss and/or circadian dysfunction on physical, neurobehavioral, and task performance; (3) Understanding basic mechanisms underlying the deterioration of sleep, circadian organization, and neurobehavioral function during space flight; (4) Developing mathematical models of performance based on circadian organization and sleep-wake history individualized to the crew members; (5) Developing countermeasures to optimize sleep and facilitate circadian adaptation in space and thereby maintain optimal neurobehavioral performance; (6) Developing methods for monitoring sleep, sleep homeostasis, circadian rhythmicity, light exposure, and neurobehavioral and task performance during space flight, with possible applications on Earth. The results are intended to accelerate progress on countermeasures that reduce the risk of human neurobehavioral or physiological performance failure during space exploration.

Learning Objectives: 1. To elucidate the problems of human performance in space and on Earth associated with alterations in circadian rhythms and sleep patterns for members of the Aerospace Medical community. 2. To discuss countermeasures for these problems.

[248] SLEEP AND SLEEP-PROMOTING MEDICATION USE IN SHUTTLE CREWMEMBERS

L. K. BARGER¹, K. P. WRIGHT² and C. A. CZEISLER¹¹Brigham and Women's Hospital, Boston, MA; ²University of Colorado, Boulder, CO

Introduction: The success and effectiveness of manned space flight depends on the ability of crew members to maintain a high level of cognitive performance and vigilance while operating and monitoring sophisticated instrumentation. An inadequate quantity or quality of sleep may impair that ability. In order to understand sleep in space more completely, we conducted a large scale study of astronauts across multiple Shuttle missions. **Methods:** Since 2000, most crewmembers assigned to shuttle flights were informed about the opportunity to participate in this experiment. Subjects wore a small light-weight ambulatory recording device [Actiwatch-L; Minimitter (Respironics), Bend, OR] for assessment of sleep-wakefulness activity and light exposure levels during three ground based increments and the Shuttle mission. Sleep was estimated using Actiware Software (Version 3.4). Additionally, crewmembers were instructed to complete a daily sleep log within 15 minutes of awakening. **Results:** Actigraphy results from the first 10 crewmembers (5 Shuttle flights) revealed that the average nightly sleep during spaceflight was 5.6±0.5 hours. Inflight, subjects slept less than 6 hours per night 62% of the time and less than 5 hours per night 24% of the time. On nights prior to extravehicular activity (EVAs), EVA crewmembers slept less than 5 hours per night 50% of the time and less than 4 hours per night 25% of the time. Daily sleep logs from the first 27 crewmembers (10 Shuttle flights) indicated that sleep-promoting medications were taken on 50% of all inflight nights. 81% of the crewmembers reported taking sleep-promoting medications. **Discussion:** Preliminary analyses from the current study suggest that astronauts obtain inadequate sleep during shuttle missions, even with medication use, and especially on nights prior to mission-critical EVAs. Prior ground-based research indicates that sleep loss, similar

to that observed in the current study, produces substantial performance decrements. This highlights the need to develop effective countermeasures to promote sleep and wakefulness inflight.

Learning Objectives: 1. The relationship between sleep loss and performance is described. 2. The audience will learn the most current data collected inflight on the sleep of the Shuttle crewmembers.

[249] COUNTERMEASURES TO NEUROBEHAVIORAL DEFICITS FROM CUMULATIVE SLEEP DEPRIVATION DURING SPACE FLIGHT: DOSE-RESPONSE EFFECTS OF RECOVERY SLEEP OPPORTUNITIES

D. F. DINGES and S. BANKS

University of Pennsylvania, Philadelphia, PA

There is extensive objective evidence that astronaut sleep is restricted in space flight, averaging between 4h-6.5h/day, as a result of endogenous disturbances of sleep (e.g., motion sickness, circadian desynchrony), environmental disruptions of sleep, and frequently, curtailment of sleep due to the work demands. This is problematic, since ground-based research has shown that cognitive performance deficits progressively worsen (i.e., accumulate) over consecutive days when sleep is restricted to levels experienced by astronauts. In as little as 1 week of restricted sleep deficits develop in a range of critical functions including increased lapses of attention, degradation of response times, deficits in complex problem solving, reduced learning, increased negative mood, and disruption of essential endocrine, metabolic, and immune responses. The prevention of these cumulative adverse effects from sleep restriction during extended duration space flight involves finding the most efficient way to optimize the recovery benefits of sleep while minimizing the time required for sleep [1]. This study aims to establish the benefits for performance from an acute increase in recovery sleep duration that occurs between two periods of chronic sleep restriction. Sleep duration dose will be varied parametrically on one night (0h, 2h, 4h, 6h, 8h, 10h, or 12h), placed midway between two 5-night periods of chronic sleep restriction (4h/night). Thus far, N=54 subjects (21-45 yr) have been studied through the complete protocol. The resulting sleep dose response curves from this subset are beginning to quantify, for the first time, the degree of recuperation and/or further decrement of neurobehavioral functions relative to a single night of varying amounts of sleep interspersed between two 5-day periods of chronic sleep restriction. Finding a sleep schedule that will prevent the development of sleep debt and its adverse effects on cognitive performance will have great relevance to work-rest scheduling in space flight and on the Moon. The results will also contribute to improved work-rest scheduling in a wide array of safety-sensitive 24/7 operations on Earth.

Reference: [1] Mollicone et al. (2007) *Acta Astronautica*.

Research supported by NASA cooperative agreement NCC 5-98 with the National Space Biomedical Research Institute, and by NIH grant M01-RR00040.

Learning Objectives: 1. Identify the cumulative performance effects of sleep restriction, and the amount of sleep needed to recovery from the deficits.

[250] ENTRAINING THE CIRCADIAN PACEMAKER WITH MODERATE INTENSITY LIGHT TO A NON-24 DAY FOLLOWING A SLAM SHIFT

N. SANTHI and C. A. CZEISLER

Harvard Medical School, Brigham & Women's Hospital, Boston, MA

Introduction: While, the range of entrainment of the human circadian pacemaker can be expanded with bright light, the light intensity required to induce entrainment to a non-24h day following a slam shift is unknown. We evaluated the efficacy of moderate intensity light to entrain subjects to a 24.65-h day initiated at an adverse phase. **Method:** 7 healthy subjects participated in a 71-day inpatient protocol consisting of 3 baseline days (16:8 h wake:sleep) followed by 60 experimental days (24.65 h, 16.43:8.22 h). The ambient light intensity during the experimental days was ~50 lux (n=5) or ~100 lux (n=2). The timing of sleep on experimental day 1 was shifted 12 h compared to baseline. Circadian phase was measured by the Dim Light Melatonin Onset (DLMO) measured 6 times under dim light (~1.8 lux ambient light) and postural control during several segments on the experimental days. To assess entrainment phase angle was calculated as DLMO minus scheduled bedtime. **Results:** Immediately following the shifted sleep-wake schedule, subjects' circadian rhythms were severely misaligned; the average phase angle in the 50 lux subjects was 12.5 +/- .26 hours and in 100 lux subjects it was 8.96 +/- .96 hours. The average phase

angle on experimental day 6 was still misaligned (50 lux = 5.8 +/- 1.6h; 100 lux = 7 +/- 3.7 h). Eventually, stable entrainment at an appropriate phase angle was achieved, with the average phase angle on the 15th experimental day at 1.5 +/- .46; the average phase angle at 2.4 +/- .31h on experimental day 34; and the average phase angle at 2.2 +/- .26h on experimental day 48 (p>.05). **Discussion:** Our results show that crew members would be most vulnerable to the detrimental effects of circadian misalignment during the first 2 weeks of a mission. It is critical to explore this window of vulnerability further and develop countermeasures to hasten circadian adaptation to short-term missions and thereby improve sleep and performance during this time. Support: NSBRI (HPF00402), R01 NIMH (MH45130) & R01 NCAAM (AT002129) to CAC & M01 RR02635 to BWH GCRC.

Learning Objectives: 1. The detrimental effects of circadian misalignment on performance and sleep will be discussed.

[251] TESTING POLYCHROMATIC LIGHT AS A COUNTERMEASURE FOR CIRCADIAN DISRUPTION IN SPACE EXPLORATION

G. C. BRAINARD, J. P. HANIFIN, M. JAMES, K. S. CECIL, M. R. JABLONSKI, E. MARTIN, K. E. WEST, B. WARFIELD, M. THIESSEN, M. STONE, B. BYRNE, S. JASSER, E. GERNER and M. D. ROLLAG

Thomas Jefferson University, Philadelphia, PA

Introduction: Health and safety risks for astronauts include disturbed circadian rhythms and altered sleep-wake patterns that can result in decreased alertness and performance. Human studies with monochromatic wavelengths indicate that the melatonin suppression, circadian phase shifting, and acute alerting effects of light are shifted towards the blue part of the spectrum (Brainard et al., 2001; Lockley et al., 2003, 2006; Cajochen et al., 2005). The aim of this study was to compare efficacy of polychromatic standard white fluorescent lamps to blue-enriched fluorescent lamps for melatonin suppression in humans. **Methods:** The light exposure systems consisted of either white (4,000 K) or blue-enriched fluorescent lamps (17,000 K) presented in a full visual field exposure. Two groups of 8 volunteers each were exposed to nine irradiances of white or blue-enriched light (0.8 to 800 $\mu\text{W}/\text{cm}^2$) and a dark control exposure with at least six days between experimental nights. Light exposure times were between 2:00 and 3:30 AM. Blood samples were quantified for melatonin. **Results:** For both the white and blue-enriched light exposed groups, comparisons of pre- versus post-exposure melatonin values showed that middle- to higher-range intensities induced a significant reduction of melatonin ($p<0.05$ to 0.001). ANOVA of melatonin control-adjusted % change scores showed a significant intensity-related suppression of melatonin ($p<0.001$). The control-adjusted % change scores were plotted on fluence-response curves with high coefficients of correlation ($R^2>0.90$). **Conclusions:** Both standard white and blue-enriched fluorescent lights suppress plasma melatonin in healthy young subjects in clear dose-response patterns, with higher irradiances eliciting progressively stronger hormone suppressions. These findings open the door for optimizing light as a countermeasure for sleep and circadian disruption during space exploration, as well as applications on earth. Support: NSBRI through NASA NCC 9-58. Philips Lighting, BV, an NSBRI partner, provided lamps for this study.

Learning Objectives: 1. The potential of nonpharmacological lighting countermeasures for circadian and sleep disruption in space exploration will be discussed.

[252] SPECTRAL SENSITIVITY OF THE HUMAN CIRCADIAN TIMING SYSTEM

J. J. GOOLEY¹, S. M. RAJARATNAM¹, G. C. BRAINARD², R. KRONAUER¹, C. A. CZEISLER¹ and S. W. LOCKLEY¹

¹Harvard University, Boston, MA; ²Thomas Jefferson University, Philadelphia, PA

In humans, the photoreceptor system that mediates circadian responses to light is hypothesized to be distinct from that used for color vision (max = 555 nm). To test this, we examined the dose-response relationship of circadian phase shifting and melatonin suppression in response to short wavelength light (blue, 460 nm) as compared to mid-wavelength light (green, 555 nm) across photon densities from 0 - 1.5 x 1014 photons/cm²/s. Healthy volunteers (18-30 yrs; n = 46) participated in a 9-day laboratory study in which monochromatic light was administered

for 6.5 hrs during the early biological night. Circadian phase was assessed by a constant routine procedure before and after the experimental light session. Both circadian phase resetting and melatonin suppression exhibited a dose-response dependent on photon density and wavelength. A wavelength-dependent shift in the sensitivity of the dose-response curves showed that 460 nm light was at least twice as effective as 555 nm light for circadian phase resetting and melatonin suppression (range, ~1.0-3.0 x 1013 photons/cm2/s). The short wavelength-sensitivity of human circadian responses to light is consistent with a role for the blue light-sensitive photopigment melanopsin in circadian phototransduction. These findings have important implications for light therapy-based treatments for sleep and circadian rhythm disorders associated with shiftwork, insomnia, and jet-lag. Support: NCCAM (AT002129, SWL); RO1NS36590 (GCB); NSBRI through NASA NCC 9-58 (SWL, CAC, GCB); NIMH (MH045130, CAC); NIH/NHLBI (T32 HL07901, CAC).

Learning Objectives: 1. The effects of light in human physiology, sleep and performance will be discussed.

[253] MATHEMATICAL MODELING OF HUMAN CIRCADIAN PHYSIOLOGY:APPLICATIONS ON EARTH AND IN SPACE

E. B. KLERMAN¹, D. DEAN², A. REED² and M. A. ST. HILAIRE²

¹Brigham and Women's Hospital/Harvard Medical School, Boston, MA; ²Brigham and Women's Hospital, Boston, MA

Circadian rhythms are an important physiological factor influencing sleep quality and duration, hormone levels, mood (including alertness) and cognitive performance. Changes in light exposure, sleep-wake timing and circadian rhythms associated with human space travel have been documented to have profound effects on cognitive performance. Decrements in human performance levels can cause errors and accidents. In order to understand and predict these known changes due to circadian rhythmicity and sleep, and to design countermeasures, our research concentrates on developing mathematical models. We have developed a mathematical model of human circadian rhythms, neurobehavioral performance and alertness. The circadian portion of this model contains three components: the circadian pacemaker; a photo-responsive input pathway; and a non-photic input pathway that includes sleep/wake timing and associated behaviors including postural changes, meals and social interactions. The output of the circadian model interacts with a sleep inertia component and a homeostatic component driven by sleep and wake duration; it predicts circadian phase and amplitude, subjective alertness and objective neurobehavioral performance. Both subjective and objective measures of alertness are important, since an individual's choice to use countermeasures frequently relies on subjective assessment of alertness. Our model simulates the circadian, performance, and alertness response to schedules including non-24-hr days (e.g., Mars 24.6-hr day or shuttle mission ~90-min light-dark cycles), and up to 80-hr sleep deprivation. It also accurately captures the effects of abrupt shifts in sleep of up to 12-hours as encountered in shift-work, multi-time-zone air travel, and by ground crews associated with space missions. We have also developed countermeasure optimization algorithm. The model can be used by individuals in transportation, medical, security and other industries to plan countermeasures or alternate schedules for those who work at night, after time shifts or at adverse circadian phases.

Learning Objectives: 1. Describe the use of mathematical models of neurobehavioral performance and alertness for crewmembers in Space and on Earth.

Tuesday, May 13

2:00PM

PANEL: History of Space Medicine: Formative Years at NASA

(Sponsored by the Space Medicine Association)

[254] HISTORY OF SPACE MEDICINE-THE FORMATIVE YEARS AT NASA

E. BOPP¹, J. KERWIN² and A. A. ARNOLD³

¹Wyle, Houston, TX; ²Retired, College Station, TX; ³Kennedy Space Center, Kennedy Space Center, FL

Almost nothing was known about the effect of spaceflight on human physiology when President Kennedy pledged to land a man on the Moon within decade and return him safely to earth. How did NASA, and it's small, new medical community have the audacity to take on that word,

"safely"? There were decisions needed to match men to the boosters and spacecraft, questions about acceleration, vibration, cabin pressure, CO2 concentration, and microgravity effects. There were the external threats, especially solar and ultraviolet radiation, meteorites and extreme temperatures. We knew there were additional questions that we didn't even know to ask. And there was no time for leisurely controlled experiments with significant numbers of animal and human subjects. They had to take risks, and judge carefully how much risk could be accepted. This panel, the first of an annual series, will begin to explore in retrospect the development of Space Medicine at NASA as told by the pioneers in the field. We will discuss the early days of USAF support at Brooks AFB, the Apollo program organization and Apollo medical support, the development of quarantine facilities for retuning Apollo astronauts, the struggles between operational medicine and research, and the experience of being the first U.S. medical officer to experience weightlessness in spaceflight. Presentations will be followed by a discussion between the Panel members about what happened, what was important, and how the lessons learned can be applied to Space Medicine for the Exploration Program.

Learning Objectives: 1. Presentations will discuss what happened, what was important and how the lessons learned applied to Space Medicine.

[255] THE EARLY DAYS OF USAF RANDOLPH/BROOKS SUPPORT OF SPACE MEDICINE

S. MOHLER

Wright State University, Dayton, OH

From the vision of Col. Harry G. Armstrong, USAF, MC, Commandant of the School of Aviation Medicine, Randolph Field, TX, the Department of Space Medicine became a reality on Feb. 9, 1949. The new Department was tasked with contributing to the emerging U.S. initiatives that were working toward achieving human space flight. A cadre of scientists, many recent immigrants from Germany, was organized around the "man in space" space mission. The studies included: Human tolerances to lengthy (7 day - test one, 10 day - test two) isolation in small sealed cabins; A method for continuously recording levels of oxygen, carbon dioxide, and other gases in sealed occupied cabins; The physics and psychophysics of weightlessness, including visual perception; Retinal adaptation in night flying; Ceiling altitude tolerance following physical training and acclimatization, Bailout at very high altitudes; Aeromedical problems of space travel; Atmospheric space equivalence; The physiologic day-night cycle in global flights; and the latency of hypoxia on exposure to altitude above 50,000 ft. The above SAM studies were published between 1949-58. The period was capped by the National Aeronautics and Space Act of 1958, the Act creating the National Aeronautics and Space Administration (NASA). In 1959 the School of Aviation Medicine moved from Randolph AFB to Brooks AFB and was upgraded in name to the School of Aerospace Medicine. Among the professionals involved in the above foundational studies were Drs. H. Armstrong, B. Balke, P. Campbell, P. Cibis, G. Clamaan, R.T. Clark, S. Gerathewohl, F. Haber, H. Haber, W. Hawkins, U. Luft, H. Strughold (Director of the Department of Space Medicine), J. Ward and numerous others.

Learning Objectives: 1. Provide a perspective concerning the historical support by USAF personnel to the nascent U.S. manned space flight program. 2. Delineate the contributions of certain USAF professionals to the beginning NASA space flight planning.

[256] MEDICAL SUPPORT OF THE APOLLO PROGRAM

C. BERRY

Retired, Houston, TX

It may surprise some to hear that the medical support of the Apollo (Lunar Landing) Program really began with the Mercury space flights in 1961. Following Al Shepard's suborbital flight of 15 minutes and 22 seconds, President Kennedy first stated to NASA officials that we should go to the moon. In planning the medical support of Apollo, information gained during the Gemini Program was vital and used extensively. In particular, the high energy cost of extravehicular activity, cardiovascular deconditioning, diminished exercise capacity and loss of red blood cell mass were important considerations in planning for lunar surface activity of the astronauts. In October 1966, an important milestone meeting regarding readiness for lunar missions was held at Johnson Spacecraft Center (JSC). The list of "Medical Issues for Lunar Missions" which I presented at that meeting was: 1. Human Capability - physiological & psychological. We were continually assailed by the scientific community as not having data. They had no understanding that we were trying to collect medical data on complex operational missions, each of which was a battle in the Cold War.

2. Crew Workload – EVA and lunar surface. This was particularly worrisome, for on each of the three previous missions Gemini IX, X, and XI the EVA activity had to be stopped due to excessive elevation of heart and respiratory rates and visor fogging. 3. Quarantine – Lunar Plague? 4. Possible illness in flight 5. Environmental Protection – Solar Flares etc. The need to make important decisions based on a very small number of data points was a constant pressure. A task of this magnitude and importance to our nation and the world required acquiring and organizing a superb multidisciplinary team to provide the needed medical support. Direct medical input at the highest managerial level was necessary and obtained. Early Apollo missions showed us that illness in flight was real – it happened. Lunar landings revealed the difficulties of a Quarantine.

Learning Objectives: 1. The individual will become aware of the key problems in providing medical support for lunar missions and of the successful missions completed by handling these problems.

[257] RELATIONSHIP BETWEEN THE FLIGHT SURGEON AND THE RESEARCH COMMUNITY

G. HOFFLER

None, Titusville, FL

Aerospace medicine assumed an unprecedented challenge when the world entered the space age 50 years ago. The discipline evolved from needs and unknowns faced by human beings who would be exposed to the space environment. Some risks were intuitive; others would only be characterized later in actual space flight. Reducing/eliminating risks and assuring health and safety of space crews and success of their missions would require comprehensive collaboration among selected clinical specialties and space-peculiar researches. Quickly realizing this mandate, space faring nations amassed the best in relevant clinical expertise and instigated broad, applied research programs to fill the existing knowledge voids. The well known love-hate relationship flight crews share for their flight surgeon stems from multiple factors. Among these are the obvious need to maintain health essential for flight certification, the critical handling of confidential medical information, and the potential loss of flying status due to disclosure of adverse health data. The physician-patient relationship could also become somewhat blurred with flight surgeons in the cockpit. Simultaneously providing medical evaluation/safety assurance AND being an advocate of the pilot-patient may sometimes tax objectivity and ethical standards. Capabilities in clinical medicine have advanced most effectively by a close and symbiotic relationship with relevant research. In a similar arena, the flight surgeon must depend on an appropriate aerospace medical research community to furnish the evidence upon which maintenance of flight crew health depends. It was into this unusual mix of roles that I was privileged to practice my training as a flight surgeon while also pursuing some of the exciting research quests—specifically in cardiovascular adaptations to the microgravity of space. These circumstances provide the basis for discussing trenchant medical matters of historical significance to aerospace medicine.

Learning Objectives: 1. To understand operational implications of the delicate balance that the essential roles of flight surgeon and applied researcher must achieve for successful human space exploration.

[258] THE DEVELOPMENT OF QUARANTINE FACILITIES FOR RETURNING APOLLO ASTRONAUTS

C. A. JERNIGAN

University of Texas Medical Branch at Galveston, Pipe Creek, TX

In his historic address to Congress in 1961, President Kennedy gave NASA a bold mandate with only one defined goal: to land Americans on the moon and return them safely to Earth by the end of the decade. As the details of the program began to be developed and publicized, the planetary science community began to recognize potential opportunities for a major expansion in lunar studies, and soon began lobbying for a lunar science program including the transport of lunar soil and rock samples to Earth for analysis. In 1964 the Manned Spacecraft Center recognized the need for a sample processing facility and began planning a small processing and distribution building. In 1960 the Space Science Board of the National Academy of Sciences first raised the issue of back contamination. Many space experts believed that lunar surface conditions made it impossible for any life forms to survive. Others postulated exotic life forms. It was not until March 1966 that NASA's appropriations bill brought the back contamination issues to the attention of Congress and the general public. Some of the challenges and near misses in the management of the back contamination program will be discussed.

Learning Objectives: 1. Global politics trump good science. 2. Discretion and good science can control the damage.

[259] SKYLAB MEDICAL INVESTIGATIONS

J. KERWIN

Retired, College Station, TX

Dr. Kerwin was selected by NASA in 1965 to be a Scientist Astronaut. The Apollo lunar landing program was underway, and Project Gemini flights had begun. They would include eight and fourteen day flights to test man's ability to adapt to weightlessness. His assignments were to train as an astronaut, learn as much as possible about the medical effects of space flight, and to represent the astronaut office in pretty much any activity with a medical aspect – space suits, life support systems, cabin pressure and bends, radiation limits, in-flight exercise and medical monitoring. Kerwin thus had a front-row seat in the developing astronaut-flight surgeon relationship. Physicians and astronauts had the same ultimate goals for space flight, but quite different priorities in how to achieve them. The doctors needed data on the body's in-flight responses; the astronauts needed any equipment and procedures to be operationally suitable but with minimum interference with their complex and dangerous flights. They were also conscious, as pilots always are, that medical data could be used to ground them. He will recount his observations of those days, and of their culmination, after Apollo, in Skylab, the first mission in which medical scientists had the priorities and resources needed to achieve their goals.

Learning Objectives: 1. The M.D. degree is a useful credential to bring to an astronaut career, because much of the medical knowledge is very relevant to the problems of human space flight.

Tuesday, May 13

2:00PM

SLIDE: Aerospace Safety I

[260] CRASH RATES OF SCHEDULED COMMUTER FLIGHTS: THE NUMBER OF SEATS MATTERS

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Purpose: The Federal Aviation Administration (FAA) changed its rule in 1997 for scheduled commuter flights so that all scheduled flights of commuter aircraft with 10 or more passenger seats would operate under Part 121 rules, rather than Part 135. We examined the impact of this rule change on the epidemiologic patterns of Part 135 crashes. **Method:** Detailed descriptions of crashes of scheduled commuters flying under Part 135 rules during 1983 to 2002 were analyzed according to the number of passenger seats in the crashed aircraft [10+ seats (N=133) vs. fewer seats (N=166)]. **Results:** Until 1997, the rate of Part 135 crashes included both aircraft with 10 or more passenger seats and those with fewer. The overall rate gradually declined by about 50% between 1983 and 1996, then jumped from 3.1 to 11.5/1,000,000 departures in 1997 before beginning to decline again. Crashes of aircraft with fewer than 10 seats were more likely than those of larger aircraft to occur in Alaska, involve flight from visual conditions into instrument conditions, and result from loss of control on landing or takeoff; their pilots were more likely to have made careless errors during preflight and poor decisions with regard to weather. Crashes of larger aircraft were more likely to have occurred at night, involved mechanical failure, and resulted from failure to see and avoid other aircraft. Pilot error contributed to 79% of crashes of smaller aircraft vs. 64% of the crashes of larger aircraft. **Discussion:** Crash rates of Part 135 flights decreased for both smaller and larger aircraft. Crash circumstances of scheduled commuter flights are associated with the number of aircraft seats. The substantial increase in the reported crash rates for scheduled Part 135 flights immediately following the rule change is an artifact, resulting from exclusion of crashes of aircraft with lower crash rates.

Learning Objectives: 1. To understand the major change in Part 135 crash rates.

[261] COMPARISON OF UNMANNED AND MANNED AIRCRAFT CRASH RATES

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Introduction: Our previous study exposed a strong exponential relationship between cumulative flight hours and crash rate for most USAF aircraft indicating a high degree of improvement with regard to safety over the life-cycle of Air Force fighter aircraft. This study compares crash rates of Air Force unmanned aircraft to fighter/attack aircraft. **Methods:** Data were obtained from the USAF Safety Center database for all major accidents (Class A Mishaps) and for annual flight hours for the Predator and Global Hawk (GH) as well as for 12 USAF fighter/attack aircraft for Fiscal Years 1950 through 2006. Flight hours for the Global Hawk were obtained from the 303 AESG. Regression analysis was accomplished on the logarithmic transformation of the cumulative flight hours and cumulative crash rate. **Results:** The relationship between crash rate, y , and flying hours, t , is approximately linear on logarithmic coordinates, so it can be expressed as a power relation, $y = btm$, where the exponent, m , reflects the slope. The model fit was significant for all the unmanned and manned aircraft studied: Predator ($r^2=0.89$, slope=-0.30), GH ($r^2=0.88$, slope = -0.59), and 12 USAF fighter/attack aircraft ($r^2=0.78-0.99$, slope = -0.25 to -0.75). GH crash rates were initially higher than Predator, but are demonstrating a high rate of improvement with cumulative flight hours. The Predator remotely piloted aircraft experienced 29 crashes of which 7 were during landing and 8 resulted from a lost link. For GH there were 4 total crashes with none during the landing phase, but all involved GH's autonomous software. **Discussion:** The parameters for the Predator and GH fell within the range of the 12 manned aircraft studied with all unmanned and manned aircraft showing a negative exponent (slope). The rate of improvement for GH (slope = -0.59) was greater than 11 of the 12 manned aircraft studied.

Learning Objectives: 1. Trends in unmanned aircraft accident rates will be described and compared with accident rates for manned aircraft.

[262] GENDER DIFFERENCES IN CANADIAN AIR CADET GLIDER OCCURRENCES: SOCIAL-PSYCHOLOGICAL AND OTHER HUMAN FACTORS

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Introduction: Recent data suggest that a disproportionate number of female pilots are involved in Canadian air cadet glider occurrences. These data contradict findings from general aviation accident records from the National Transportation Safety Board in the United States, according to which male pilots had a higher accident rate than female pilots. Other research suggests a mixed picture regarding gender differences in aviation safety. For instance, compared to males, female flight students may be quicker to grasp instrumental flight; have far fewer fatal accidents; tend to learn procedures correctly and be more consistent in using them; tend to operate the controls of an airplane more skillfully; and may be less likely to fly into dangerous weather or "show off" for spectators. However, female flight students may also have less technical background/experience; may be more fearful of stalls or other unusual attitudes; may be slower to gain confidence; and may be more apprehensive about their first solo flight. Research also suggests that commercial aviation continues to be dominated by "masculine" cultural values and practices, possibly leading to feelings of pressure among females to perform well above average, as well as prejudicial attitudes towards female aviators. This study explores social-psychological and other human factors that may be involved in gender differences in glider occurrences among Canadian air cadets, including the role of gender socialization and the social environment of the glider program and broader air cadet organization. **Methods:** The study incorporates findings from interviews with key informants (instructors, trainers, students) and archival sources (accident reports, training manuals). **Results:** The research suggests that social-psychological and other human factors may underpin gender differences in air cadet glider occurrences. **Discussion:** Recommendations are made toward increasing an understanding of gender-related diversity in the air cadet community, developing better training approaches, and preventing future occurrences.

Learning Objectives: 1. Social-psychological and other human factors in explaining gender differences in Canadian Air Cadet glider occurrences are explored in this study.

[263] PILOT ERROR IN AIR TAXI ACCIDENTS: ARE THERE AGE DIFFERENCES?

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Introduction: Questions about whether pilots become less safe as age increases have been a focus of research since the "Age 60 Rule" became effective in 1960. This study aims to examine age-associated differences in the prevalence and patterns of pilot error in air taxi accidents. **Methods:** Investigation reports from the National Transportation Safety Board for accidents involving non-scheduled Part 135 operations (i.e., air taxis) in the United States between 1983 and 2002 were reviewed to identify pilot error and other contributing factors. Accident circumstances and the presence and type of pilot error were analyzed in relation to pilot age using Chi-square tests. **Results:** Of the 1751 air taxi accidents studied, 28% resulted from mechanical failure, 25% from loss of control at landing or takeoff, 7% from visual flight rule (VFR) into instrument meteorological condition (IMC), 7% from fuel starvation, 5% from taxiing, and 28% from other causes. Accidents involving older pilots were more likely to involve VFR into IMC, whereas accidents involving younger pilots were more likely to be taxiing events. Pilot error was a contributing factor in 67%, 71%, 69%, 71%, 65%, 79%, 72%, and 77% of the accidents involving pilots ages <30 yr, 30-34 yr, 35-39 yr, 40-44 yr, 45-49 yr, 50-54 yr, 55-59 yr, and > 60 yr, respectively ($p = 0.11$). The patterns of pilot errors were similar across age groups. Overall, 27% of the pilot errors identified were flawed decisions, 26% were inattentiveness, 23% mishandled aircraft kinetics, and 15% mishandled wind and/or runway conditions. **Conclusion:** Despite the difference in crash circumstances, the prevalence and patterns of pilot error in air taxi accidents are similar across age groups.

Learning Objectives: 1. To describe the prevalence and patterns of pilot error in air taxi accidents. 2. To examine whether there are age differences in pilot error in air taxi accidents.

[264] PILOT'S MEDICAL CONDITION AS THE CAUSE/FACTOR IN CIVIL AVIATION ACCIDENTS, 1990-2004

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Introduction: In-flight medical incapacitation has ever been a concern in aviation. The purpose of this study was to analyze the presence of medical conditions as the cause of civil aviation accidents. **Methods:** National Transportation Safety Board (NTSB) Aviation Accident Database was examined for the medical conditions that have been reported as the cause/factor of civil aviation accidents and incidents that occurred during a 15-year (1990-2004) period. **Results:** In the total of 32302 US civil aviation accidents analyzed by the NTSB from 1990-2004, 278 accidents were associated with the medical condition of the pilots (0.86%). In 236 of 27154 general aviation accidents (0.86%), 13 of 1485 air taxi and commuter flight accidents (0.87%), 15 of 1068 air carrier accidents (1.39%), and 9 of 1864 agricultural flight accidents (0.48%) medical condition of the pilot was reported as the cause/factor of the accident. The highest rates of medical conditions in the accidents have been reported in the years 1991, 1997, and 1993 (1.43%, 1.24%, and 1.09%). **Conclusion:** The rate of medical conditions as the cause/factor of accidents is not too high. However, the higher rate in the air carrier accidents was an interesting finding.

Learning Objectives: 1. The rates of medical conditions reported by the NTSB as the cause/factor of accidents in the last 15 years will be discussed.

[265] GRANDFATHERING OF CRASHWORTHINESS STANDARDS - HIGH TIME FOR RETIREMENT?

R. A. COCKS

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Introduction: Helicopter Type Certification under FAR and JAR arrangements requires compliance with set crashworthiness performance standards under Emergency Landing Conditions. FAR 29.561(b)(3), introduced in 1964, required only that the aircraft structure should give each occupant a reasonable chance of escaping serious injury in a minor crash landing. Protection limits were set at 4G forward and 4G vertical in 1964, but in 1993 a revision of the Standards upgraded these limits to 16G forward and 20G vertical (after intended displacement of any seat device). However, after 1993 manufacturers could still apply to airworthiness regulators for a reversion to the earlier standards ("Grandfathering") where compliance would be "impractical" in later variants of aircraft types which existed before 1993. No time limit was set for the abolition of this dispensation. **Methods:** This presentation examines the injurious results of reversions to the 1964 standards, with special reference to recently-published accident investigation reports on crashes involving nearly-new helicopters. **Results and Discussion:** Evidence is presented of preventable

injuries, and these are discussed in relation to the crash dynamics of the accidents and the potential for mitigation of severity by protection systems and crashworthiness standards.

Learning Objectives: 1. The practical impact of crashworthiness standards in helicopters will be discussed. 2. The medical consequences of continuing to build aircraft to obsolete standards will be illustrated.

Tuesday, May 13

2:00PM

PANEL: Show Me the Evidence III: New Evidence for Evidence-Based Aeromedical Decisions

[266] "SHOW ME THE EVIDENCE!": NEW EVIDENCE FOR OUR EVIDENCE-BASED AEROMEDICAL DECISIONS

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This panel is a continuation of the "Show me the evidence!" series. Our underlying premise is that making reasonable, replicable, and reviewable aeromedical decisions requires the "conscientious, explicit and judicious use of current best evidence" in conjunction with the assessment and 'management' of the risks that are identified. In this panel we explore new data and evidence that may be helpful in our future evidence-based aeromedical risk management decision making.

Learning Objectives: 1. An understanding of some of the limitations and underlying principles that apply to evidence-based aeromedical risk management.

[267] DR WATSON'S CHALLENGE - THE CASE OF THE MISSING EVIDENCE

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Aviation medicine requirements have retained the same format since they were first written almost a century ago. The advances in medical science and improvements in health and education during this period have been reflected in the detail of the standards. Periodicity of the examinations and associated tests has continued to be determined by age. With an increased emphasis on targeting those at higher risk and 'light touch' regulation for those at lower risk, it behoves the aeromedical community to gather evidence to shift the focus to appropriate individual risk based assessments. The first step is to determine what medical risks are important for flight safety and could present as incapacitation or impair the pilot's ability to undertake flight crew duties. The second is to develop assessment techniques that will reliably detect the underlying medical conditions that represent an increased risk. The third is to identify the individuals who are at increased risk of these events and to apply limitations to their activities in a proportionate manner. This paper will explore the evidence that flight safety is being compromised by reviewing medical-cause accidents and incidents and risk factors for in flight medical events. There will be discussion of the means currently available to detect the medical conditions of most relevance and how to apply a risk based approach in practice. The evidence required to support this approach will be explored.

Learning Objectives: 1. The gathering of evidence to support individual risk-based aeromedical assessment will be explored.

[268] CABIN CREW MEDICAL EXAMINATIONS - IS THERE ANY EVIDENCE?

A. HEGDE

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There has been a longstanding debate in the aviation community over the merit of medical examinations for Cabin Crew. The United Arab Emirates is one of the few countries in the world where Medical Examinations for Cabin Crew are mandated by the Aviation Regulatory Authority. These regulations specify a comprehensive Initial Medical Examination by a designated AME and a Renewal Medical Examination every 3 years. This presentation will report the findings of an audit of 2703 Initial and 1500 Renewal Cabin Crew Medical Examinations that were completed for one UAE airline in 2006. The results demonstrate that the

rate of pick up of significant medical conditions with a comprehensive medical examination is comparable to that of a medical questionnaire.

Learning Objectives: 1. The basis for medical standards in the cabin crew population will be explored. 2. To discuss the evidence based approach to regulations in aerospace medicine.

[269] CABIN CREW HEALTH ASSESSMENTS: HANDS ON, OR HANDS OFF? – EVIDENCE FROM IN-FLIGHT OCCURRENCE REPORTS

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Introduction: The issue of health standards and requirements for periodic medical assessment for cabin crew remains controversial. **Methods:** The UK CAA Mandatory Occurrence Report database was searched for the keywords cabin crew incapacitation / illness for the 10-year period 01/01/1997 to 31/12/2006. Any flight-crew incapacitations were excluded. **Results:** 810 medical occurrences in cabin crew were reported. In 2003-2005 there was a doubling of the number of incapacitations per year compared with the average of the preceding 6 years, followed by a further doubling in 2006. Approximately half were injuries occurring in flight as opposed to illness. The majority of events were not serious. Only rarely did the injuries/illnesses result in the diversion of the aircraft. Although many of these events resulted in the affected cabin crew being stood down, with the remainder of the flight being operated below crew minima, this did not appear to adversely affect flight safety. None of the medical events occurring in the cabin crew resulted in a fatal accident or injury to the rest of the crew or passengers. **Discussion:** The increasing rate of reports is likely to be primarily due to a combination of increasing numbers of flights and changes in reporting behaviour. This study does not lend support to the mandatory application of licensing medicals for cabin crew.

Learning Objectives: 1. The cabin crew incapacitation experience of UK operators for the past 10 years will be described.

[270] ARE TWO EYES ARE BETTER THAN ONE? THE DYNAMICS OF THE PULFRICH STEREO-ILLUSION IN CENTRAL SEROUS RETINOPATHY

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Introduction: Central serous chorioretinopathy (CSCR) is a disease in which a serous detachment of the neurosensory retina occurs over an area of leakage from the choriocapillaris through the retinal pigment epithelium. The Pulfrich stereoisillusion occurs when a difference in retinal illuminance between the two eyes creates difficulty with vector analysis of moving objects. The effect has been documented in many diseases of the visual system. In such cases, symptoms such as difficulty judging the path of oncoming cars have been reported. To the best of our knowledge the Pulfrich effect has not been previously documented in a pilot with CSCR. **Methods:** We present an airline captain who presented with scotoma, micropsia, metamorphopsia, dyschromatopsia, decreased night vision, and kinetic dysmetria. Fluorescein Angiography and Optical Coherence Tomography confirmed CSCR. He met his aviation authority's visual requirements on static testing. However in a dynamic situation he experienced significant disorientation which resolved on closing the affected eye. The condition spontaneously resolved over a 3 month period with subjective clinical recovery lagging behind objective resolution by a few weeks. **Results:** Review of the literature shows that patients with unilateral cataract perceive the Pulfrich effect using a two dimensional computer generated image. We elected to assess him in the flight simulator. He was assessed in photopic, scotopic and mesopic conditions; in low contrast lighting; addressing both stationary and moving objects of regard in peripheral and central vision. This was completely normal and he was granted unrestricted certification, with 3 monthly ophthalmology review. **Discussion:** Recertification of flight crew with unilateral disease of the visual system requires awareness that reduction in retinal illumination (relative to the fellow eye) may cause spatial disparity in moving objects. This case demonstrates that in patients with such conditions, routine static testing alone may not be sufficient.

Learning Objectives: 1. The potential for unilateral disease of the eye where there is a reduction in retinal illumination (relative to the fellow eye) to cause visual illusions will be discussed.

[271] AN OBLIQUE VIEW OF THE 1ST DIAGONAL

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Introduction: Many pilots are able to return to flying duties following a coronary ischaemic episode. Some do so following angiography and stent insertion. Smaller blood vessels such as the 1st diagonal artery are generally not able to be stented despite significant stenosis found at angiography. As such smaller vessels stenosis may become the limiting factor when considering certification following revascularisation. **Methods:** We report several cases of stenosis of the first diagonal. We review and discuss these cases, and the literature pertaining to the prognosis of such cases. **Results:** There is useful medical evidence in the literature about the prognostic value of stress myocardial perfusion scans in the case of known coronary artery disease. There is however a paucity of medical evidence when considering a subset of patients with disease in smaller untreated vessels. **Conclusion:** Several recent cases of 1st diagonal coronary artery disease have necessitated the exploration of the prognostic implications of the condition. On the one hand the demonstration of reversible ischaemia is associated with an elevated risk of a future cardiac ischaemic event while, on the other hand there may be some face credibility in the suggestion that disease in smaller untreated vessel has a better prognosis

Learning Objectives: 1. The aeromedical implications of ischaemia in smaller untreated coronary arteries are discussed. 2. To recognise the limitations of coronary artery stenting when considering aeromedical disposition.

[272] CRIGLER-NAJJAR SYNDROME: FIRST EXAMPLE OF CLASS 1 AEROMEDICAL CERTIFICATION?

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Crigler-Najjar syndrome (CNS) is a very rare hepatic enzymopathy which is characterised by persistent hyperbilirubinaemia. With only several hundred cases having been reported worldwide it is not surprising that few have had cause to consider the aeromedical disposition of CNS sufferers. This case report relates to an otherwise healthy young woman, with Type 2 CNS (UDP glucuronosyltransferase 1A1 activity not entirely absent), aspiring to become a professional pilot. Faced with the absence of an extensive aeromedical literature base and in the absence of any known previous examples of CNS pilots the assessing medical personnel and the responsible regulatory authority found themselves reverting to medical and aviation first-principles and attempting to consider the case from a risk-management perspective. Advice was sought from, and provided by, an extensive global (cyber) community of aeromedical practitioners and enthusiasts and this, in turn, assisted in certifying this applicant for professional aviation. This appears to be the first case of aviation medical certification of a CNS case and is offered as an example of: Returning to the first principles of evidence-based risk management in aeromedical decisions; and The rapidity and extent of information-sharing and mutual support that is available to aeromedical practitioners via modern internet communications.

Learning Objectives: 1. An appreciation of the aeromedical implications of the Crigler-Najjar Syndrome.

[273] HYPOPLASTIC IVC- "MORE THAN A FEELING" NEEDED IN THIS CABIN CREWS AEROMEDICAL DISPOSITION

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Background: VTE is a major cause of morbidity and mortality. In the USA DVT alone are responsible for up to 600,000 PE of which 20-25% are fatal. The risk of VTE is higher when components of the Virchow's triad are present. **Case Report:** Mr. N, a 25 yr old Kenyan was noted to have prominent inguinal varicose veins at Initial Cabin Crew medical. He reported acute bilateral leg swelling in 2002 that resolved

as varicosities developed. Work up included abdominal u/s, CT, full thrombophilia screen and VQ scan. The u/s revealed extensive DVT in the iliac veins and distally. The CT showed congenital hypoplasia of the IVC with extensive para-aortic venous collateral channels and the VQ scan was -ve. The full thrombophilia screen and D-dimer was also -ve. After discussion with a Haematologist, the patient was started on lifelong warfarin therapy. **Discussion:** Venous stasis due to the hypoplastic IVC was the causative factor and not resolvable. In the aeromedical disposition of this case we considered the following. 1) Risk of further DVT 2) Risk of PE 3) Risk of complications relating to long term warfarin 4) Whether the flying environment would have a detrimental effect on his condition or the stability of the INR. Warfarin therapy will markedly reduce the risk of further DVT. There are no long term follow up studies of similar patients to give exact statistics. The risk of PE is negligible in view of the condition itself. With a hypoplastic IVC, embolism to the pulmonary circulation is highly unlikely. The critical factors in the final disposition are the treatment and INR control. Some studies show that the risk of bleeding on warfarin, when the INR is between 2-3, can be as low as 1-1.5%. Mr. N showed excellent compliance with both medication and INR testing and no early complications of bleeding, so the board recommended a return to flying duties with close monitoring of the INR. Eventually the UAE GCAA accepted the board findings and Mr. N has been flying as a Cabin Crew with Emirates for the last 6 months with no issues.

Learning Objectives: 1. Although rare in the general population this case highlights the fact that IVC anomalies should be considered as a cause for DVT in the younger person.

Tuesday, May 13

2:00PM

SLIDE: Visual and Auditory Information Processing

[274] ACOUSTIC CHANGES TO HUMAN SPEECH INDUCED BY VARYING COGNITIVE LOAD AND PSYCHOSOCIAL STRESS

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Increases in the durations of verbal responses marked by increased pause durations, increases in the fundamental frequency of phonation (F0) and "jitter" – local, period by period fluctuations in F0 – were robust acoustic correlates of task-induced stress for 24 subjects performing two mental arithmetic tasks under low and high workload stress conditions. These acoustic metrics all significantly differentiated the "easy" (ET) from the "difficult" (DT) descending subtraction tasks (p values ranging from 0.005 to 0.0001), despite the presence or absence of additional psychosocial feedback stressors and sleep deprivation. Behavioral measures of the number of problems completed in a fixed period of time and error rates provided an independent metric of task difficulty, hence cognitive load, differentiating the two task levels. In the ET, the range of problems completed in a 120 second period was 40-100 (M=67), while in the DT the range was 12-34 (M=22), (p < 0.0001). The mean error rate for the ET was 4% while the mean error rate for the DT was 37% (p < 0.0001). Increased verbal response durations and the pauses between responses were the most robust acoustic metrics (both p < 0.0001). Increased duration appears to reflect the recruitment of additional neural resources in the difficult condition. We are using these metrics to create an automated system for stress detection.

Learning Objectives: 1. The effects on speech of cognitive load, stress, and sleep-deprivation (such as that experienced by astronauts) and its detection will be discussed. 2. The combined effects of biological and psychological stressors will be considered.

[275] THE QUALITY OF SPOKEN DISCOURSE IN GUIDED MEDICAL PROCEDURES ON ORBIT

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Introduction: The linguistic aspects of private medical conferences and procedures are underestimated. Despite superior communication skills of the parties, spoken discourse in space medicine deserves special

attention. We studied linguistic features of the discourse between ground-based medical professionals and space-based operators or subjects. **Methods:** Over 110 hours of medically relevant discourse with the International Space Station (ISS) crew were reviewed. Most of the recordings belonged to the Advanced Diagnostic Ultrasound in Microgravity ISS experiment. Segments considered "less than optimal" included instances of information overload, cultural difference, emotion, interruption, misleading or ambiguous commands, and others. Consequences of the above, if any, were noted. Successful solutions such as speech simplification, feedback, adequate use of closed-ended and open-ended questions were also noted. **Results:** While the results of the sessions were adequate, both general and space flight-specific barriers were identified as hampering discourse. Information overload and command redundancy were the most common pitfalls followed by disregard of communication latency, denial of feedback, use of technical (medical) terms, and occasional speech irregularities. All deviations tended to decrease in frequency during a single session, as well as across sessions run by the same individuals. **Conclusion:** Medical remote guidance in either "diagnostic" (e.g., physical examination or imaging session) or "treatment" (e.g., wound dressing or tooth extraction) procedures is a contiguous process whereas each step is determined by the results of the previous step. Medical communication sessions are time constrained, and enhanced performance and precision are expected from all, even in research or training events. Optimization of spoken discourse prevents deleterious mistakes, saves time, ensures mutual confidence, and may directly translate into higher quality of the activity and improved outcome of a medical condition.

Learning Objectives: 1. Enhanced understanding of the common linguistic pitfalls and their impact during remote medical events and guided procedures. 2. Discussion of measures for improving the efficiency, safety and overall success of remote guidance.

[276] FIGHTER SURFACE ATTACK ON NIGHT VISION GOGGLES (NVGS) DURING DUSK AND DAWN: HUMAN FACTORS, CHALLENGES, AND PERFORMANCE ENHANCEMENT

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Introduction: Fighter surface attack aircraft are often called to support continuous 24/7 ground operations. These close air support missions are often conducted during the transitional lighting conditions encountered at dusk and dawn. Transitional lighting conditions present unique challenges for the aviator dependant on either unaided vision or NVGs. **Discussion:** This presentation will discuss the human factors encountered during dusk and dawn surface attack operations including NVG limitations, dark vision adaptation, and human systems integration issues. Authors will highlight specific challenges for aviators in maintaining visual fighter mutual support, in visual identification of both friendly and enemy forces, and in the safe and effective employment of air-to-ground weapons. A case report from the current combat theater will illustrate specific challenges performing strafe operations during transitional lighting conditions. Finally, authors will discuss recommendations for improving performance and mitigating risk including preflight planning tools, in-flight decision making, crew coordination, and sensor management. **Conclusion:** Close air support operations flown at night on NVGs present unique challenges to aircrew, especially during the transitional periods of dusk and dawn. It is imperative that flight surgeons understand the challenges involved to better support the warfighter, minimize the risks and improve aircrew performance.

Learning Objectives: 1. Understand the human factors encountered during dusk and dawn surface attack operations and ways to improve performance and mitigate risk.

[277] EFFECT OF A MONOCULAR HELMET-MOUNTED DISPLAY ON AIRCREW HEALTH: A 10 YEAR PROSPECTIVE COHORT STUDY OF APACHE AH MK 1 PILOTS-A FOUR-YEAR UPDATE

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Background: In 2000, the Headquarters Director Army Aviation, Middle Wallop, United Kingdom and the U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL initiated the first systematic study to investigate potential physiological effects of long-term use of a monocular helmet-mounted display (HMD). This collaborative 10-year longitudinal occupational medicine study is being conducted under the auspices of The Technical Cooperative Program, Subgroup U, Technical Panel 7 (Human Factors in the Aviation Environment.) The HMD is the Integrated Helmet and Display Sighting System (IHADSS) employed on the AH Mk 1 Apache helicopter. The system consists of a right-sided monocular HMD that serves as the pilot's primary source of information concerning the aircraft's state and the outside environment. Over the past 20 years, numerous anecdotal reports have arisen among Apache pilots regarding visual problems resulting from the long-term use of the IHADSS HMD. Past user surveys have documented these complaints. **Methods:** The study follows both Apache pilots and a control population of non-Apache pilots. Data is collected via an expanded battery of monocular and binocular tests accompanied by an extensive questionnaire. **Results:** At the 4-year milestone, a total of 53 Apache pilots and 136 control subjects have enrolled in the study. The pilots have a mean age of 35 years and a mean of 116 hours using the AH-64's monocular IHADSS HMD. Control subjects have a mean age of 31 years and a mean of 51 flight hours using night vision goggles. Between-group comparisons revealed no statistically significant differences for any vision test parameter. A within-subject analysis showed that Apache pilots' performance improved on the Bailey-Lovie high contrast visual acuity test. **Conclusions:** At this point in the study, there is no indication that long-term use of the IHADSS HMD results in negative physiological effects, especially related to vision.

Learning Objectives: 1. Participants learn how a longitudinal cohort study can be used to elucidate longterm health effects. 2. Human factors issues surrounding the use of monocular helmet mounted sights will be discussed.

[278] ON DETERMINING A HUMAN FACTORS STANDARD FOR SEE-THROUGH HMD SYMBOLOGY: VISUAL LUMINANCE REQUIREMENTS

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As the Army increases its reliance upon and continues to develop helmet mounted displays (HMDs), it is paramount that HMDs are developed that meet the operational needs of the warfighter. In see-through HMDs, symbology is overlaid or added to the ambient background. For the symbology to be seen and understood, the symbology must have sufficient contrast to stand-out from the background and be clearly recognized. In an earlier paper, Harding et al., 2005, we showed that the quality of see-through symbology was greatly dependent, in an orderly fashion, on the luminance complexity of the ambient scene. Last year (Harding et al., 2007), we introduced an equation that describes the limits of natural scene complexity over a range of daylight luminances. Natural scene complexity was defined as the standard deviation of small background areas, approximately subtending the size of a symbology character. The scene complexity equation simplifies the characterization of natural scenes while suggesting a strategy for evaluating the HMD luminance requirements for good contrast symbology. The present paper describes the implementation of this strategy and applies it in several contexts. Example calculations will be presented for already fielded HMDs and visor combinations. References: [1] Harding, T.H., Martin, J.S., and Rash, C.E., 2005, Using a helmet-mounted display computer simulation model to evaluate the luminance requirements for symbology. *Helmet- and Head-Mounted Displays X: Technologies and Applications, Proceedings of the SPIE*. 5800, 159-168. [2] Harding, T.H., Martin, J.S., and Rash, C.E., 2007, The legibility of HMD symbology as a function of background local contrast. *Helmet- and Head-Mounted Displays XII: Design and Applications, Proceedings of the SPIE*. 6557, OD 1-OD 8.

Learning Objectives: 1. The educational objective of this presentation is to describe the importance of scene complexity in the quality of see-through symbology and how this information can be used to develop human factors standard for HMDs.

[279] HUMAN INFORMATION PROCESSING IN DYNAMIC ENVIRONMENTS: A COMPREHENSIVE COGNITIVE ASSESSMENT DURING GZ ACCELERATION

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Introduction: The stress of acceleration-induced hypoxia can have a significant impact on a fighter pilot's cognitive ability to perform critical flight tasks. Because neural tissue requires large amounts of oxygen to function, decreases in regional cerebral oxygen saturation (rSO₂) can have significant impacts on cognition. The graded nature of G-induced hypoxia indicates that various cognitive functions are not affected equally and largely depend on the anatomic position of the nuclei critical for their execution. This program investigated 12 different abilities relevant to agile flight during high Gz maneuvers. **Methods:** 10 different experiments were conducted, each probing specific cognitive abilities. For each experiment, 8-10 subjects performed a cognitive performance task during a 3, 5, 7 Gz 15-sec plateau, and a 7 Gz SACM (simulated air combat maneuver) on each of 3 test days. There was a one-minute rest period between each profile. Data collection was performed on the Dynamic Environment Simulator (DES) centrifuge at Wright-Patterson AFB OH. Performance metrics and rSO₂ measures were collected and analyzed for each experiment. **Results:** Analyses of variance showed significant ($p < 0.05$) differences in performance during the following tasks: tracking, motion inference (fast and slow), relative motion, and peripheral information processing. Additionally, significant declines in rSO₂ were found during each of the Gz profiles. **Conclusions:** The extent of cognitive performance impairment during acceleration stress appears to be linked to the area(s) of the brain that control its function. Those utilizing nuclei dorsal to the horizontal plane are far more sensitive to Gz stress than those that are more ventral. Of course, Gz maximum level, duration, and Gz protection all influence the amount of oxygen supplied to the cortical tissues and consequently, the pilot's cognitive performance. Decrements have been incorporated in an overall cognitive performance model; however it still must be validated. Validation is scheduled for spring 2008.

Learning Objectives: 1. The relationship between Gz acceleration and cognitive performance. 2. Effects of graded hypoxia on different brain areas and the corresponding cognitive functions. 3. Application of modeling techniques to simulate cognitive performance under Gz stress.

Tuesday, May 13

2:00PM

PANEL: Update: Aeromedical and Human Systems Integration—I

(Sponsored by the International Association of Military Flight Surgeon Pilots and the Aerospace Physiology Society)

[350] UPDATE ON AEROMEDICAL AND HUMAN-SYSTEMS INTEGRATION CONCERNS

D. A. HOLLAND¹ and W. D. AGERTON²

¹University of Virginia, Charlottesville, VA; ²United States Navy, China Lake, CA

This session will provide an update in some key areas for military aerospace medicine and aerospace human-systems integration issues. Presenters will concentrate on a wide range of issues which fall under Human Systems Integration/Interface. Beginning with the integration of HSI into the requirements generation process as a foundation for the programs in question and continuing on with a discussion of the role of physicians with support of the warfighter and how that may be viewed from both within the military and from outside the military. Legal as well as practical issues laid out for examination and comment. Occupational Risk Management as a component of the HFACS system and integration into HSI are reviewed and updated. The international aspects of HSI as it results to the Eurofighter Typhoon and pilot/aircrew training are reprised in detail. Night Vision Systems are discussed with a short review of their history as well as what the future holds and how more concentration on HSI will be necessary in order to field more complex systems. Discussion of various mishaps as a component of HSI are examined. Overall the importance of HSI has been well known retrospectively, this panel will discuss the paths taken thus far and those which are being explored.

Learning Objectives: 1. Provide an update on current systems from an aerospace medical viewpoint. 2. Increased understanding of the spectrum of HSI issues. 3. Have a broad survey of several important areas.

[281] EXPERIENCES OF AN AEROMEDICAL DUAL DESIGNATOR IN COMBAT

T. R. OELTMANN

United States Government, Vista, CA

The Hippocratic Oath by which all Flight Surgeons abide demands "First do no harm." Aviators are officers who defend the Constitution of the United States against all enemies with the use of deadly force. Aeromedical Dual Designators (AMDD) are both Physicians and Naval Aviators (NA) whose professional obligations exist both in peacetime as well as in combat. The current conflict in Iraq has placed AMDDs in multiple physician provider roles ranging from running the Flight Line Aid Station (FLAS) to flying on Casualty Evacuation (CasEvac) missions. As a NA, they are scheduled as pilots to perform strike missions requiring the delivery of forward firing ordnance against foreign forces in direct support of ground troops. The unique perspective of "both sides of combat" directly adds to the overall effectiveness of the fighting Squadron. This presentation discusses the role, challenges, responsibilities and experiences of an AMDD serving with a Marine Corps AH-1W Cobra Squadron in combat.

Learning Objectives: 1. The role of the Dual Designator in Combat is discussed.

[282] NSAWC / TOPGUN MISHAP REDUCTION

K. M. BELLAND

USUHS, Bethesda, MD

In 1998 the Naval Strike and Air Warfare Center (NSAWC) in Fallon Nevada had a significant increase in aviation mishaps which necessitated and intense US Naval safety center review. The review included human factors analysis classification (HFACS) as well as a comprehensive review of prior recorded mishaps in the area of interest. As a result of the HFACS analysis, the command instituted a comprehensive mishap reduction plan otherwise known as Operational Risk Management (ORM) directed at mitigating the identified risk. Included in the plan was a pre-deployment personal message from the commanding officer to each aircrew member, staff education and training by the command safety department as well as a mandatory incoming aircrew pre-brief by the commands flight-surgeon pilot. The mishap rate appeared to be marked reduced over time. A biostatistical and epidemiologic analysis of the mishap rate per 100K flight hour covering ten years prior to the intervention will be compared to the mishap rate per 100K flight hours for the ten years after implementation of mitigating modalities. Specific recommendations will be made to reduce military mishaps through the proactive implementation of surgically directed common sense ORM.

Learning Objectives: 1. Aviation Mishap Reduction Modalities.

[283] VERSATILITY IN THE AIR: THE RAF AVIATION MEDICINE FLIGHT

K. G. HUGHES

United States Air Force, Henlow, UK

Introduction: The Aviation Medicine Flight is a unique organisation within the Royal Air Force Centre of Aviation Medicine (RAF CAM). The RAF is the only Air Force in the world which has invested in dedicating aircraft specifically for the purpose of aeromedical testing and evaluation. **Discussion:** The Aviation Medicine Flight conducts in-flight assessments of new or modified aircrew flying equipment in the British Aerospace (BAe) Hawk T Mk1 aircraft, which is capable of rapid onset rates up to +9.5Gz. Currently underway are assessments of aircrew helmets and helmet-mounted displays for the RAF and Allied Air Forces around the world. Additionally, pilots selected to fly the Typhoon aircraft experience high-Gz physiologic training in a realistic airborne environment. The Aviation Medicine Flight also performs in-flight clinical evaluation and rehabilitation for aircrew referred for medical conditions, injury or motion sickness. As part of a panel presentation, this briefing will discuss the capabilities of the BAe Hawk aircraft, review the previous and current flight trials of the Aviation Medicine Flight, and demonstrate how the work of the Aviation Medicine Flight advances the capacity for Human Systems Integration in the development of life support systems for current and future aircraft. **Conclusion:** The capability to provide in-flight trials of aircrew equipment, airborne clinical assessments/rehabilitation and physiologic training is essential to supporting the mission of RAF CAM and is critical to the advancement of life support systems for the RAF and its allies.

Learning Objectives: 1. Understand the advantages of specialized in-flight evaluation in the development of aircrew equipment and the assessment and treatment of clinical cases.

[284] ADVANCEMENTS IN NVG AND HMD SYSTEMS: AEROMEDICAL CONCERNS

J. ANTONIO

NAVAIR, Gold Canyon, AZ

Night vision goggles have been in use for many years and limitations in their use have been well studied through training research and flight experience. However, advances in technology have led to improvements in NVG capabilities and in some cases helmet mounted display (HMD) technology has begun replacing NVG systems. These changes have led to operational limitations different than those noted with standard NVGs. This presentation will address some of those limitations from an aeromedical perspective. Included will be discussion concerning: wide-field-of-view systems, effects due to increased interocular separation, effects due to see-through visor designs, and aircraft integration issues. Training concerns and potential mitigation strategies for HMD design concepts will also be covered. The issues discussed are important for flight surgeons to understand as these systems begin making their way into the cockpit of fleet aircraft.

Learning Objectives: 1. Advances in NVG and HMD systems is described. 2. The audience will learn limitations in the use of advanced night vision systems. 3. Human factors aspects regarding aircraft integration of advanced NVG and HMD systems will be discussed.

Tuesday, May 13**2:00PM****PANEL: Aviation Color Vision—I***(Sponsored by the Aerospace Human Factors Association)***[285] RECENT PROGRESS IN AVIATION COLOR VISION ISSUES**J. HOVIS¹ and N. J. MILBURN²¹University of Waterloo, Waterloo, Ontario, Canada; ²FAA, Oklahoma City, OK

The use of color to code information in the aviation environment has continued to increase along with the controversies that accompany the phrase “adequate color perception for the aviation environment.” The controversies take two forms: one is the question of what constitutes critical color-related tasks in aviation, and the other question is what constitutes an appropriate set of tests for evaluating a person’s color perception. This panel will examine both of these questions and present perspectives from both the civilian and military aviation communities. Presentations will examine color-critical tasks in aviation, changes in color perception in compromised environments, differences between the military and civilian approaches to addressing the issues, and various testing protocols that include the usual screening tests and some newer instruments.

Learning Objectives: 1. Overview of some of the problems encountered in setting color vision standards in aviation.

[286] ANOMALOSCOPE STUDIES: NEW FINDINGSJ. L. BARBUR, M. RODRIGUEZ-CARMONA and J. A. HARLOW
City University, London, United Kingdom

Introduction: The parameters of the yellow match are often used to detect and classify the type of color vision deficiency involved. A narrow red-green range is also taken to indicate good color discrimination, as expected in normal trichromatic vision, whilst an extended red-green range is taken to indicate loss of chromatic sensitivity. The purpose of this study was to investigate why some matches depart from these expectations and the significance of such findings in relation to quantifying color vision loss within the aviation environment. **Methods:** Chromatic discrimination sensitivity, Nagel anomaloscope matches and predicted $\delta\lambda_{\max}$ separations based on genetic analysis of cone pigment genes were measured in 24 color deficient subjects. In addition, a model of the yellow match was also developed. The model predicts how changes in $\delta\lambda_{\max}$, selective changes in optical density of photoreceptors and post-receptoral amplification of L and M cone signals can affect both the subject’s midpoint and the range on the Nagel anomaloscope. **Results:** The Nagel matches reveal a diversity of results that cannot be explained easily in terms of altered $\lambda_{\max}$ values of cone photoreceptors. Some subjects accept most, but not all of the red-green mixture range, others require significantly more red or green light in the match, but only accept a very narrow range of red-green mixtures that yield chromatic sensitivity values equivalent to or better than a normal trichromat. **Conclusion:** The model predicts why some color

deficient observers can produce normal anomaloscope matches. The model also predicts accurately the unusual anomaloscope matches measured in some deutan and protan observers with only small $\delta\lambda_{\max}$ separations by appropriate changes in optical density and post-receptoral amplification of cone signals. The results also show poor correlation between the parameters of the yellow match and the subject’s ability to discriminate color differences under more normal conditions of illumination.

Learning Objectives: 1. A model is described that accounts for the parameters that affect a red-green match on the Nagel Anomaloscope.

[287] FAILURE OF THE FARNSWORTH D15 TEST AND THE NAGEL ANOMALOSCOPE MATCHING RANGE

J. BIRCH

City University, London, London, United Kingdom

The Farnsworth D15 test (D15) is often used to select color deficient recruits that are able to distinguish pigment codes of the type used in air traffic control displays. People with significant color deficiency are expected to fail the D15. The Nagel anomaloscope is a “gold standard” reference test for identifying and classifying red-green color deficiency. The matching range on the red/green mixture scale indicates the severity of the hue discrimination deficit in anomalous trichromatism. Results for 107 protanomalous and 410 deuteranomalous trichromats were abstracted from files in a Color Vision Advisory Clinic and compared with the Nagel anomaloscope matching range. The D15 was illuminated with the MacBeth Easel lamp. Thirty-six percent of subjects passed the D15 using the criterion of a circular results diagram, 27% of subjects passed if 1 red-green isochromatic error was included as a pass. A higher percentage of protanomalous than deuteranomalous trichromats failed. Failure was clearly related to the Nagel matching range in deuteranomalous but not in protanomalous trichromatism. For example, 84% of deuteranomalous subjects with matching ranges > 30 scale units failed the D15, using the criterion of a circular results diagram, but only 2% with matching ranges < 9 scale units were unsuccessful. In comparison 53% of protanomalous subjects with matching ranges > 15 scale units and 33% with matching ranges < 5 units failed the test. Protanomalous trichromats are able to utilise perceived luminance contrast to obtain good results on the D15 because relative luminous efficiency is shifted towards shorter wavelengths. The shift is smaller in slight/minimal protanomalous trichromatism and the high failure rate shows the true loss of hue discrimination ability found in this type of color deficiency. Use of the D15 for occupational selection should be limited to deuteranomalous trichromats.

Learning Objectives: 1. To demonstrate the importance of clinical audit. 2. To show that “screening” accuracy depends on test design.

[288] AUTOMATED TESTING OF CONE CONTRAST SENSITIVITY

J. RABIN, J. GOOCH and D. IVAN

USAF School of Aerospace Medicine, Brooks City-Base, TX

The ability to discriminate the myriad colors that surround us depends fundamentally on three cone photoreceptors (red=L, green=M, blue=S). Hereditary color deficiency (CD; 8% of males, 1/200 females) is due to a sensitivity shift or lack of L or M cones. Hereditary S cone CD is rare but S cone sensitivity loss occurs early in eye disease making S cone clinical tests needed. While most color tests readily indicate the presence of CD few reveal type (L, M or S) or severity of CD and few quantify S cone CD. Numerous occupations are seeking quantitative tests which link measured color ability to real-world color demands. We describe a computer-controlled test in which L, M and S-specific colored targets appear briefly on a grey background in gradually decreasing steps of visibility (contrast). The lowest contrast for target recognition is determined separately for L, M and S (cone contrast sensitivity; cone CS). Sensitivity of cone CS in CD pilots and aircrew (n=161) is 100% with all correctly identified as protan or deutan as confirmed by anomaloscope. In comparison, single-test PIP screening identifies only 68% of the same CD population while combining multiple PIP tests improves sensitivity to 93%. Yet cone CS has several advantages over PIP and comparable testing including: (1) Stimulus randomization to prevent rehearsal/learning effects (2) Time-limited stimulus presentation with the ability to record reaction time (3) Voice-activated automated scoring (4) Quantification of true threshold L, M and S cone specific performance in <2 minutes. In addition, cone CS has proven invaluable for detection of acquired CD in eye and neurological disease (e.g., retinopathy, neuropathy, glaucoma) and in rare forms of hereditary CD (e.g., tritan). The automated version of cone CS will

be demonstrated and the relation between cone CS and computer-based operational tests of color performance will be described.

Learning Objectives: 1. To understand cone specific contrast sensitivity. 2. To understand how cone specific testing reveals type and severity of color deficiency. 3. To comprehend benefits of automated testing of color vision.

[289] COLOR VISION STANDARDS: US ARMY PERSPECTIVE

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¹Brooke Army Medical Center, Fort Rucker, AL; ²None Given, Enterprise, AL; ³US Army Aeromedical Activity, Fort Rucker, AL

The current policy for disqualification and waivers/exceptions to policy for Color Vision Deficiencies in the US Army will be reviewed. A brief review of the history of handling previous cases and policies will be presented. The US Army philosophy of evaluating and managing those with color vision abnormalities will be discussed. The policy was reviewed and revised in January 2007 and then again in October 2007 after the recent Tri-Service Color Vision Summit in August. Color vision deficiencies are disqualifying with waivers/exceptions to policy allowable based on a comprehensive evaluation and assessment of functional performance.

Learning Objectives: 1. Review of US Army Aeromedical policy on Color Vision Deficiency 2. Discuss Color Safe versus Color Normal. 3. Discuss areas of functional research needed.

[290] COLOR VISION ASSESSMENT. A U.S. NAVY PERSPECTIVE

R. A. BEANE, S. O'CONNELL, K. MCGOWAN and A. STALCUP

Naval Aerospace Medical Institute, Pensacola, FL

The U.S. Navy has incorporated color vision in the assessment process for U.S. Navy aviators since its inception. Under the premise of color effective vice color normal, the U.S. Navy has employed the Farnsworth Lantern and a combination of Pseudo-Isochromatic Plates vice the use of the Anomaloscope for this assessment. Although gross safety suggests that the standards are sufficient for safety of flight, no assessment has focused on cockpit performance to date. The ever increasing technology, both within the cockpit and the air traffic control environment, present significant issues to both aircraft designers and to the aeromedical assessment community. The U.S. Navy approach will be to stratify the level of color vision deficit within our aviator population and prospectively assess any correlation with performance within the cockpit. In addition, the use of the Farnsworth F2 plate, a blue-yellow discriminatory pattern, may prove useful in assessing acquired color vision deficits. Finally the ability to develop a frequency specific pseudo-isochromatic plate, specific to hues employed within modern day and future cockpits, may be achievable.

Learning Objectives: 1. Clarification of U.S. Navy color vision policy. 2. Identify opportunities for future color vision research.

[291] EFFECTIVENESS OF THE FARNSWORTH LANTERN, D-15, AND FM-100 HUE TESTS TO IDENTIFY COLOR VISION DEFECTIVES WITHIN A PRE-SCREENED USAF PILOT CANDIDATE POOL

D. J. IVAN¹, C. KURZ², J. GOOCH³, J. RABIN³ and B. THOMPSON¹

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Purpose: Normal color vision (CV) has been a prerequisite for military aviation since World War I. Over the years, emergent technologies and modern operational demands have expanded CV challenges beyond simple red, green, yellow, and white tasks into more complicated full-spectral challenges. Following successful passage of a pseudoisochromatic plate test (PIP I, congenital red-green; 10/14 correct to pass), all prospective USAF pilot applicants are further screened for CV normalcy using a battery of tests during Medical Flight Screening (MFS) at USAFSAM. Methods: All USAF pilot applicants who passed the PIP I in the field were tested on the MFS CV battery. Out of 10,760 eyes, 141 CV defective eyes, as verified by Rayleigh and Moreland anomaloscopes, were administered the Farnsworth Lantern (FALANT), Farnsworth-Munsell 100-Hue (FM-100), and Dichotomous D-15. This study compares the effectiveness of these common ancillary CV tests to identify CV defective pilot applicants.

Results: Within this USAF pilot applicant population, the FALANT, FM-100, and the D-15, only identified, respectively, 45.9%, 36.9%, and 19.1% of CV defective eyes, to include severe deficits. Hence, these ancillary tests failed to identify a CV deficiency in 53-81% of applicants. **Discussion:** Although pre-screening CV with a PIP I in the field eliminates some candidates, it does not reliably identify all CV defectives. Further, the FALANT, FM-100, and D-15 do not definitively identify significant CV deficiencies, even within a PIP I pre-screened population.

Learning Objectives: 1. Learn effectiveness of common ancillary color vision tests. 2. Effectiveness of the PIP I in a pilot candidate pool. 3. Understand effectiveness of USAF color vision testing for pilots.

Tuesday, May 13

2:30PM

POSTER: Human Factors in Aviation

[292] PRIVATE PILOT AIRPLANE SINGLE-ENGINE LAND (P-ASEL) INSTRUCTION AND PRACTICAL TEST EXPERIENCES

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Introduction: The Federal Aviation Administration (FAA) and the aviation industry work together to prevent general aviation (GA) accidents. As part of that collaboration, designated pilot examiners (DPEs) and Part 141 schools with examining authority are tasked with ensuring that only those capable of safely performing as pilot in command are certificated with those privileges. Ensuring that pilot applicants' examinations are in full compliance with the Practical Test Standards is one of the many safeguards in place to maintain GA safety. **Methods:** Pilots who were newly certificated for the Private Pilot Airplane Single-Engine Land category and class rating were surveyed. In 2006, we distributed 5,896 surveys and received 2,399 responses, for a return rate of 41%. Included were respondents who had recently been certificated by an examiner and had not failed a previous practical test. This resulted in 1,732 remaining valid surveys. **Results:** The majority of pilots were positive about the quality of their flight instruction, with 85% giving high marks. When asked about events evaluated during their exam, 94% said they were asked about weather information, 98% performed steep turns, and over 96% were evaluated on stalls (power-on and power-off). Pilots also indicated which events, if any, they were asked to repeat during their examination. Steep turns were repeated by 10% of pilots, 7% repeated short-field approach and landing, and 6% repeated power-on stalls. When we examined the reasons for the request to repeat, 28% of pilots surveyed provided at least one reason that we content-coded as marginal or poor performance. **Conclusions:** Allowing flight maneuvers to be repeated during an exam due to poor performance does not comply with FAA regulations. FAA Flight Standards adopted several recommended practices aimed at improving the DPE program, including briefing examiners on survey results and emphasizing the importance of standardized practical tests.

Learning Objectives: 1. Factors related to testing pilots during their practical test will be discussed. 2. Importance of standardized tests will be described.

[293] AVIATION SAFETY INSPECTORS' MAINTENANCE HUMAN FACTORS SURVEY

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¹FAA, Oklahoma City, OK; ²FAA, Atlanta, GA; ³FAA, Washington, DC

Introduction: The National Transportation Safety Board has issued several recommendations for air carriers to reduce the number of human errors in aviation maintenance. One of those recommendations includes implementing a human factors (HF) program. Currently, the Federal Aviation Administration (FAA) has opted for a voluntary approach to maintenance HF programs in contrast to other regulatory bodies such as the European Aviation Safety Agency. We surveyed Flights Standards Service (AFS) Airworthiness Aviation Safety Inspectors (ASIs) who oversee and enforce safety regulations for the maintenance of aircraft and asked their opinion of maintenance HF issues. **Methods:** A 45-item, on-line survey was distributed to 1,824 AFS Airworthiness ASIs during April 2007, resulting in an overall response rate of 44.9% (n=819). Survey areas

included job function, demographics, operator oversight, and maintenance HF. **Results:** Nearly 90% (87.4%) of ASIs indicated the FAA should mandate maintenance HF programs. The FAA has developed an operator's manual with a simple and manageable list of actions to implement a maintenance HF program; however, 31.9% of ASIs are not familiar with it and 50.9% do not use the manual in their job duties. Only 24.1% of ASIs indicated they have adequate knowledge about HF to perform their duties, and 73.9% of ASIs would like the FAA to provide more HF training to assist them with maintenance HF oversight. Of the ASIs (n=694) with operator oversight, (1) Pressure, (2) Complacency, and (3) Norms were rated as the top three HF challenges to their operators. **Discussion:** The majority of ASIs want regulatory support for maintenance HF programs. Open-ended comments from ASIs suggest that, without regulatory requirements, they do not have the necessary influence to encourage companies to adopt HF practices beyond the bare minimum.

Learning Objectives: 1. Learn more about maintenance human factors issues from the perspective of FAA Airworthiness Inspectors.

[294] INTERNATIONAL SURVEY OF AIRLINE MAINTENANCE ORGANIZATIONS REGARDING HUMAN FACTORS BY SIZE OF COMPANY

K. HOLCOMB, C. HACKWORTH, J. BANKS and D. SCHROEDER
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Introduction: Human factors (HF) aviation maintenance programs can affect the day-to-day operations of maintenance organizations. Few studies have explored organizational differences in HF programs. This study examines the diversity of HF programs by size of company. **Method:** An on-line survey was e-mailed to 630 respondents, and 414 valid surveys were returned from respondents from more than 50 countries (65.7% response rate). Respondents were split into four groups based upon the number of employees that worked in their maintenance and engineering department/company (Small [1-30], n = 69; Medium [31-300], n = 81; Large [301-1500], n = 70; and Extra Large [XL, 1500+], n = 70). **Results:** Almost 95% of XL companies have either a formal or informal approach to human error (HE) investigations, with large companies following close behind at 89.7%; whereas, small companies (16.1%) have no processes or immediate plans for HE investigations. Of those that had a formal or informal approach, over 70% of large and XL companies have HE data stored in a database; whereas, less than 60% of small and medium companies do. More than 20% of respondents from small companies do not know if their companies store their HE data. Nearly 90% of all large and XL companies have an existing course for HF training or are developing a course. By contrast, small companies (24.1%) have no plans for development. Over 50% of all companies introduce HF in training of new maintenance employees, with large companies having the most at nearly 75%. **Conclusion:** The more employees a company has, the more likely they are to have a formal or informal system for HF, storage of HE data, and better training for new maintenance employees.

Learning Objectives: 1. To explore the diversity of human factors programs by size of company.

[295] THE EVALUATION OF PILOT'S INFLIGHT WORKLOAD

Z. Y. JUN

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Introduction: Establishing a standard evaluation procedure of flight workload by using the Pilot's Inflight Physiology Parameters Recorder (BodyMonBelt?), providing flight surgeons an effective method to evaluate pilots' inflight mental and physiology conditions. **Methods:** The relationship between G load, ECG, HRV (heart rate variability) recorded by BodyMonBelt? and fighter plane pilot's in flight workload was evaluated through a mathematical function setup via statistical ways, then the evaluating results were tested in actual flights. **Results:** 7 fighter plane pilots and 17 sorties of aerobatics were recorded. While the G loads increased from 1 to >7 Gz, the mean heart rate increased from 84±9 bpm to 108±16 bpm (P<0.05). The LFNU index of HRV increased from 71.47±21.13 to 94.14±7.00 (P<0.05). The workloads affecting the physiological parameters significantly in statistics were divided into 5 levels by sort ascending. With discriminatory analysis, the function of the G load growing rate, maximum instant heart rate and the inflight physical workload, and the function of the mean heart rate, HRV and the mental workload were established. The internal test showed there were no overlaps of judgement between level 1 and level 5 workloads completely. In external test, if a pilot, whose workload was determined by level 1, appeared at workload level 5, the pilot was considered in "abnormal" heavy workload. Whereas at

level 5 but appeared at workload level 1, was considered in "abnormal" light workload. There were 24 pilots and 79 sorties recorded and 9691 data were obtained in external tests. The determining coincidence rate of physical workload level 1 was 100%, mental workload level 1 was 99.31%. The level 5 "abnormal" mental workloads occurred during taking off, landing, attack and unexpected events and they all coincident with the accruals. The hypothesis is proved. **Conclusion:** Flight surgeons should pay more attention to those pilots who were in "abnormal" workloads evaluated by this procedure. This procedure has put into actual operations.

Learning Objectives: 1. The relationship between the G load, ECG, HRV (heart rate variability) and the fighter plane pilots in flight workload will be discussed.

[296] THE AFFECT OF INCREASING THE AIRCREW ANTHROPOMETRIC RANGE

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The anthropometric measures associated with defining the minimum level of physical accommodation for men and women in the cockpit, have been completed over the years by various nations to enable the design of the cockpit environment, the aircrew flight equipment and the escape system. Historically, this was limited to a smaller male population, but the introduction of small female aircrew, along with the global increase in human body sizes, has now meant that a wider anthropometric range needs to be addressed. The resulting affects of increasing the anthropometric range, is that the cockpit must be accessible to a small female with a reach of 26.1-inches, and not restrictive to a large male with a reach of 33.9-inches, the restraint system must be able to cater for a shoulder height of between 19.5 – 27.6-inches and the seat contours, under thigh support and rudder pedal positions must achieve suitable comfort for all. Additionally, an increase in body mass to 245lbs will affect the escape system performance with regards to clearance, ejection injuries, parachute opening forces and the overall descent rate, and these changes must be both statistically analysed and tested. The development of escape systems and their integration into the cockpit must address these human factors and ensure through design and testing that the accommodation range is met. Presented here will be a comparison between various anthropometric surveys, how they are used to drive designs and how they affect aircrew tasks and fundamentally the escape system performance.

Learning Objectives: 1. The affect that increasing the anthropometric range has on seat design, ergonomics, cockpit environment and the ejection seat escape system is described.

[297] APPROACH AND LANDING FLIGHT SYMBOLOGY FOR THE PREDATOR UNMANNED AERIAL SYSTEM

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Introduction: The need for specialized flight symbology during low-visibility and nighttime landings continues. Several programs have surfaced over the past few years that address the landing issue by developing improved sensors, installing better aircraft handling capabilities, and studying modifications to the way lift is generated. All of these programs are important and will yield improvements to the flight capability of future aircraft, but simple changes to flight symbology can be made now that will help resolve landing problems found with Unmanned Aerial Systems like Predator. The prototype Visual Orientation and Landing Attitude (VOLA) HUD was first demonstrated in 2006 to help solve this problem and met with some success. **Methods:** The VOLA HUD takes traditional flight symbology currently used for precision instrument approaches and develops it so the symbology can provide all the necessary information to continue the approach beyond decision height to the touchdown phase. The idea is to create a seamless transition at the decision height so the pilot can continue all the way to touchdown without the need to see anything other than the flight symbology. **Results:** Most pilots were able to land within the first 1/3 of the runway; a landing footprint will be shown for a variety of visibility conditions. It was found that the symbology for distance along the runway must be improved but the first part of the landing phase shows promise. **Discussion:** Cognitive task analysis of the landing phase of flight can be used to inform the design of flight symbology, which may have application in both unmanned and manned cockpits.

Learning Objectives: 1. Future symbology development will be discussed as it applies to Unmanned Aerial Systems.

[298] LEARNING AND RETENTION OF VR-BASED PREFLIGHT 3D NAVIGATION TRAINING

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Introduction: Spatial disorientation and navigation problems have been frequently reported by astronauts, complicating responses to emergencies. Complex 3D architecture and inconsistency of the visual vertical of adjacent modules of spacecraft, combined with the limited visual experience, are the major causes. Navigation requires cognitive skills to interrelate cues perceived in a body-centered (egocentric) frame of reference built up through experience and an overall (allocentric) frame of reference defined by the spacecraft. Astronauts can either learn to make this interrelationship inflight, or prior to flight via VR simulation. This study intended to clarify whether VR navigation training of ISS modules in their flight configuration can help to develop cognitive skills and to improve skill retention. **Method:** In the experiment, two groups of subjects (Control, Treatment; 6 subjects each) explored a virtual ISS with a desktop computer. During Training, two groups were trained in different manner but had the same total training time. The control group learned each module separately, while the treatment group learned whole ISS at once. The treatment group also could see through the wall of local module and manipulate a virtual 3D ISS model. In Testing, subjects were told their destination and asked to point there. Upon arrival at the destination they pointed back to the start point. Smoke sometimes obstructed the visibility. Testing was also done 7 and 30 days later, where only the treatment group was told pointing angular error in the previous testing as feedback. **Results:** Pointing angular error and time to move between modules were less in the treatment group on the training day, but the same in both groups 30 days later. **Conclusion:** The results showed the effectiveness of preflight VR training, especially in early stage of learning. Supported by NASA Cooperative Agreement NCC9-58 with NSBRI.

Learning Objectives: 1. The effectiveness of VR-based preflight spatial orientation and navigation training will be discussed.

[299] ROD PLACEMENT DIFFERS WITH CLOCKWISE AND COUNTERCLOCKWISE FRAME ORIENTATIONS USING THE CLASSIC ROD AND FRAME TASK: IMPLICATIONS FOR SPATIAL DISORIENTATION

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Purpose: The Rod and Fame Task (RFT) identifies field dependent individuals who align a rod in the direction of the frame's rotation from field independent individuals who are not affected by the frame's orientation. From several preliminary studies, we noticed an asymmetrical effect where the counterclockwise frame produced a larger rod placement error than the clockwise frame. From the literature, either one off-axis frame orientation was presented not allowing a comparison, or if both were presented, the difference between clockwise (CW) and counterclockwise (CCW) orientations were not discussed. **Method:** Thirty-two men and women, Mean age 20.9 years volunteered. Seventeen had normal, uncorrected vision and 15 had myopic vision. An eye chart verified reported vision status. Using a Latin square design, observers were presented with a frame at 22.5 deg CW, 22.5 CCW, and upright. Starting position of the electroluminescent rod was counterbalanced between left and right. Two trials were presented for each frame orientation. Nearsighted observers were tested twice, with and without vision correction. The square frame measured 109.2 cm on a side. The rod locate in the center was 2.54 cm W x 66 cm L. The apparatus was 183 cm from the nasion to the apparatus, with a retinal angle of 31 deg. **Results:** The CCW frame produced a significantly larger rod deviation ($M = 3.69$ deg) from the upright than the CW orientation ($M = 2$ deg), $t(31) = 2.98$, $p < .002$. No differences were found between nearsighted individuals with and without vision correction and normal, uncorrected vision individuals. A significant correlation was found between nearsighted individuals with and without vision correct for CCW (0.89), but no correlation was found for the CW orientation. **Discussion:** These findings suggest that viewing an external scene rolled CCW may result in more disorientation.

Learning Objectives: 1. The audience will learn of the asymmetrical effects associated with a spatial display.

[300] MOTION SICKNESS, POSTURAL INSTABILITY AND VIRTUAL ENVIRONMENTS

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Background. Large-field visual oscillations of a physical environment (e.g. a moving room) have been shown to induce both instability in body posture and motion sickness. We investigated whether visual oscillation of a virtual environment via a video projector system would exhibit the same nauseogenic properties and postural instability.

Method. Standing participants were exposed to a computer-generated simulation of an oscillating virtual room. The simulation was viewed for up to 40 minutes, and participants were requested to discontinue the experiment if they experienced motion sickness symptoms. Sickness was assessed by subjective reports and symptom severity was evaluated using the Simulator Sickness Questionnaire (SSQ). Postural motion was assessed by tracking movements of the head and torso. Results. Motion sickness incidence (42%) was not different than previous studies which used the analogous physical moving room. Post-test SSQ scores were significantly higher than pre-test scores for the Sick group relative to the Well group. Changes in the magnitude of movement prior to the onset of motion sickness were exhibited by the Sick group relative to the Well group.

Conclusion. The nauseogenic properties of physical moving rooms extend to virtual moving rooms. As predicted by the postural instability theory of motion sickness, changes in postural motion preceded motion sickness in an oscillating virtual environment. These findings may have practical implications for the use of virtual environments as models for training in physical environments.

Learning Objectives: 1. The audience will learn about the influence of body sway on susceptibility to motion sickness when exposed to visually challenging virtual environments.

[301] EXERCISE-INDUCED DEHYDRATION AND ITS EFFECTS ON MOOD, PERCEPTION, AND SLEEPINESS IN SEDENTARY SUBJECTS

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Purpose: To determine 1) the impact of dehydration on perception, mood, and sleepiness and 2) the ability of salivary osmolality to detect hydration status. **Method:** Four female and 2 male (19-22 yrs) volunteers self-reported casual exercise 3 or less times/week. Acute states of dehydration were generated by requiring hydrated participants to exercise until weight was reduced by 2% of pre-exercise weight. All subjects were hydrated during a 48 hour period before testing by consuming a predetermined volume of water based on their weight. At 6:00 AM on the day of testing food and water intake was stopped. At 7:00- AM pre-exercise perception tasks and mood and sleepiness scales were administered. Immediately upon completion they began their exercise program for 1.5 – 2.5 hrs without fluids. Saliva samples were collected from each subject immediately post-exercise. Perception tasks, and sleepiness and mood scales were re-administered. Saliva samples were obtained one and two hrs after psychological testing. For the hydration phase the above conditions were repeated and subjects hydrated without exercise for 1.5- 2.5 hrs. The following perception tasks and scales were administered: 1) the Autokinetic Illusion, 2) Rod-Frame Task 3) eye alignments 4) Epworth Sleepiness Scale and 5) Positive and Negative Affect Scale. **Results:** Only positive mood was significantly reduced after exercise-induced dehydration ($M = 32.7$ to 21.5), $t(5) = 4.68$, $p < 0.0054$). No difference occurred between pre- and post control (no exercise). No changes were found for negative affect, sleepiness, and the perception tasks. Osmolality of saliva failed to reflect any differences among the various samples from the hydrated state. **Discussion:** A 2% level of dehydration significantly reduced positive affect but did not effect perception & sleepiness in sedentary individuals.

Learning Objectives: 1. We will discuss the role of dehydration on mood in sedentary individuals.

[302] EXERCISE-INDUCED DEHYDRATION AND ITS EFFECT ON MOOD, SLEEPINESS, AND PERCEPTION IN FIT SUBJECTSA. DILZER¹, L. HOWE¹, A. SORRENTINO¹, P. ILCZYSZYN¹, M. MIRAGLIA¹, J. SMITH¹, A. GEBczyk¹, K. CUBITO¹, E. SHUSTERMAN², W. R. PROULX¹ and L. T. GUZY¹¹State University of New York at Oneonta, Oneonta, NY; ²Oraya Therapeutics, Inc., Newark, CA

Purpose: To determine 1) the impact of dehydration on perception, mood, and sleepiness and 2) the ability of salivary osmolality to detect hydration status. **Method:** Six women and three men (20-25 yrs) who self-reported regular exercise of at least one hour/day volunteered. Acute states of dehydration were generated by requiring hydrated participants to exercise until weight was reduced by 2% of pre-exercise weight. All subjects were hydrated during a 48 hour period before testing by consuming a predetermined volume of water based on their weight. At 6:00 AM on the day of testing food and water intake was stopped. At 7:00- AM baseline saliva and body weights were obtained. Subjects performed their regular exercise program for 1-1.5 hrs without fluids. Post-exercise saliva samples were collected from each subject immediately following exercise. Perception tasks, and sleepiness and mood scales were administered. Saliva samples were obtained one and two hrs after psychological testing. For the hydration phase the above conditions were repeated except subjects maintained their pre-exercise weight by consuming water throughout the 1-1.5 hrs of exercise. The following perception tasks and scales were administered: 1) the Autokinetic Illusion, 2) Rod-Frame Task 3) eye alignments 4) Epworth Sleepiness Scale and 5) Positive and Negative Affect Scale. **Results:** Only positive mood was significantly reduced after exercise-induced dehydration ($M = 31.1$ to 23.4), $t(7) = 5.8$, $p < 0.0001$). No changes were found for negative affect, sleepiness, and the perception tasks. Osmolality of saliva accurately reflected the pre-exercise hydrated states ($M = 58$) and post-exercise dehydrated state ($M = 89$), $t(8) = 3.05$, $p < 0.02$. **Discussion:** A 2% level of dehydration significantly reduced positive affect but not negative affect, perception & sleepiness. Salivary osmolality detected dehydration in 7 of 9 participants. Salivary osmolality returned to pre-exercise levels after 1 hour of hydration.

Learning Objectives: 1. The role of dehydration as it relates to mood will be discussed.

Tuesday, May 13

2:30PM

POSTER: Aviation Safety**[303] ODONTOLOGY: KEY IN AVIATION ACCIDENT INVESTIGATION**

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Currently, commercial aviation has increased along with the number of personnel involved in the industry and the number of flights that service the world's public. As a consequence, the number of flight personnel such as aircrew and flight attendants has also increased. In terms of aviation accidents that occurred during the last ten years, the identification of human remains has been aided by the following methods: 1) assessment of passenger lists, 2) Association and Exclusion, 3) Assessment of Personal Effects, 4) Dactiloscopia, 5) Genetics (DNA sampling), and 6) Odontology. This list reflects the order in which the investigator proceeds to identify the accident victims and in which odontology is the last technological recourse considered for said identification. Meanwhile, there are an augmented number of flights proceeding from nations which odontological "culture" is not adequate or parallel to those nations that are more advanced in this aspect of health care. For example, oral health in advanced and wealthy nations is a basic custom where routine oral care is common, including clinical and radiographic information obtained as a result of the propedeutic assessment of the patient. Other nations, particularly in Asia, Africa, Latin-America, and some in Europe, do not enjoy this culture or the dentist does not possess the equipment and materials necessary to realize it, including x-ray technology. In spite of these shortcomings, it is necessary that the appropriate authorities require all commercial aviation personnel to count with an ante-mortem odontologic profile that includes dental chart and x-ray records (e.g., panorex and periapical) sufficiently complete and which utilize a clear, common, and practical language for use throughout the world. This profile will significantly facilitate the immediate identification of accident victims. The presentation will provide the implications of this recommendation and the methodology to make it possible for implementation.

Learning Objectives: 1. The need for ante-mortem odontology records in accident investigation.

[304] PITFALLS IN TOXICOLOGICAL INVESTIGATION FOLLOWING AIRCRAFT ACCIDENTS

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Introduction: Extensive toxicological investigation following aircraft accidents are indispensable to causal clarification. Due to the particular nature of aircraft accidents, numerous difficulties occur in the process which need to be taken into account during investigation and in the interpretation of findings. **Methods:** Due to the potential vast range of legal consequences, the equipment and methods used must be state-of-the-art and must conform to current scientific standards and applicable regulation. Whenever possible, the results must be confirmed by at least two mutually independent investigations, using different principles of measurement. Two exemplary cases demonstrate how limited toxicological analyses may result in grossly wrong assessments. **Results:** The cases shown demonstrate that in the event of aircraft accidents only a large-scale investigation will produce useful and meaningful results. In the process, extensive toxicological investigation of various materials is urgently required not only for pharmacological reasons. In most cases, postmortem changes or any other disturbing factors can thus be recognised and be adequately taken into account. In addition, only close cooperation between the toxicologist and the post-mortem examiner and/or the accident site team frequently allows for the conclusive interpretation of findings. This, however, involves a high risk of being "misled" by background information and of limiting the volume of investigation, thus missing essential findings in the first place. **Conclusion:** Post-accident toxicological investigations must be performed on several different materials, using several mutually independent methods. The impact of potential postmortem changes or of other disturbing factors must be taken into account. Although background information may contribute to saving costs, it may also lead to an unnoticed limitation of the investigation and finally yield incorrect results.

Learning Objectives: 1. Post-accident toxicological investigations must be performed on several different materials, using several mutually independent methods. 2. The impact of potential postmortem changes or of other disturbing factors must be taken into account.

[305] IDENTIFICATION AND VALIDATION OF GENE EXPRESSION CHANGES OCCURRING DURING ACUTE ETHANOL USE

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Introduction: As part of the aviation safety program to define the adverse effects of ethanol on flying performance, we previously presented results of DNA microarray analysis of samples from a timecourse study of individuals given ethanol orally, and then evaluated by breathalyzer to monitor blood alcohol content (BAC). At five points, T1-T5, blood was drawn such that the samples represented 0%, 0.04%, 0.08%, return to 0.04%, and 0% BAC. The microarray analysis showed that changes in gene expression could be detected across the timecourse. This suggested that it was possible to detect patterns of change in gene expression due to the acute presence of imbibed ethanol using total RNA isolated from whole blood. **Methods:** In a continued study reported here, differential expression analysis of the microarray data was performed using either a modified t-test (LPE) or Extraction of Differential Gene Expression (EDGE). Candidate genes of interest (GOI) were selected over a range of fold changes for validation of the microarray analysis with Q-PCR. Primers targeted to the same region of mRNA as the microarray were developed for each candidate. **Results:** The Q-PCR results supported the microarray data for EDGE-selected GOI and for seven of eight LPE-selected genes. The failed GOI had a fold change of 1.25. The lowest validated fold change was 1.5. **Discussion:** It appears that both methods used for analysis of microarray data are valid. Both selected genes whose expression indicated change with time and alcohol concentration that could be validated via Q-PCR. The limits of detection were 1.5 fold for the LPE-selected genes and Q-values <0.0019 in the EDGE-selected genes. These methods can be utilized as a workflow to identify timecourse changes in gene expression that may affect pilot performance.

Learning Objectives: 1. The audience will understand methods of validating patterns of gene expression reflecting levels of imbibed ethanol in blood.

[306] SHAKEN AVIATOR SYNDROME: TRAUMATIC BRAIN INJURY IN TWO U.S. ARMY HELICOPTER ACCIDENTS

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Introduction: Head injuries commonly occur as a result of aviation-related mishaps. It is estimated that up to 20% of all aircraft mishap fatalities are due to serious head injury. The integration of protective headgear (i.e., helmets) into military aviation has not only led to a reduction in sustained head injuries, it has also proven to be life saving. However, in some cases of severe accelerative forces, helmets offer little or no protection. **Methods:** Two recent fatal accidents involving U.S. Army UH-60 aircraft were investigated by the Aviation Life-Support Equipment Retrieval Program (ALSERP) of the United States Army Aeromedical Research Laboratory (USAAARL). **Results:** These two cases illustrate examples of head-injury mechanisms in rotary-wing accidents. In both UH-60 mishaps, the occupant was exposed to a different directional acceleration. Specifically, in the first mishap, the occupant was subjected to rotational acceleration which resulted in a subdural hematoma. The occupant involved in the second mishap experienced vertical acceleration resulting in a subarachnoid hemorrhage. Both individuals showed evidence of diffuse axonal injury caused by the shearing of brain tissue and stretching of blood vessels. While neither occupant showed signs of significant external head trauma, both later died of internal head injuries. **Discussion:** Accelerative forces during aircraft accidents can cause severe head motion, which in turn, strain the vessels and tissue of the brain. During an accident, the brain may move relative to the dura and skull causing localized strain on vascular tissue. The vessels may become stretched beyond their elastic limit resulting in rupture, hemorrhage, or even death. The kinematics of some rotary-wing mishaps produce head accelerations which can cause traumatic brain injury with no evidence of external trauma to the head or damage to the helmet. In these cases, the helmet provides very little protection against internal head injuries.

Learning Objectives: 1. While protective headgear reduces the risk of some head injuries, it may not always protect against internal head injuries that result from accelerative forces. 2. Head injuries may be present with no external head trauma or damage.

[307] COMPARISON OF STUDIES ON GENERAL AVIATION ACCIDENTS IN DIFFERENT COUNTRIES USING THE HFACS MODEL

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Introduction: The application of the HFACS model [1] for aircraft accident analysis facilitates comparisons between different studies and countries. The aim of the present study was to compare published studies on aircraft accidents in the field of General Aviation (GA) and to identify and compare causing factors by means of the HFACS model. **Methods:** A systematic Medline research was performed to gather all published studies on GA aircraft accidents between 1968 and 2007. Data was compared using the HFACS model. **Results:** A total of N=10 studies on GA accident analysis were identified. N=6 studies were excluded from analysis (investigation was mainly military and airline operation). N=4 studies dated 1978 to 2005 were analyzed [2-5]. The mean time frame of these studies was 11±9 years. Three studies analyzed US and one German GA accidents (total N=534 aircraft accidents). None of the studies reported ergonomic or medical problems. Only one study reports 7 % of accidents due to crew resource management problems and 15 % due to organizational factors. All four studies state skill-based errors as the main reason (mean 53±19 %) for accidents. Decision errors (21 %) and 37 %) were reported in only two studies. Only one study mentions perception errors (34 %) and violations (8 %) as causing factors. Pilot errors were reported to contribute to GA accidents homogeneously in approx. 80 % of all analyzed cases. **Conclusion:** Comparing different published studies on GA accidents is difficult due to inhomogeneous denominator data. For future research it is essential to define uniform denominator data and consistent data sets. Skill-

based pilot errors were homogeneously reported as the main causing factors, but were not further divided and analyzed.

References: [1] Shappell SA et al. Hum Fact Aerosp Safety 2001;1:59-86. [2] Dambier M et al. Air Med J 2006; 25(6):265-9. [3] Pagan BJ et al. Aviat Space Environ Med 2006;77:950-2. [4] van Doorn RRA et al. Aviat Space Environ Med 2007;78:26-8. [5] Gaur D. Aviat Space Environ Med 2005;76:501-5.

Learning Objectives: 1. Studies on General Aviation accidents are difficult to compare.

[308] CATEGORIZATION OF PRIMARY RECOMMENDATIONS FROM FY 06 AND 07 USAF CLASS A AVIATION MISHAPS WITHIN THE DESIGN ORDER OF PRECEDENCE

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Introduction: US Air Force Instruction 91-204 says all safety investigations should include recommendations to mitigate future mishaps and developing these recommendations requires recognition of the "order of precedence" concept. This concept means identifying recommendations in the following order: design fixes, incorporating safety devices, providing warning devices, and, lastly, developing training and procedures. Recommendations higher in the "order of precedence" will more completely eliminate the hazard. To date, no specific work has categorized the recommendations of USAF Class A Aviation mishaps to level of the "order of precedence." **Methods:** Four expert raters reviewed mishap reports for 70 United States Air Force Class A mishaps from FY 06 and 07. Reviewers were professional safety investigators and safety policy consultants. All were thoroughly trained in US Air Force mishap investigation and had experience in writing recommendations. Each rater classified each recommendation from the 70 mishaps within one of five categories (the categories included the four categories of the "order of precedence" and an additional other category to classify outliers). The four raters reviewed all recommendations in a group setting to reach a consensus on the classification of the recommendations. **Results:** The mishaps were broken down into two categories, mishaps which were not coded with human factors codes and mishaps which were coded with human factors codes. The recommendations for non-human factors coded mishaps had a tendency to intervene at the upper level of the "order of precedence" and human factors-related mishaps had a tendency to intervene at the lower end of the "order of precedence." **Discussion:** Recommendations from FY06 and 07 USAF aviation mishaps attempt to prevent future mishaps. Recommendations for non-human factors Class A Aviation mishaps tend to be higher on the "order of precedence" and human factors-related Class A Aviation mishaps tend to be lower on the "order of precedence."

Learning Objectives: 1. The audience will learn the "order of precedence" classification for FY06-07 USAF Class A Aviation mishap recommendations.

[309] APPLYING THE HFACS MODEL TO A NEW DOMAIN: THE MAINTENANCE OF GERMAN ULTRALIGHT AIRCRAFTS

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Introduction: The HFACS model [1] is established since many years to analyze aircraft accidents in detail. It is used to identify and analyze the "human error" in an error chain leading to an aircraft accident [1]. Recently, first concepts to use HFACS for maintenance in commercial aviation were published. To date, the HFACS model has never been used to analyze the maintenance of ultralight aircrafts. The aim of the present study is to gather data for a low-regulated field of general aviation (ultralight aircraft) in Germany. **Methods:** In this prospective ongoing study, modification- and maintenance-deficiencies were retrieved by a standardized form and compared to data already published for General Aviation. Additionally denominator data were gathered by questioning technical examiners of ultralight aircrafts. **Results:** Data acquisition is very difficult due to concerns of technical examiners and aircraft owners. First results are promising, but do not allow a detailed analysis yet. **Conclusion:** Using the HFACS model in the maintenance domain, technical problems may be identified prior to aircraft accidents due to technical problems. This may interrupt the error chain leading to an accident. Concerns of participating organizations are intelligible, but need to be eliminated.

References: [1] Wiegmann DA. Aviat Space Environ Med 2001;72:1006-16.

Learning Objectives: 1. HFACS can be applied to maintenance.

[310] DATA DRIVEN AND THEORETICALLY DRIVEN APPROACHES TOWARD UNDERSTANDING SITUATION AWARENESS RELATED ACCIDENTS IN GENERAL AVIATION

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Background: Between the years 2000 and 2005, an average of 1750 general aviation accidents occurred annually, and an average of 600 lives were lost each year in general aviation (FAA, 2005). Loss of situation awareness (SA) may be part of the problem, as sustaining a high level of SA has been named an important but also a demanding aspect of the aviation environment (Endsley & Garland, 2000). Blickensderfer, Boquet, Nickens, & Duff (2007) identified over 200 general aviation accidents as caused by a loss of SA. The current study aimed to better understand the loss of SA in these 200+ accidents. **Methods:** Two studies were conducted. Both studies used an expert card-sort research method. Study one used a data driven approach to the card-sort. Three graduate students from a southeastern university who were studying SA theory (one of whom was a certified GA pilot), independently sorted the accidents into unspecified subcategories. Following the individual sorts, the three raters came to a consensus on the final categories. Study two used a theoretically driven approach to the card-sort method, as three additional raters sorted the same GA accidents according to the three levels that define SA (i.e., Endsley, 1995). In study two, all raters were certified GA pilots. **Results:** Subcategories from study one included weather (18%), fuel (12%), pilot inattention (15%), pilot inexperience (13%), and others. Study two indicated that 56% of the SA accidents were categorized as Level 1 (detection), 20% as Level 2 (comprehension), and 12% as Level 3 (prediction). **Conclusions:** This project examined general aviation accidents associated with SA. The results indicated that the majority of SA related accidents involve the most basic level of SA: detecting information. Additionally, this study indicates that the exact subject of the SA related accidents varies but frequently includes weather and fuel.

Learning Objectives: 1. Describe the expert card sort research method. 2. Name the situation awareness categories with the most accidents according to this study.

Tuesday, May 13

2:30 PM

POSTER: Human Performance in Aviation

[311] RELATIONSHIPS BETWEEN BEHAVIORAL COPING STRATEGIES AND DIURNAL CORTISOL

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A diurnal salivary cortisol rhythm characterized by high morning levels and low evening levels is thought to be indicative of healthier neuroendocrine functioning. In contrast, many studies have linked flattened diurnal salivary cortisol profiles to morbidity and mortality. We explored the effect of behavioral coping strategies on the diurnal cortisol profile in military men. **Methods:** 25 military men (age: 21.9 ± 2.4 years) in a free-living environment self-collected salivary cortisol samples for two consecutive days, at three time points each day: 0730, 0900, and 1930. In addition, the Ways of Coping Questionnaire was administered. Correlational analyses assessed relationships between coping strategies and cortisol concentrations. For those coping strategies demonstrating significant links to cortisol concentrations, a median split was conducted (i.e. high vs. low endorers of a given strategy), followed by a 2 (group) x 3 (time) mixed model ANOVA with repeated measures, in order to examine if a group x time interaction was present. **Results:** Significant positive correlations were observed between cortisol at 0730 and both distancing ($r = .55$, $p < .004$) and accepting responsibility ($r = .39$, $p = .055$). Significant inverse relationships were observed between cortisol at 1930 and planful problem solving ($r = -.47$, $p = .019$). Relative to distancing and accepting

responsibility, different diurnal patterns were exhibited. Distinctively, high endorers revealed elevated cortisol values at 0730, similar or lower cortisol values at 0900, and comparable values at 1930 (distancing-interaction effect, $p = .063$, observed power = .51; accepting responsibility-interaction effect, $p = .033$, observed power = .62). These patterns were not mediated by total sleep time or wake time. **Conclusion:** Our findings suggest that high endorers of certain coping strategies produce diurnal cortisol profiles containing a higher morning peak followed by a dramatic decrease throughout the day. This study was supported by the Office of Naval Research, Award No. N0001406WX20141.

Learning Objectives: 1. The relationships between behavioral coping styles and diurnal cortisol patterns will be explained.

[312] STANCE WIDTH INFLUENCES INCIDENCE OF VISUALLY INDUCED MOTION SICKNESS

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Background: Motion sickness is known to affect control of the body: people who are motion sick often are "wobbly". Our previous research has shown that unstable movement precedes subjective motion sickness symptoms. In unperturbed stance, postural sway in the body's mediolateral axis is reduced in magnitude when the feet are further apart in side-by-side stance. We evaluated the hypothesis that a stabilizing stance might reduce the incidence of visually induced motion sickness. **Methods:** Participants stood in a moving room that oscillated along their line of sight. Separate groups of participants stood with their heels together (0 cm condition), or with midlines of the heels 17 cm or 30 cm apart. The room moved in a sum-of-sines oscillation with frequencies from 0.1 – 0.4 Hz and amplitude 2 cm. Participants viewed up to four 10-minute presentations of oscillation and were instructed to discontinue immediately if they experienced any symptoms of motion sickness. We monitored movement of the head and torso using a magnetic tracking system. **Results:** Motion sickness incidence was 63%, 45%, and 24% in the 0 cm, 17 cm, and 30 cm conditions, respectively. The incidence of sickness differed across conditions ($p < .05$), indicating that motion sickness incidence was influenced by stance width. The mean time of discontinuation was 24 minutes (i.e., during trial 3). To be conservative, we analyzed movement data for trial 1 only. In the 30 cm condition mediolateral sway was reduced relative to the other conditions. Across conditions, sway tended to increase over time (during exposure) for both Sick and Well participants; however, the rate of increase was significantly greater among Sick participants. **Discussion:** Across conditions, motion sickness was preceded by changes in postural sway. In addition, the incidence of visually induced motion sickness was reduced when participants adopted a wider side-by-side stance.

Learning Objectives: 1. The audience will learn about the influence of posture (distance between the feet in side-by-side stance) on susceptibility to visually induced motion sickness.

[313] EFFECT OF INTRANASAL SCOPOLAMINE ON REACTION TIME AND WORKING MEMORY

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Introduction: Space Motion Sickness (SMS) is experienced by many astronauts during the initial 72 hours of space flight; promethazine and scopolamine are choice drugs for treatment. PMZ has sedative side effects and has been shown to reduce cognitive function. An intranasal dosage form of scopolamine (INSCOP) has been developed for prophylactic and rescue treatment of SMS to enhance efficacy and minimize cognitive side effects. The purpose of this dose escalation study is to determine the effect of INSCOP on cognitive function using reaction time and working memory tests. **Methods:** In a randomized, cross-over design, 12 healthy volunteers were administered 0.1, 0.2 and 0.4 mg INSCOP and a placebo one week apart. A cognitive test battery that included Match-to-Sample (working memory), Running Memory (short-term memory) and Simple Reaction Time tests were administered using the Automated Neurological Assessment Metrics (ANAM) Readiness Evaluation System (ARES®) cognitive test battery on a Palmpilot®. The tests were completed at scheduled times before and for 24 h post-dose. Reaction time and accuracy were calculated and compared between treatments and placebo using a general linear model. **Results:** No statistically significant differences were observed for mean reaction time and accuracy between placebo and treatments. However, a trend for increased reaction time at higher doses (between 0.75 - 3 h

post dose) was noticed. There was no significant effect of session order on any of the variables measured indicating that observed differences were treatment effect. These results indicate that INSCOP, at the administered doses, does not have significant cognitive side effects and therefore, is a better choice drug for the treatment of SMS.

Learning Objectives: 1. Microgravity effect on neurophysiology. 2. Microgravity effect on drug kinetics/dynamics. 3. Novel biomedical technology and applications to space flight.

[314] PSYCHOMOTOR PERFORMANCE AND PHYSIOLOGICAL EFFECTS OF HYPOBARIC EXPOSURE TO 12,400 FT

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Introduction: As part of a larger study to evaluate a 4-hr exposure to a hypobaric altitude-equivalent of 12,400 ft, we compared Psychomotor Vigilance Task (PVT) performance, heart rate (HR), blood oxygen saturation (SaO₂), and symptoms with pre- and post-ground level (GL) trials. **Method:** 20 male volunteers (Ss) consented to participate following a modified class 3 flight physical. Training occurred a day before altitude exposure (ALT). Pre-exposure testing was completed before ascent to 12,400 ft for 4 hr. Ss completed a 5-min PVT-192 trial at 3.75 hr into exposure. Post-exposure testing began 15 min after returning to GL. SaO₂ and HR were monitored (Nelson Pulse Oximeter) with a forehead electrode placement, and symptoms were reported using the USAF SAM Hypoxia Questionnaire. **Results:** Analysis of the pre-, during-, and post-altitude trials showed mean differences for performance and physiological measures at 12,400 ft, including: PVT mean response speed (MRRT=4.46, 4.14, 4.33), average number of lapses (i.e., RT>500 ms; 0.8, 1.5, 1.1), and false starts (2.5, 1.5, 3.9), as well as reported fatigue (4.2, 6.4, 4.7). SaO₂ (98.9, 87.8, 98.8%) and HR (75.8, 83.5, 74.4 BPM) also showed significant changes at altitude. More subjects (9 vs. 3) reported symptoms with greater severity (5.6 vs. 3) at altitude. **Discussion:** Although the PVT is known to be particularly sensitive to stressor conditions and not necessarily as complex as operational aviation tasks, an increased risk associated with degraded performance during mild hypoxic exposures should not be understated. Complacency and a simple lapse of attention at the wrong time can have catastrophic consequences, as seen in transportation statistics. The current study provides additional evidence that flight at the higher altitudes not requiring supplemental oxygen produces mild hypoxia, which can result in degraded performance and the increased risk of accidents.

Learning Objectives: 1. The audience will hear details of a study to look at the performance and physiological effects of a 4 hr exposure to hypobaric pressures equivalent to 12,400 ft. 2. The audience will learn about the sensitive measures of a psychomotor vigilance task. 3. A review of the basic physiological responses to reduced ambient pressures will also be made.

[315] DEXTROAMPHETAMINE VERSUS ALTERNATE INTERVENTIONS AS A FATIGUE COUNTERMEASURE IN MILITARY PILOTS: A SYSTEMATIC REVIEW OF THE LITERATURE

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Introduction: Pilot fatigue is a safety problem in military aviation. As such, the U.S. military has adopted a multi-factorial approach to fatigue countermeasures including using psychostimulants other than caffeine for improving alertness and performance in fatigued pilots. Specifically, dextroamphetamine and recently modafinil, have been used in military aviators. However, evidence suggests that modafinil may be as effective as dextroamphetamine in maintaining alertness and performance, with fewer side effects and less abuse potential. The objective of this study is to assess the evidence related to dextroamphetamine's efficacy compared to caffeine or modafinil at maintaining alertness and performance in fatigued military pilots; and to determine whether dextroamphetamine's use is supportable despite its abuse potential and known side effects. **Methods:** A systematic review was undertaken by searching PubMed since its inception. Inclusion criteria were: randomized controlled trials, in which pilots were the study subjects, and caffeine, dextroamphetamine and/or modafinil were used as at least one of the study interventions. **Results:** Fewer than ten studies were identified, and none of these compared dextroamphetamine directly with caffeine and/or modafinil in pilots, in an operational setting. Furthermore, sample sizes in all studies were small and the majority of studies, including all of those conducted with dextroamphetamine, were done by just one

research group. Finally, although some results suggest that modafinil may be as effective as dextroamphetamine, methodological differences among studies prevent meaningful direct comparison or aggregation.

Discussion: There is need for methodologically sound RCTs comparing dextroamphetamine to modafinil in fatigued pilots. Recommendations for such studies are provided.

Learning Objectives: 1. The evidence of the relative efficacy of psychostimulants such as caffeine, dextroamphetamine and modafinil, as a fatigue countermeasure, is reviewed.

[316] SIMULATOR SICKNESS IN THE AH-6 (LITTLE BIRD) FLIGHT SIMULATOR

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Introduction: The U.S. Army Aeromedical Research Laboratory (USAARL) was asked to analyze data representing the symptoms reported from AH-6 simulated flight. Discussions with visual engineers and AH-6 SME's indicated that the source of the problem may be the simulator's impressive 240 degree by 98 degree field-of-view. Simulators with wide field-of-views commonly exhibit higher rates of simulator sickness. In addition, large field-of-view often comes with a tradeoff in image quality. The AH-6 simulator is scheduled for an upgrade and USAARL's input may help direct fixes to alleviate associated symptomatology. **Methods:** After each simulator session, pilots were asked to complete a Simulator Sickness Questionnaire (SSQ) and provide comments regarding any physiological symptoms and/or their simulator session. Most sessions lasted two hours. SSQ data from 12 sessions were analyzed; a response rate of approximately 20%. **Results:** There was considerable simulator sickness, as 10 out of the 12 surveys (83%) reported some symptomatology. The median Total SSQ score was 29.92, indicating a problem simulator. The profile of subscales indicated that disorientation symptoms predominated, followed by nausea and then oculomotor symptoms. The most commonly reported symptoms included general discomfort, difficulty focusing, sweating, and eyestrain. Recommendations for reducing the symptoms include reducing the field-of-view at the first sign of discomfort and improving the resolution of the generated images. Installation of visual upgrades will require significant downtime. Once the simulator becomes available again, early training sessions should be frequent (every other day), brief (no more than one hour), and initially be limited to non-aggressive maneuvers to allow for the most successful adaptation. **Discussion:** SSQ results suggest that the Little Bird simulator is a problem simulator. Upgrades to the visual system are scheduled, as well as a follow-up study, which will allow for assessment of the recommendations and upgrades with regard to reducing simulator sickness.

Learning Objectives: 1. To apply lessons learned in the existing simulator sickness literature to address recurrent problems inherent to flight motion simulators.

[317] UPDATE DELAY AND SIMULATOR SICKNESS DURING HEAD-MOUNTED DISPLAY OF VIDEO CAPTURED SCENES

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Introduction: Display update delay, a characteristic of helmet-mounted displays (HMDs), may have detrimental effects on user experience in a virtual environment (VE). Simulator sickness while immersed in an HMD VE has been suggested to increase in a linear fashion as update delay increases (DiZio and Lackner, 1997). This study examined the effect of update delay on simulator sickness and presence when using an HMD to view a natural, "real-world" scene, rather than a virtual scene. **Methods:** 22 subjects participated in 5 intervals of 40 head movements to search for 8 objects located throughout the laboratory. Subjects viewed the laboratory with an HMD. Subjects took part in both update delay conditions of minimal, system delay and an additional 200 ms of delay, separated one week apart. The Simulator Sickness Questionnaire (SSQ; Kennedy and Lane, 1993) was administered pre and post practice, after intervals 1-5, and 5 and 10 minutes post completion. The Presence Questionnaire (Witmer and Singer, 1998) was administered after the last trial. **Results:** A marginally significant increase in peak SSQ score between minimal delay (mean = 33.83, SE = 6.65) and the additional delay (mean = 43.57, SE = 7.53; $t = -1.708$, $p = .051$) was reported. A 2 (condition) $\times$ 9 (trial) repeated-measures ANOVA showed a significant main effect of trial $F(1,8) = 15.816$, $p < .001$, but no effect of condition. There was a marginally significant interaction, $F(1,8) = 1.983$, $p = .052$. The Presence score with minimal delay

(mean = 151.1, $SE=6.36$) was significantly higher than with the additional delay (mean = 139.8, $SE=5.85$; $t=4.093$, $p=.001$). **Discussion:** Update delay may contribute to sickness symptoms but it is clearly not the only mitigating factor since the only main effect was trial, or time on task. Other characteristics of viewing virtual scenes in an HMD VE may affect simulator sickness and requires further investigation.

Learning Objectives: 1. Inform about issues relating to virtual environments/HMD's and simulator sickness.

[318] STATUS OF THE 1984/1985 ATCS COHORT 20 YEARS LATER

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Introduction: The availability of data from Air Traffic Control Specialists (ATCSs) hired after the 1981 strike provides an opportunity for a large-scale examination of controller career progression. We examined historical data to predict how many controllers should be hired to maintain sufficient staffing. This study is especially relevant considering that approximately 70% of the workforce is expected to retire by 2015. **Methods:** Career status as of 2005 was examined for a group of 2,325 ATCS trainees who successfully completed the FAA Academy screening program during 1984 and 1985. Databases were analyzed that contained information about training status at their first facility and career progression over time. **Results:** Twenty-three percent of the 1984/85 cohort are no longer employed by the FAA. Most separations resulted from failure to complete field training. One percent of the original cohort is still with the FAA but no longer in the ATCS career field. Sixty-five percent still actively control traffic, either as ATCSs or supervisors who maintain their certification. Seven percent are staff or Traffic Management Coordinators and no longer maintain ATC certification. Four percent are managers at field or other (regional or HQ) ATCS facilities. ATCSs remaining in the occupation changed facilities often, either transferring to lower-level facilities after failing training at higher level facilities or to transferring to higher level facilities to advance their careers. **Conclusions:** Considerable effort has gone into developing algorithms that predict how many controllers will retire. These results suggest that future predictions could benefit from consideration of historical data. Our analysis indicated that it will be necessary to hire about 150 controller trainees to produce 100 active controllers who will be in the workforce 20 years later. This estimate will be affected by changes to selection, training, or job requirements.

Learning Objectives: 1. Methods used to record and analyze career status and progression are presented. 2. Information about air traffic controller career progression will be described. 3. Attrition projections from ATCS career field will be presented.

[319] PRELIMINARY ANALYSIS OF THE UNLIKELY VIRTUES SCALE OF THE AT-SAT EXPERIENCE QUESTIONNAIRE.

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Purpose: The Unlikely Virtues (UV) scale of the Experience Questionnaire (EQ), a subtest of the Air Traffic Selection and Training battery, was designed to detect applicants engaging in unsophisticated attempts to present themselves in an overly positive light. Currently, the UV scale is not incorporated into the EQ score; before it can be included in the scoring process it should be examined for reliability. **Method:** Data from 1574 applicants were analyzed. Of these, 3 had missing data and were excluded. Frequency distributions were calculated for each of the 10 items in the scale. This analysis suggested that 4 of the items were not similar to the others. One item had limited variability and was excluded from further analyses. Chronbach's α was computed with and without the remaining suspect items. Also, an exploratory factor analysis (EFA) was conducted. **Results:** The reliability of the UV scale was not computable due to the lack of relationship among the items. The removal of the suspect items resulted in an unacceptable Chronbach's α of 0.144. Because it is possible that the scale measures multiple types of impression management, EFA were conducted. The eigenvalues indicated a 3-factor solution; however, this was not appropriate because with 6 items there would be 0 degrees of freedom. A 2-factor model was tested, but this model did not fit the data well, $\chi^2(4) = 36.568$, $p<0.001$. **Discussion:** The UV scale does not measure a unitary construct. When 4 items were removed, Chronbach's α was lower than acceptable. EFA of the 6 remaining items resulted in poor-fitting models suggesting that the UV scale does not meet the criteria used to determine if a test is reliably assessing the construct of interest; therefore, it should not be used.

Learning Objectives: 1. Reliability of Instruments measuring impression management.

[320] PREDICTORS OF DISSOCIATIVE STATES IN EXTREME ENVIRONMENTS

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Introduction: Peritraumatic dissociative states (i.e., perceptual disconnectedness experienced during or immediately after exposure to a traumatic event) are associated with subsequent development of posttraumatic stress disorder. A growing body of literature has examined dissociative states during acute military stress. No research has examined prospective (pre-stress) markers of peritraumatic dissociation. Presently, we explore some physiological and psychological predictors of dissociation during military survival training. **Methods:** 30 military men (age: 21.9 ± 2.5 years) participated in this study. 1-3 weeks prior to participation in Survival, Evasion, Resistance, and Escape Training, nighttime electrocardiographic monitoring of heart rate variability was performed using the Aria Holter monitor with a sampling rate of 128 samples per second. Principal Diagnostic Modes method was used to separate and quantify dynamic components of the sympathetic and parasympathetic nervous activities on the basis of ECG signal. Participants also completed the Perceived Stress Scale. Thereafter, participants attended SERE training, where dissociation was measured directly after an acute captivity-related event. Correlational and linear regression analyses were conducted to prospectively examine markers of dissociation as well as possible mediating pathways. **Results:** Pre-SERE sympathetic ($r = -.39$, $p = .04$) and parasympathetic ($r = -.39$, $p = .03$) input during sleep were both inversely related to dissociative symptoms occurring during survival training. Pre-SERE perceived stress was positively associated with dissociation symptoms during training ($r = .44$, $p = .01$). Linear regression analyses indicated that perceived stress may be a mediating pathway between sympathetic input and subsequent dissociation. **Conclusion:** Our findings suggest that central nervous system activity during sleep may ameliorate while perceived stress may exacerbate dissociation symptoms which occur during acute stress. This study was supported by the Office of Naval Research, Award No. N0001406WX20141.

Learning Objectives: 1. Predictors of dissociative states during extreme military training will be described.

[321] PERITRAUMATIC DISSOCIATION PREDICTS SUBSEQUENT IMPACT OF STRESSFUL EVENTS

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Introduction: Peritraumatic dissociative states (i.e., perceptual disconnectedness experienced relative to one's environment) may be associated with subsequent development of posttraumatic stress disorder (PTSD). Here we examine the relationships between peritraumatic dissociation during stressful military training and PTSD symptoms (i.e., intrusive thoughts, avoidance, and hypervigilance) occurring 24 hours after the conclusion of training. **Methods:** 29 military men (age: 21.8 ± 2.5 years) participated in this study. Participants attended SERE training, where dissociation was measured directly after an acute captivity-related event. 24 hours after the conclusion of training, the Impact of Events Scale-Revised (IES-R) was administered to quantify PTSD symptoms. Correlational analyses were conducted to examine relationships between dissociation and each of the IES-R subscales (intrusive thoughts, avoidance, and hypervigilance), as well as total impact of events. **Results:** Dissociation during SERE training was positively associated with subsequently experienced avoidance ($r = .54$, $p = .002$), hypervigilance ($r = .46$, $p = .01$), and a total impact of events score ($r = .50$, $p = .005$). A nonsignificant trend was also observed between dissociation and intrusive thoughts ($r = .35$,

$p = .06$). **Conclusion:** Peritraumatic dissociative states occurring during stressful military training appear to influence PTSD symptoms, thus reinforcing a growing literature citing dissociation as a prospective marker of PTSD. More research is needed to better understand the biological mechanisms underlying this relationship, as well as causal pathways. This study was supported by the Office of Naval Research, Award No. N0001406WX20141.

Learning Objectives: 1. Prospective predictors of PTSD symptoms are described.

[322] SCREENING AIR TRAFFIC CONTROL SPECIALISTS FOR PSYCHOPATHOLOGY USING THE MINNESOTA MULTIPHASIC PERSONALITY INVENTORY-2

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Introduction: The Federal Aviation Administration (FAA) has been psychologically screening applicants for air traffic control specialist (ATCS) positions with the 16 Personality Factor (16PF) test since 1965. This method has identified an increasingly small subset of applicants who require additional psychological assessment. Consequently, the operational community desired a more robust screening method. There was also a desire to automate this screening process, using computer technologies that are becoming ubiquitous. **Methods:** Men (794) and women (220) attending ATCS training, who had been cleared using the 16PF screening method, were invited to complete the Minnesota Multiphasic Personality Inventory-2 (MMPI-2) on a research basis. Due to the interest in applying this research to the practical matter of employee selection, and in compliance with the Civil Rights Act of 1990, their responses were scored using nongender-specific norms. The profiles of the 1,014 participants were sorted into "match" (notionally meaning no additional psychological assessment would be necessary) and "non-match" (notionally meaning additional psychological assessment would need to be conducted) categories based on elevations (at least two standard deviations above the published norms) on clinical scales. **Results:** Despite use of the 16PF as the initial screen, administration of the MMPI-2 revealed that 50 participants (4.9%) had significant elevations on the clinical scales. The percentage of identified men (5.3%) was slightly higher than the percentage of identified women (3.6%). **Discussion:** These results reveal some of the limitations of the use of the 16PF. The MMPI-2 appears to be more robust for screening individuals entering the ATCS career field. Since the MMPI-2 will be used as a case identifier, we will not know the full benefits until we observe the results from operational administration prior to entry and examine outcomes from the follow-on secondary assessments.

Learning Objectives: 1. Learn the association between psychological testing and psychopathology.

[323] SUICIDE MORTALITY IN ACTIVE DUTY U.S. AIR FORCE PERSONNEL: 1990 TO 2004

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Introduction: Suicide is the second leading cause of death in active duty Air Force (ADAF) personnel. In spite of the significant public health and military operational burden, most analyses of suicide trends have used only crude mortality rates, without adjustment for the age, gender, and racial distributions of the ADAF population. This study attempts to measure suicide mortality rates, indirectly standardized using the U.S. general population as the reference. **Methods:** The study period was 1990 to 2004. Counts of ADAF suicide deaths were obtained from the Air Force Mortality Registry. This surveillance system collects death certificates issued on ADAF decedents by military or civilian medical authorities. Underlying cause of death data are then analyzed and recorded. ADAF population counts for each year of the study period were obtained from the Defense Manpower and Data Center. Suicide mortality rates for the U.S. general population for each year of the study period were obtained from the National Center for Health Statistics. The population counts and reference rates were stratified by age, gender, and race. **Results:** For 1990 to 2004, the standardized mortality ratios (SMRs), adjusted for age,

gender, and race, were for all enlisted personnel, 0.64 (95%CI: 0.59-0.69), and for all officer personnel, 0.14 (95%CI: 0.10-0.20). Adjusted for age and race, the SMR for enlisted men was 0.63 (95%CI: 0.58-0.68) and the SMR for enlisted women was 0.95 (95%CI: 0.66-1.33). Similarly adjusted, the SMR for officer men was 0.12 (95%CI: 0.08-0.17) and the SMR for officer women was 0.67 (95%CI: 0.27-1.36). **Conclusions:** Compared with the general population, there were significant deficits of suicides in all enlisted and all officer personnel. However, in both groups, there were significant deficits only in men. Suicide mortality in enlisted and officer women was not significantly less compared to their general population counterparts.

Learning Objectives: 1. The suicide mortality experience of active duty U.S. Air Force personnel is described.

[324] PSYCHOLOGICAL ASPECTS OF LONG LASTING FLIGHTS

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Background: Long distance flights and a long time stay in the air are needed more often than in the past decades. These long flights pose new demands and pressure on the pilots. These demands arise from the mission itself, the aircrew ground life, his personality traits and his physical condition and fitness. The pilots ability to balance his mental and physical resources is crucial to his fillings, the crew team work, the atmosphere in the cabin and most important his mission performance. Little research had been done on the field of long flights. **Goal:** To define psychological aspects of the long lasting operational flights and how they project on the performance and moral in the flight cabin. **Methods:** We preformed interviews with 20 pilots, who fly routinely long flights. The questions in this interview dealt with the pressing aspects of the flight, with an effort to pin-point the difficult parts of the whole flight and to find out what makes one part or one mission more difficult then the other. Another focus was put on the coping skills with the mission- before; during; and after the flight. **Outcome:** Base on the results of the interviews, we built a psychological map of the long lasting flights. The map points the pressure sources, the populations at risk and ways to cope. **Conclusion:** A new guiding program is needed for the long haul flights aircrew. They should practice ways to save and manage their resources, in a different method then during short active missions. The crew commander should also pay attention to the team handling. We believe that this guidance could make these long flights easier and lower their negative impacts.

Learning Objectives: 1. The psychological aspects of the long lasting operational flights and how they project on the performance and moral in the flight cabin.

Tuesday, May 13

4:00 PM

SLIDE: Commercial Spaceflight--Show Me the Money

[325] WHAT MEDICAL SUPPORT SHOULD COMMERCIAL SPACE FLIGHT COMPANIES PROVIDE AT THEIR LAUNCH AND LANDING FACILITIES?

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Fewer than 500 people have flown in space and most were professional astronauts/cosmonauts who met minimum health benchmarks. Consequently, there is limited knowledge of the effects of space flight on the general public yet the emergence of Commercial Space Flight (CSF) offers flight opportunities based on wealth, not health. Many questions regarding the potential in-flight effects of space flight on certain pre-existing medical conditions remain unanswered. Does this uncertainty have implications for what would be considered prudent medical capabilities at the commercial launch and landing facilities? Moreover, there are a number of vehicles in development that differ in launch and landing profiles, and use fuels with varying levels of toxicity. Again, what implications, if any, do these factors have on the definition of prudent medical support? Finally, spaceports not co-located with a Federal launch facility are located in remote locations to lessen the possibility of catastrophic failures that may injure bystanders. During a medical emergency, a consequence of this remote location (with no co-located Federal facility) is a protracted transition to a tertiary care facility. Therefore, given:

- a remotely located facility that is handling toxic and explosive materials
- launch vehicles that subject occupants to a physiologically stressful environment
- a high probability of a large number of public spectators

What might constitute adequate and prudent on-site medical care resources? This presentation will explore the challenges faced by the CSF flight surgeon in determining the launch and landing support needed to handle the possible outcomes of engaging in sub-orbital space flight.

Learning Objectives: 1. The audience will understand the medical challenges imposed on CSF companies when flying the general public in space.

[326] DEMOGRAPHICS OF INITIAL GROUP OF COMMERCIAL SPACEFLIGHT PARTICIPANTS

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Introduction: We present the demographics and initial medical statistics on 70 Virgin Galactic commercial Space Flight Participants (SFPs). This group is a self selected set of individuals who pre-paid to be in the first 100 to fly with Virgin Galactic (the Founders). **Methods:** Gender, age and place of birth demographics and screening medical data were obtained from 70 of the Founders using medical questionnaire and physical exam forms. This preliminary medical data was collected to assess the SFP's suitability for suborbital spaceflight and initiate their training. **Results:** The group consists of 58 males and 12 females. The average age is 51, mean age is 49 with a range from 30 to 88. The 70 members of the VG Founder group represent 24 countries by place of birth. 43% of this group resides in the USA and 19% in the UK. No other country comprises more than 4%. The average height for the group was 175 cm (range 143-193) and average weight 81 kg (range 44-173). Average glucose for the group was 95 ($\pm$ 17) mg/dl. The mean heart rate and mean arterial pressure (MAP) for the group, at the time of exam was 66 ($\pm$ 9) bpm and 92 ($\pm$ 9) mm Hg respectively. Pre-hypertension or hypertension was present in 27% and 5% respectively. A wide variety of medical conditions were present, the most common being, allergies, high cholesterol, hypertension, spinal symptoms, GI symptoms renal stone history and heart disease. Over 33% are currently taking medications for their medical conditions. **Conclusion:** The VG SFP Founders group consists largely of middle-aged males dominated by 50% origin from the USA or UK but includes a widely diverse group of people from 24 countries around world. The most common underlying medical conditions and medications were typical of this age range of individuals.

Learning Objectives: 1. The audience will learn about the demographics and basic medical health of the initial commercial spaceflight market.

[327] MEDICAL CLEARANCE FOR G-TRAINING OF COMMERCIAL SPACE FLIGHT PARTICIPANTS

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Introduction: Commercial space flight participants (SFPs) represent a much broader range of ages and medical conditions than seen previously in individuals exposed to centrifuge training. The Virgin Galactic (VG) Founders' centrifuge training at the NASTAR Center is a joint endeavor by VG and NASTAR personnel. We present the medical clearance process and results for the initial group of 43 VG Founders to complete this training. **Methods:** Medical clearance included a review of an initial screening medical history and physical examination performed by each individual's personal physician. A resting ECG was mandatory. The medical conditions identified of concern were hypertension, cardiovascular disease, hyperlipidemia, diabetes, and spine disorders. Additional medical data, including exercise stress testing, echocardiography, fasting glucose level, lipid profile, and medication usage, were requested, as appropriate, for individuals with these medical conditions. In some cases, a consultation between the VG Chief Medical Officer and the Founder's physician was conducted to further elucidate the medical status of an individual. The age range of this group was 30 to 77, 8 were female. Additional information was requested from 1/3rd of this Founder group. Advice was provided on withholding certain medications with hypotension potential prior to training. **Results:** The majority of founders with medical conditions of concern were cleared by the NASTAR medical monitor upon the review of the additional medical data. Five SFPs fell into one of three categories:

disqualified, deferred for further medical evaluation and stabilization before training, or training modified to avoid exacerbation of chronic medical problems. Thirty-nine individuals successfully accomplished the training to a peak of 3.5 Gz and 6.0 Gx. Several individuals successfully completed the training while taking a beta blocker for hypertension. **Conclusion:** Basic medical screening, with augmentation of medical data where necessary, resulted in accomplishing successful G-training for 91% of the Founder's.

Learning Objectives: 1. The audience will learn the approached used to medically clear commercial SFPs for centrifuge training.

[328] G-TOLERANCE IN COMMERCIAL SPACE FLIGHT PARTICIPANTS (CSFPs)

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Introduction: The G-tolerance of CSFPs of a wide age range and physical condition is unknown. We present medical monitoring data obtained during centrifuge training of CSFPs. **Methods:** Forty five CSFPs were monitored during a centrifuge training program (maximum of 4.0 Gz and 6.0 Gx). Each CSFP had a baseline physical exam, pre-exposure blood pressure recording, and monitoring of ECG during exposures as part of the centrifuge safety program. CSFPs were taught the anti G straining maneuver (AGSM) in two parts: 1) constant leg, arm, and abdominal tensing, and if needed 2) the "hook" maneuver. They were interviewed about physiologic effects after their exposure. Data was collected in a deidentified database of observations made by the centrifuge medical officer during safety monitoring. Data collection is ongoing. **Results:** Of the 45 CSFPs, 10 were female. The mean age was 48 (range 28 to 78 years). Mean heart rate (HR) and mean arterial pressure (MAP) obtained during the prequalifying flight physical was 69 ($\pm$ 8) beats per minute (bpm) and 92 ($\pm$ 8) mm Hg. The mean pre exposure MAP was 104 $\pm$ 9 mm Hg. The mean peak sustained HR during each of the exposures during centrifuge training was 110 $\pm$ 19 bpm. The maximum peak HR attained was 128 $\pm$ 25 bpm and the range was 88 to 190 bpm. Younger CSFPs were more likely to experience greyout (student's T test $p < 0.01$) and faster peak HRs (linear regression $p < 0.001$). Older CSFPs were more likely to demonstrate higher pre-exposure MAP (linear regression $p < 0.05$) and demonstrate benign ectopy and arrhythmias (linear regression $p < 0.001$), however pre-exposure MAP did not correlate to reported greyout. **Conclusion:** The cardiovascular response to acceleration changes with age. Younger CSFPs are more likely to experience greyout and tachycardia, while older CSTs are more likely to demonstrate pre-exposure blood pressure elevations and benign arrhythmias.

Learning Objectives: 1. The audience will learn the relationship between G-tolerance and age in commercial space travelers.

[329] MEDICAL SELECTION PROCESS OF THE MALAYSIAN ANGKASAWAN PROGRAMME

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Introduction: On October 10, 2007, Malaysia sent its first Angkasawan (Spaceman) to the International Space Station on board the Russian Soyuz TMA-11. The Institute of Aviation Medicine (IAM), Royal Malaysian Air Force (RMAF) was tasked to assist the Agensi Angkasa Negara (Angkasa), Malaysia to conduct medical selection for the potential Angkasawan. On-line registration was conducted by Angkasa from November 2003 to May 2005. A total of 11,245 Malaysian citizens registered before the number of candidates were narrowed down to the final 2. **Methods:** Selection process was conducted in phases. Phase I - The Angkasawan 3.5-km run and general medical check-up. Phase II - The aeromedical and dental examination. Phase III - medical examination, altitude chamber, G-tolerance, psychological and survival tests. Those who passed these phases underwent a Selection Panel interview. **Results:** Phase I, 426 participated in the Angkasawan Run. 189 (44.3%) completed the cut-off time of 20 minutes. 67 (15.7%) were deemed fit to proceed to Phase

II after general medical check-up. Phase II, 59 (13.8%) candidates turned up, 57 males and 2 females. 27 (6.3%) qualified to go to Phase III. At the end of Phase III, 8 (1.8%) candidates, 7 male and 1 female qualified for the Selection Panel interview. 4 candidates were sent to Russia to undergo the Russian Space Agency Medical Evaluation. One primary candidate and one back-up candidate was selected. They were sent to Yuri Gagarin Cosmonaut Training Center for 12 months prior to the October 2007 launch. **Discussion:** This was the first time that Malaysia had embarked on a project of this nature. The programme which was open to all Malaysian citizens made the selection process more challenging. Various committees were formed to conduct the selection process. In general, the selection process was a steep learning curve for aviation and health practitioners in Malaysia.

Learning Objectives: 1. To share the Institute of Aviation Medicine, Royal Malaysian Air Force experiences in conducting the medical selection process for The Malaysian Angkasawan Programme.

[330] QINETIQ AEROSPACE MEDICAL SUPPORT TO SPACE TOURISM

H. LUPA

QinetiQ, Farnborough, Hampshire, United Kingdom

QinetiQ has been very active in providing aerospace medical support to space tourism over recent years. Two of the space tourists that have flown to the International Space Station (ISS), plus a number that have yet to do so, have undergone medical assessment and training at the QinetiQ centrifuge facility, Farnborough. We have been working with leading space tourism companies to define medical standards for space tourists and provide advice as to how prospective astronauts, who have stepped forward from the general population, can be medically assessed and trained. A comprehensive triage system has been proposed and new techniques have been developed to allow a better understanding of the physiological effects of a typical space tourism acceleration profile. These techniques, all used on our centrifuge, include electrical impedance tomography (EIT) to look at changes in lung ventilation, breath to breath respiratory mass spectrometry to investigate respiratory gaseous exchange, and near infra red oximetry (NIRO) to provide an indication of cerebral perfusion. An overview of this technology will be presented and discussed in the context of forming part of a future space tourist medical assessment programme. Furthermore, our experience has indicated that a centrifuge training programme should be a mandatory precursor for all prospective space tourists and should minimise risks to both the tourist and the operator, enhancing the chances of a safe enjoyable flight. The rationale behind this view will be discussed.

Learning Objectives: 1. To demonstrate the importance of the centrifuge for the medical assessment and training of space tourists.

Tuesday, May 13

4:00 PM

SLIDE: Aerospace Safety II

[331] PHYSIOLOGICAL INCIDENTS AND GENERAL AVIATION AVIONICS DISPLAYS – FLIGHT DATA RECORDERS FOR THE COMMON MAN?

M. A. GARBER

National Transportation Safety Board, Atlanta, GA

Introduction: Many new general aviation cockpit displays record a wide variety of data regarding aircraft position and performance. The NTSB has found in recent investigations that the data recorded by these displays can substantially enhance the ability to evaluate particular aspects of specific accidents and incidents. **Accident sequence:** In August 2006, according to the pilot, a Cirrus SR-22 in cruise flight at 9,500 feet mean sea level encountered severe clear air turbulence. He stated that the airplane bounced once in turbulence, lost altitude, then had another hard bounce of turbulence. He said that, after he stabilized the airplane, he and his passenger observed thin lines of paint missing from the tops of both wings. The pilot slowed the airplane down to about 90 knots and performed a precautionary landing. **Accident investigation:** The aircraft was equipped with an Avidyne Primary Flight Display and Multi-Function Display. Parameters recorded by these devices include time and GPS data, certain engine parameters, altitude, certain electrical currents, airspeed, vertical speed, certain pilot settings (to include vertical speed, heading, and altitude bugs among others), certain navigation settings, some displayed messages from the system to the pilot, as well as pitch, roll, heading,

and 3-axis accelerations. Preliminary evaluation of these data identified substantial differences from pilot-reported altitudes and events. Analysis of these data will permit the identification of relevant physiological events that may have played a role in the incident. These data were downloaded into inexpensive commercially available software to create a straightforward vivid animation of the events depicted by the data. **Conclusion:** The data available from new general aviation cockpit displays may provide data similar to and in some cases exceeding the quality of commercial aircraft flight data recorder information. These data can be utilized in the investigation of aeromedically-relevant incidents and accidents.

Learning Objectives: 1. To become familiar with the capabilities of modern cockpit displays as regards recording physiologically relevant information.

[332] IDENTIFICATION OF VICTIMS AFTER FATAL AIRCRAFT ACCIDENTS

B. MAYR

German Airforce Institute for Aviation Medicine, Fuerstenfeldbruck, Germany

Introduction: The identification of flight accident victims frequently poses difficulties. Primary problems involved are the high degree of destruction of bodies caused by traumatic lesions or the presence of numerous body fragments that require matching as well as advanced decay. Thus, visual identification is impossible in most cases. **Methods:** All flight accident victims investigated by us since 1990 were identified using common methods of Forensic Medicine, while considering at least one of the evidential features, namely dental status, finger-/footprints, radiological characteristics and DNA profiles. The less reliable identification signs, e. g. personal effects, anthropometric data, individual characteristics such as tattoos, scars etc. may also be taken into account. Several particular cases will be presented. **Results:** Most identifications were achieved by comparing ante- and post-mortem dental findings. In some cases, assigning numerous body parts to different bodies was possible only by applying various evidential identification methods, e. g. the comparison of ante- and post-mortem DNA profiles, of radiological features or finger-/footprints. **Conclusion:** Even badly destroyed bodies can be identified using appropriate methods and if authentic findings or material are available.

Learning Objectives: 1. Even bodies with a high degree of destruction can be identified if appropriate methods are used and authentic findings and material are available.

[333] DID VERTIGO KILL AMERICA'S FORGOTTEN ASTRONAUT?

G. A. BENDRICK and P. MERLIN

NASA Dryden Flight Research Center, Edwards AFB, CA

On November 15, 1967, U.S. Air Force test pilot Major Michael J. Adams was killed while flying the X-15 rocket-propelled research vehicle in a parabolic spaceflight profile. This flight was part of a joint effort with NASA. An electrical short in one of the experiments aboard the vehicle caused electrical transients, resulting in excessive workload by the pilot. At altitude Major Adams inappropriately initiated a flat spin that led to a series of unusual aircraft attitudes upon atmospheric re-entry, ultimately causing structural failure of the airframe. Major Adams was known to experience vertigo (i.e. spatial disorientation) while flying the X-15, but all X-15 pilots most likely experienced vertigo (i.e. somatogravic, or "Pitch-Up", illusion) as a normal physiologic response to the accelerative forces involved. Major Adams probably experienced vertigo to a greater degree than did others, since prior aeromedical testing for astronaut selection at Brooks AFB revealed that he had an unusually high degree of labyrinthine sensitivity. Subsequent analysis reveals that after engine burnout, and through the zenith of the flight profile, he likely experienced the oculoagravic ("Elevator") illusion. Nonetheless, painstaking investigation after the mishap revealed that spatial disorientation (Type II, Recognized) was NOT the cause, but rather, a contributing factor. The cause was in fact the misinterpretation of a dual-use flight instrument (i.e. Loss of Mode Awareness), resulting in confusion between yaw and roll indications, with subsequent flight control input that was inappropriate. Because of the altitude achieved on this flight, Major Adams was awarded Astronaut wings posthumously. Understanding the potential for spatial disorientation—particularly the oculoagravic illusion—associated with parabolic spaceflight profiles, and understanding the importance of maintaining mode awareness in the context of automated cockpit design, are two lessons that have direct application to the commercial space industry today.

Learning Objectives: 1. Know the definition of oculogravic illusion, and understand how it relates to the somatogravic and oculogravic illusions. 2. Understand the concept of mode awareness, and the importance of discriminability in the design of multi-use displays.

[334] PREVENTATIVE ASSESSMENT OF UNDERWATER ESCAPE TRAINING FOR ROYAL NAVY AIRCREW

D. CAREY

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Introduction: The incidence of sinus and ear Barotrauma during Underwater Escape Training (UET) in the Royal Navy is estimated to be around 60-80%. The exact mechanism of injury is largely unknown but may be due to a number of factors including, sudden change in depth, an inability to equalise or the presence of unknown pathologies, such as infection. There have been recorded cases of underwater escape from ditched helicopters where the individual has successfully escaped yet forgotten to inflate their Life Preserver Jacket (LPJ). This may be due in part, to the fact that UET does not actively teach the use of the (LPJ) under water; although it is used for other drills on the water surface such as sea drills. Accordingly, a simple, yet practical system which might help to screen those at risk of barotrauma combined with the underwater use of an LPJ was sought. **Methods:** A procedure was designed which involved aircrew passing down a line, under water, to a depth of around 3 meters on a single breath-hold. During the descent they could stop at any point to equalise. Once they had reached the bottom of the pool they would then move horizontally along another line to a set point where an instructor-diver would signal to them to ascend. At this point they would inflate their LPJ and ascend to the surface. **Results:** The procedure was evaluated by UET Staff and a medical officer who found it safe and simple to perform. The entire evolution took around 30 seconds. The drill was digitally recorded. **Discussion:** This system may prevent injury to those with hidden middle ear or sinus problems. It allows the individual to evaluate their ability to equalise, at a rate of descent controlled by them, and the opportunity to assess any associated symptoms, such as pain. It estimates an individuals ability to breath-hold under water and in turn should increase confidence. It provides the opportunity to inflate the LPJ under water. It would be simple to implement, conduct and establish, especially since the drill was filmed and could be incorporated easily into a training brief.

Learning Objectives: 1. The active prevention of barotrauma in Underwater Escape Training (UET) for aircrew. 2. Training in the use of a Life Preserver Jacket (LPJ) under water. 3. A programme to increase confidence in Underwater Escape Training (UET).

[335] SPINAL TRAUMAS (FRACTURES) IN AIRCRAFT PILOTS / WSO CAUSED BY EJECTION SEAT USE OF THE GERMAN AIR FORCE (GAF) IN THE PERIOD 1974 – 2007

T. M. PIPPIG

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Background: The ejection seat saved the lives of numerous jet pilots worldwide. Past GAF studies (by Becker: 1957 – 1969 and by Beckmann: 1965 – 1980) could prove that 80% of the pilots/WSOs survived ejection seat use and 20% were fatally injured. 20% of the survivors, severe spinal fractures were documented. The database held at the GAFIAM will be completed until September 2007 and then be evaluated by the author. **Methods:** An epidemiological and comparative study evaluates “successful” instances of ejection seat use (i.e. the pilot or WSO activated the system) on the basis of data covering the period 10/1974 thru 08/2007 provided by Director of Flight Safety in the GAF. 99 pilots/WSO of RF-4E, F-4F, Tornado and MiG-29 aircraft are being evaluated and compared. In addition, flight-specific parameters (altitude, speed, ejection handle, helmet), flight experience (flight hours, age) as well as physical characteristics (height, weight, BMI, sitting height) and their impact on the frequency of spinal trauma. **Results:** 51 flight accidents involving (26 Tornado, 13 F-4F, 11 RF-4E, 1 MiG-29) are being evaluated. Out of 99 pilots/WSOs involved 89 of 99 (89.9%) have survived the ejection, 10 out of 99 (10.1%) suffered fatal trauma (polytrauma, drowning). Their average age was 33 years, and the ejection happened after an average number of 1396 flight hours. 44 out of 89 pilots/WSOs (49.5%) suffered no spinal injuries, and 45 (50.6%) suffered spinal injuries. 28 out of 89% pilots/WSOs (31.5%) suffered a spinal fracture, 19 out of 89 (21.3%) suffered soft-tissue injuries (mainly of the cervical spine). In total, 46 vertebral fractures were counted (7 cervical, 31 thoracic and 8 lumbar vertebrae fractures). **Conclusion:** A comparison

between the first studies and the actual study shows that the survival rate on ejection seat use rose from 80% to 90%, and the frequency of spinal fractures in surviving pilots/WSOs rose from 20% to 31.5%. Age, flight hours, physical characteristics, and flight-specific parameters had no significant impact on the frequency of spinal injuries.

Learning Objectives: 1. Spinal fracture. 2. Classification of spinal fractures. 3. Prevention of spinal injuries.

[336] TRANSIENT CIRCUIT ANALYSIS OF EXTRAVEHICULAR MOBILITY UNIT TOUCHING SOLAR ARRAY IS IT AS SAFE AS A “BIRD ON A WIRE” OR IS IT A NEW EVA HAZARD?

D. R. HAMILTON

Wyle, Houston, TX

Introduction: Plasma is a fourth state of matter, which makes it different from ordinary gas in that it conducts electricity. Astronauts performing EVAs are in an environment where the local plasma may conduct current through the crew member’s body if an active solar array is touched. **Problem:** Suppose an EVA crew member contacts an active solar array. Does the crew member’s body charge and how long will it take? What electrical currents occur? Can the crewmembers EMU arc to the plasma? What happens when the crewmember finally comes in contact with ISS structure? **Analysis:** Three cases to consider:

1. Direct grounded contact with solar array. - This will conduct at least 2 amps of current across the thorax for more than 1 millisecond - a catastrophic hazard.
2. Charging without ISS contact. This is the “bird on a wire” scenario. These currents are not sufficient to cause fibrillation. Our analysis shows that these currents (> 600 microseconds and > 800 milliamps) are of sufficient magnitude and duration to activate skeletal muscle and nervous tissue in a manner similar to a TASER.
3. Contact ISS after being charged. In this case, EMU is charged up to solar array voltage disconnected from the array and then comes into contact with ISS. The conduction of 300 micro amps of current through a small area of skin or mucus membrane for more than 1 second represents a critical (possibly catastrophic during an EVA) hazard.

Results: Applying the data from literature, Medical Operations was able to help the Plasma Hazard Environment Team (PHET) understand the severity of these very extraordinary electrical current exposures. This presentation describes how Medical Operations worked with the PHET to confirm that operational hazards controls were the only means possible to control these catastrophic shock hazards during an EVA.

Learning Objectives: 1. Understand that EVA in Low Earth Orbit on the ISS presents unique shock hazards to crewmembers. 2. Understand why the “bird on a wire” concept does not apply to ISS EVAs.

Tuesday, May 13

4:00 PM

PANEL: Show Me the Evidence IV: A Potpourri of Interesting Clinical Cases

[337] “SHOW ME THE EVIDENCE!”: A POT POURRI OF INTERESTING CLINICAL CASES

D. WATSON¹, J. PICKARD² and W. B. KRUYER²

¹Civil Aviation Authority (New Zealand), Wellington, New Zealand; ²Brooks City-Base, TX

This panel is a continuation of the “Show me the evidence!” series. In this panel a diverse variety of clinical aeromedical cases are presented, along with explanation how each case represents a “conscientious, explicit and judicious use of current best evidence”. These presentations cover the scope of aeromedical decision-making, from the sublime to the ridiculous. There are: Developing new themes with a poor literature base for decision-making; Serious “fascinomas” where the practitioners need to resort to the textbooks before searching the literature; Differences of opinions, and conflicting high quality evidence; Mistakes and misinterpretations; Confusing and complicated cases that twist and turn with every new snippet of evidence.

Learning Objectives: 1. The conscientious, explicit and judicious application of the best medical evidence to a variety of clinical aeromedical situations.

[338] AEROMEDICAL DISPOSITION FOLLOWING SPONTANEOUS CORONARY ARTERY DISSECTIONC. G. PREITNER, D. B. WATSON and P. D. NAVATHE
Civil Aviation Authority (New Zealand), Wellington, New Zealand

Introduction: Spontaneous coronary artery dissection (SCAD) is a relatively rare cause of acute myocardial ischaemia. Unlike the main cause of acute myocardial ischaemia SCAD is most common in young people and affects mainly women. The condition is thought to be under-recognised. Increased use of coronary angiography in patients with troponin elevation will likely identify more patients with SCAD. **Methods:** In considering the case of a 38 year old pilot with this condition we reviewed the literature, searching for medical evidence, in particular in relation to the risk of recurrence. **Results:** Only around 200 cases of SCAD had been reported in the literature by year 2002. There are no controlled studies on this topic and only a very few series with over 40 patients. The condition affects mainly women (70% of cases). While many associations have been found with this condition, inclusive of conditions affecting the collagen, there are no reliable data allowing estimation of the risk of recurrence. **Conclusion:** Our assessment of the aeromedical disposition of a pilot with SCAD was assisted by a very limited literature base. Faced with a paucity of quality published evidence our decision was strongly guided by Class 5 evidence – expert opinion without explicit critical appraisal – in the absence of systematic review. We anticipate an improvement over the next few years in the published literature concerning SCAD, to better inform our future aeromedical decision.

Learning Objectives: 1. To learn about a rare cause of acute coronary event. 2. To consider aeromedical disposition in such a case.

[339] THE DORMOUSE AT THE TEA PARTY: NARCOLEPSY OR NOT?J. PICKARD
USAFSAM, Brooks AFB, TX

Introduction: Narcolepsy, a disorder that primarily affects young adults, is generally accepted as incompatible with aviation duties. Although based on textbook depictions the diagnosis appears deceptively simple, non-pathologic sleep disorders such as delayed sleep phase syndrome and poor sleep hygiene are far more common in this age group, and may mimic narcolepsy. This case is presented to review the diagnostic value of historical criteria and laboratory testing in confirming this diagnosis. **Clinical Case:** A 25 year old pilot applicant was evaluated by a local neurologist for hypersomnolence. He diagnosed narcolepsy on the basis of putative cataplexy, described only as visual tunnelling. Polysomnography and multiple sleep latency testing each showed one episode of sleep onset REM, but sleep hygiene was problematic. **Evaluation:** At ACS evaluation, she recounted a history of short refreshing naps, hypnagogic hallucinations four times a week, hypnopompic hallucinations and sleep paralysis twice a month, and multiple episodes of automatic behavior. She described four episodes of presyncope with periods of emotional stress, without muscle weakness or loss of posture. Polysomnogram showed a shortened sleep latency, and was negative for sleep-disordered breathing. Multiple sleep latency testing showed mean latency of 1 minute 14 seconds, without REM. **Discussion:** Based on history and sleep laboratory evaluation, she was diagnosed with atypical narcolepsy without cataplexy. She was begun on modafinil, and disqualified for all classes of military aviation. Four other cases have been referred to the ACS with a provisional diagnosis of narcolepsy; in each of those, the diagnosis was removed. Since narcolepsy is clearly disqualifying and often misdiagnosed, a careful review of historical and laboratory data is mandatory.

Learning Objectives: 1. The utility of narcolepsy-associated symptoms and laboratory evaluation is described.

[340] PRESYNCOPE EPISODES IN A MILITARY STUDENT PILOT – HOW MUCH IS TOO MUCH?S. R. JOHNSON¹, R. REYNOLDS² and W. B. KRUYER²
¹14 MDOS/SGOAF, Columbus AFB, MS; ²USAF School of Aerospace Medicine, Brooks City-Base, TX

Introduction: A military student pilot presented to his flight surgeon after several episodes of presyncope during pilot training. Aeromedical disposition is discussed considering possibility of recurrence of presyncope, risk of related cardiac events and the intangible concern of how much “benign” presyncope is too much. **Methods:** A military student pilot presented for evaluation of several episodes of presyncope occurring

under different situations during pilot training. Evaluation included thorough medical history by the flight surgeon and cardiology consultant, noninvasive cardiac testing, and review at a central facility of experienced military aeromedical physicians. **Results:** This 28 year old male student pilot presented with 4-5 episodes of presyncope or faintness. Interview and physical examination by the flight surgeon and cardiology consultant disclosed no suspicion of cardiac or neurological disorder. Episodes were typical vasovagal/vasodepressor or classic “pre-faint” episodes, occurring always while standing and with expected noxious stimuli, such as presenting a briefing in a training situation and prolonged standing at attention. He never fully lost consciousness and responded within seconds to sitting or lying down. Electrocardiogram (ECG), echocardiogram, treadmill stress test and extended ambulatory ECG monitoring were normal. He had none of his typical episodes during any of the cardiac testing. **Discussion:** This student pilot had only presyncope; data reviewed were for syncope. About 3% of men and women report at least one episode of syncope in their lifetime, with incidences reported much higher in both the young and elderly populations. Recurrence rates for multiple episodes of noncardiac syncope range from 25 to 50%, typically within 1-2 years. Although this student pilot experienced several presyncopal episodes, they were all limited to predictable and potentially avoidable settings and were felt not likely to occur in the aviation environment. Return to flying training was advised.

Learning Objectives: 1. Understand the different types of syncope and presyncope. 2. Learn recurrence and related cardiac event rates for syncope and presyncope. 3. Appreciate the aeromedical concerns for “benign” syncope and presyncope.

[341] HOLEY HEARTS AND HAZY HISTORIES: A CASE OF MISTAKEN CAUSALITYJ. R. STRADER and W. B. KRUYER
USAF School of Aerospace Medicine, Brooks City-Base, TX

Introduction: Patent foramen ovale (PFO) is a common condition seen in approximately 20% to 25% of the general population. In populations exposed to decompression sickness (DCS)-causing environments (aviators and divers) the risks of PFO is largely unknown. **Clinical Case:** A 19 y/o airman basic was referred to the USAF School of Aerospace Medicine Aeromedical Consult Service because of a finding of a presumptively symptomatic patent foramen ovale (PFO). The member had been involved in water training exercises to become an USAF Combat Controller (CCT). During one exercise he reportedly had symptoms of dyspnea and fatigue and per report became confused. He was referred for an echocardiogram secondary to the dyspnea, which suggested a PFO. This finding was subsequently confirmed on transesophageal echocardiography (TEE). A presumptive diagnosis of decompression sickness with paradoxical bubble embolism and CNS involvement was made. Secondary to the presumptive CNS involvement, the member was disqualified from further training. **Evaluation:** CCT involves multiple high-risk activities such as High-Altitude Low-Open jumps (HALO jumps) and SCUBA diving to depths of >100 feet. As such, repeated exposures to DCS-causing environments are routine, and progression in this type of training was thought to be contraindicated. However, subsequent history challenged the diagnosis of DCS and any CNS involvement. After an exhaustive literature review, consultation with the Naval Undersea Medical Institute (NUMI), and a more thorough history, recommendation was made to proceed with CCT training. **Discussion:** This case highlights the difficulties in attributing causality of symptoms to the common anatomic variant of a PFO, while also illustrating the importance of an accurate history in assessing the significance of PFO’s in aviators and divers.

Learning Objectives: 1. The risks of PFO’s in aviators and divers. 2. The difficulty in attributing causality to symptoms thought secondary to a PFO. 3. The importance of an accurate history in assessing causality of symptoms with a PFO.

[342] A YOUNG MILITARY AIRCREW WITH MYOCARDIAL INFARCTION: TO FLY OR NOT TO FLY?W. B. KRUYER
USAF School of Aerospace Medicine, Brooks City-Base, TX

Introduction: The frequent occurrence and the several presentations of coronary artery disease make it one of the most common and important topics of aeromedical decision making. Published data regarding outcomes of myocardial infarction in aircrew are limited. This case is presented to discuss the diagnosis, prognosis and aeromedical concerns regarding myocardial infarction in a young female military aircrew member. Guidelines for aeromedical disposition of myocardial infarction will be

proposed. **Methods:** A military aircrew member presented for evaluation and consideration for return to flying duties following an acute transmural myocardial infarction and coronary stent procedure. Subsequent evaluation included non-invasive cardiac testing, coronary angiography and deliberation by a board of experienced military aeromedical physicians.

Results: Twelve days after an uncomplicated pregnancy and delivery, this 39 year old female aircrew presented with acute coronary syndrome and evolved a transmural inferior myocardial infarction by enzymes and ECG changes. Coronary angiography showed partial occlusion the distal right coronary artery by thrombus, possibly from a ruptured plaque. A branch of the circumflex artery had a long segment of irregular, significant narrowing, apparently atherosclerotic. Intervention with stent was performed only on the distal right coronary artery lesion. After an uneventful recovery she presented for aeromedical evaluation. Noninvasive cardiac testing showed evidence of myocardial infarction but no reversible ischemia and normal cardiac function. Coronary angiography showed excellent stent results and essentially normal coronary arteries elsewhere, including at the site of the previously noted circumflex branch lesion. **Discussion:** Based on the specific aircrew position, cardiac testing results and an anticipated event rate of 2-4% per year from the literature and limited experience in military aircrew, return to flying duties was recommended.

Learning Objectives: 1. Short-term cardiac event rates for young subjects with myocardial infarction. 2. Aeromedical concerns regarding myocardial infarction and various aircrew positions. 3. Application of standard cardiac literature and aircrew databases to an aeromedical disposition.

[343] SPILLING TEA AT THE TEA PARTY / THE FULL MONTY

D. E. DEAKINS¹ and H. O. PORTER²

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The case of a private pilot with a history of metastatic malignant melanoma is presented for consideration of a (FAA) special issuance. The original presentation was of a lung lesion originally diagnosed as a bronchogenic squamous cell cancer in 2000, which was resected. Subsequently a cerebellar lesion was found and resected, and it and the original lesion were reclassified as melanomas. The original lesion may represent a collision tumor (two tissue types). Two large lymph nodes were subsequently found at the anterior border of the right latissimus dorsi and under it, two years apart. The airman is approaching three years since the last node was excised with no further evidence of disease. The arguments for and against medical certification will be presented to delineate the evidence on which to base an aeromedical decision.

Learning Objectives: 1. Things aren't always as simple as they appear (Monty Hall Paradox). 2. The "reasonable man" approach may be fettered by protocols. 3. Some decisions must be made without all the facts.

Tuesday, May 13

4:00 PM

SLIDE: Training & Selection Issues

[344] USING SELF-CRITIQUE TO IMPROVE GENERAL AVIATION PILOTING SKILLS: AN EMPIRICAL INVESTIGATION

E. BLICKENSDECKER and J. JENNISON

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Background: After each practice/training flight during general aviation (GA) pilot training, the instructor debriefs the pilot-in-training. Frequently, however, these debriefs tend to be "one-way": the instructor talks and the pilot-in-training listens. Recently, research has examined a debriefing strategy which includes learner self-critique (Prince, Salas, Brannick, & Orasanu, 2005). In general aviation, this style of debrief is referred to as "Learner Centered Grading" (LCG) (French, Blickensderfer, Summers, Ayers, & Connolly, 2005). LCG includes two parts. First, the learner completes a self-assessment checklist. Next, the learner discusses this self-assessment in a detailed debrief with his/her instructor. The purpose of the LCG process is to stimulate growth in the learner's thought processes and, in turn, behaviors. The current study examined the efficacy of the LCG debrief to train task management and single pilot resource management skills in GA pilots-in-training. **Methods:** 31 participants (pilots-in-training) performed a 50-minute simulated flight scenario during which a variety of challenging events occurred (e.g., Landing gear failure, Pitot tube freeze-up). Next, each participant was debriefed by a certified flight instructor. Participants in the control group received a traditional style debrief, and participants in the experimental group, received an LCG debrief. The participants then flew another 50-minute flight scenario.

Results: Pilots-in-training in the experimental group demonstrated significantly better performance on behaviors relating to communicating with the passenger, using the checklists, and overall performance than did the pilots-in-training in the control group. **Conclusions:** Changing the post-exercise debrief to the LCG style improved pilot-in-training performance on task management related skills. Most likely, these results will generalize to other skills. This research demonstrates the LCG style debrief's effectiveness and also underscores the importance of feedback, in general, to simulation based training.

Learning Objectives: 1. Describe the "Learner Centered Grading" debriefing style. 2. Explain the difference between the "Learner Centered Grading" flight debrief and the traditional style of debrief. 3. Describe the research methods used in this study.

[345] THE ATTITUDES OF U.S. NAVY DIVERS TOWARDS THE NONTECHNICAL SKILLS REQUIRED FOR SAFE AND PRODUCTIVE DIVING OPERATIONS

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Introduction: Although U.S. Navy diving is remarkably safe, when accidents do occur, the majority are caused by nontechnical or human factors errors. An attitude questionnaire based upon the Flight Management Attitude Questionnaire (FMAQ) was used as the basis of a diving attitudes questionnaire. **Results:** The confirmatory factor analysis (CFA) process resulted in a stable factor structure, with an acceptable level of reliability for the three subscales of the attitude questionnaire. From the 272 responses obtained, junior divers are found to want to ask questions, but senior divers do not desire to be questioned. Furthermore, Navy officers and inexperienced divers are more sensitive to the effects of fatigue and stress on performance than senior divers. **Discussion:** Crew Resource Management (CRM) training may provide a palatable method for changing the attitudes of U.S. Navy divers to the nontechnical skills required for safe and productive diving operations.

Learning Objectives: 1. The attitudes of U.S. Navy divers towards the nontechnical skills required for safe and productive diving operations will be discussed.

[346] SPATIAL ABILITY AS A PREDICTOR OF SPACE ROBOTICS TRAINING PERFORMANCE

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Introduction: Current astronaut robotics training procedures are both long and intensive. Trainees vary significantly in their initial performance, natural ability, rate of learning, and level of mastery. Initial performance is not a reliable predictor of final level of mastery and, in a few cases a protracted training period is needed to achieve mastery. We hypothesize that metrics of human spatial ability can predict performance on certain tasks, such as maintaining spatial situation awareness and arm clearance, that are learned and practiced during robotics system training. **Methods:** We tested the spatial ability of 40 current astronauts with robotics training experience against four tests: 2D Card Rotation (Card), Vandenberg Mental Rotation (MRT), the Purdue Spatial Visualization - Views (PSVT) and Perspective Taking Ability (PTA). These were correlated with scores on the NASA Aptitude for Robotics Test (ART) "Gate" task, a measure of initial robotics performance, and the General Spatial Awareness (SA) score of the astronauts' final evaluation test of their first robotics training course, either Generic Robotics Training (GRT) or Shuttle PDRS Training. Only the data from the 13 astronauts who took ART prior to their robotics training was analyzed. **Results:** There are significant correlations among the standardized Card, MRT, and PSVT scores and the General SA score for GRT, as well as among MRT, PSVT, and PTA and the log(standardized "Gate" score). As expected, no significant correlation was found between the initial ability and final level of mastery. No significant effect of gender was found. **Discussion:** The Card Rotation, Mental Rotation, and Purdue Spatial Tests are potential predictors of General Situation Awareness performance during robotics training. Further analysis of performance in individual lessons of a training course will determine if learning rates can also be predicted. Supported by NASA Cooperative Agreement NCC9-1 with NSBRI.

Learning Objectives: 1. The applicability of human spatial ability tests as a predictor of performance in space robotics training will be discussed.

[347] ASSESSING LEARNING ACROSS TRIALS IN THE AIR TRAFFIC SCENARIOS TEST (ATST)

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Introduction: The Air Force Research Laboratory (AFRL) requested that the Federal Aviation Administration (FAA) examine the Air Traffic Scenarios Test (ATST) to determine if it could be shortened while maintaining reliability and validity. The ATST is one of 12 subtests in the FAA's Air Traffic Selection and Training Battery (AT-SAT). When combined with the Armed Services Vocational Aptitude Battery (ASVAB), the ATST added incremental validity to the prediction of controller training success. However, the current version of ATST was too long to be included as a permanent addition to the ASVAB. We examined ATST trial-level data to determine if any trials could be dropped, to shortening the ATST testing time. **Method:** Data are from 391 job applicants who took AT-SAT operationally during a two-month period. We examined scores for efficiency of aircraft movement to destination, procedural accuracy, and maintenance of aircraft separation. A multivariate repeated measures design with performance variables and trials as within subject factors was conducted. Wilk's Lambda was significant for the effect of trials. Univariate ANOVAs showed that the effect of trials was consistent across the performance variables. **Results:** On all measures, performance improved from Trial 1 to Trial 2. Performance declined on Trial 3, most likely due to the 30% increase in the number of aircraft managed during the scenario. The large improvement in performance from Trial 1 to Trial 2 is probably due to insufficient practice time provided by the three practice trials. **Conclusions:** It is possible that, with a more structured approach to designing practice sessions, one of the first two trials may be replaced, thus reducing the total testing time. Future research should examine the reliability and validity of a shorter version of the ATST.

Learning Objectives: 1. How ATST contributes to the prediction of military controller training success.

[348] TEAM TRAINING EFFECTS ON DISTRIBUTED TEAM PERFORMANCE AND INTERPERSONAL DYNAMICS

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Introduction: Crews on long-duration space missions will need to perform their mission tasks accurately and maintain high levels of team cohesion. The role of training on cohesion and performance is not well understood, despite considerable past research. This project examined the impact of two team training strategies in a computer-based distributed team problem solving environment. **Methods:** Interpersonal Relations Training (IRT) was designed to foster crewmember trust, cohesion, and self-awareness, factors that have been found in high-performing teams. Team Adaptation and Coordination Training (TACT) was designed to train crews to work together as a team, cope with stress, and communicate effectively. Five-member mixed-gender teams engaged in six 75-minute search missions on a simulated lunar surface over three days. **Results:** TACT training resulted in marginally better individual and team performance than IRT training: TACT-trained individuals earned almost 50% higher scores; TACT-trained crews completed twice as many missions as IRT crews. One possible reason the IRT training did not enhance performance is that it did not achieve its goal of improved team cohesion, which did not differ significantly across training conditions. Our prior work demonstrated that high cohesion was associated with high levels of team coordination and mission success. Higher performing teams expressed more positive affect in the form of jokes and compliments on each other's performance, while lower levels of performance were associated with negative interpersonal dynamics. Anger and Aggression (A&A) as measured by the Group Environment Scale were negatively correlated with team success. IRT-trained crews exhibited the highest levels of A&A relative to TACT and control crews. **Discussion:** These results indicate that training can affect both performance and interpersonal dynamics, but that the relation between these factors is not straightforward. Future analyses will examine the contributions of individual differences and crew composition.

Learning Objectives: 1. Increase understanding of the relations between interpersonal dynamics, performance and training strategies.

[349] COMPARISONS OF CONTENT- AND CONSTRUCT-ORIENTED APPROACHES TOWARD THE DEVELOPMENT OF COLOR VISION TESTS FOR CONTROLLER SELECTION

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Introduction: Content-oriented tests for controller selection are typically based on realistic job simulations that involve multitasks. However, it is difficult to measure multitask performance through the aggregation of one-dimensional measurements that are desirable for the decision criterion of a selection test. An alternative approach is a construct-oriented strategy in which a selection test is based on independent constructs that link job behaviors to underlying information processing. This report describes the results of applying both approaches to the development of color vision tests for air traffic controller selection. **Method:** Five color-normal subjects (CNs) and ten color-vision-deficient subjects (CVDs) completed both a content-oriented and a construct-oriented test. In the content-oriented test, subjects performed multitasks using an air traffic control simulation interface: managing traffic, maintaining separation, and detecting alerts. Six performance measurements were used, including the error rate of red dot detection. The construct-oriented approach employed a test that simulated one of the constructs associated with using color displays: detecting salient (colored) targets. A computer display sequentially presented test samples, some of which included a red target datablock along with many other datablocks in various other colors. Subjects' task was to detect whether a target was presented in each sample. The performance measure was the percent of detection errors. **Results:** Error rates for CNs and CVDs were mixed in the content-oriented test. Moreover, Scores of most CVDs had a low repeatability ($r=0.67$), as they were affected by the strategies for managing multitasks. In the construct-oriented test, CNs made 5% detection errors on the average compared to CVDs who made an average error rate of 37%. The results are statistically consistent across several parallel forms of the test ($r=0.97$). **Conclusion:** Construct-based approach is a viable way to develop selection tests in response to the introduction of complex new technologies.

Learning Objectives: 1. Methods of developing selection tests. 2. Human performance measurements. 3. Applying psychophysical methods to human factors practices.

Tuesday, May 13

4:00 PM

PANEL: Update: Aeromedical and Human Systems Integration II

(Sponsored by IAMFSP and the Aerospace Physiology Society)

[350] UPDATE ON AEROMEDICAL AND HUMAN-SYSTEMS INTEGRATION CONCERNS

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This session will provide an update in some key areas for military aerospace medicine and aerospace human-systems integration issues. Presenters will concentrate on a wide range of issues which fall under Human Systems Integration/Interface. Beginning with the integration of HSI into the requirements generation process as a foundation for the programs in question and continuing on with a discussion of the role of physicians with support of the warfighter and how that may be viewed from both within the military and from outside the military. Legal as well as practical issues laid out for examination and comment. Occupational Risk Management as a component of the HFACS system and integration into HSI are reviewed and updated. The international aspects of HSI as it results to the Eurofighter Typhoon and pilot/aircrew training are reprised in detail. Night Vision Systems are discussed with a short review of their history as well as what the future holds and how more concentration on HSI will be necessary in order to field more complex systems. Discussion of various mishaps as a component of HSI are examined. Overall the importance of HSI has been well known retrospectively, this panel will discuss the paths taken thus far and those which are being explored.

Learning Objectives: 1. Provide an update on current systems from an aerospace medical viewpoint. 2. Increased understanding of the spectrum of HSI issues. 3. Have a broad survey of several important areas.

[351] THE AEROMEDICAL CHALLENGES OF EUROFIGHTER TYPHOON

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Introduction: The development of fourth generation military combat aircraft has raised many aeromedical challenges. The UK, in partnership with Germany, Italy and Spain, has built and introduced into service the Eurofighter Typhoon to meet a swing-role air combat requirement. **Discussion:** To utilize the military capability of the aircraft fully protection against co-incident stresses of high altitude and high G as well as consideration of thermal, orientational and human factors challenges have all had to be addressed. The novel aerodynamic principles of the design and the advanced life support systems utilized have required careful consideration and assessment. This has progressed from fundamental scientific research, through laboratory man-rating and in-flight assessment to monitored in-service trials. The facility for a progressively expanded Release to Service of single and twin-seat aircraft has been of considerable value. The introduction of advanced anti-G protection system in combination with high altitude operational flying has necessitated revision of aircrew training to prepare pilots to meet these challenges. The development process continues and is being widened to include the introduction of helmet mounted display systems, which can be considered an important element of the aircraft's weapon systems, will augment operational capability. **Conclusion:** A close association between scientists, doctors, aircrew and engineers has been essential to bring into operational service advanced aircraft and Life Support Systems and to capitalize on the operational capability of the Eurofighter Typhoon. The aeromedical challenges and the means by which they have been addressed are outlined and can be used to guide similar requirements for future aircraft.

Learning Objectives: 1. An understanding of the aeromedical processes required to introduce advanced aircraft into service.

[352] INJURY AND FATALITY PATTERNS IN US NAVY ROTARY WING MISHAPS, A DESCRIPTIVE REVIEW OF CLASS A & B MISHAPS FROM 1985–2005.

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Introduction: This study describes aircrew and passenger injury patterns associated with US Navy (USN) and US Marine Corp (USMC) helicopter mishaps for fiscal year 1985 through 2005. The objective is to identify any relationship between injury outcomes with crew position, seat design, helmet use, and restraint configuration. **Methods:** The US Navy Safety Center provided the data set that includes 370 class A & B mishap events involving 405 aircraft. Each mishap event report includes data regarding injury severity and body location of injury for all personnel on board. Injuries were divided into seven categories of severity and eleven anatomical location categories. Descriptive statistics are used to illustrate associations of these categories with crew position, seat design, helmet use, and restraint configuration. **Results:** Rotary wing mishaps in USN/USMC aviation accounted for 273 fatalities and 387 injuries in this data set. This analysis illustrates injury association patterns with regard to seat design, helmet use, and restraint configurations. **Discussion:** Many injuries and fatalities have occurred over this twenty-one year period due to limitations with helicopter seating, restraints, and helmets. These associations should be considered to improve life support equipment technology and rotary-wing flight safety.

Learning Objectives: 1. The audience will learn the injury and fatality patterns caused by USN/USMC rotary wing mishaps. 2. Seating and helmet design are key areas to reduce injuries and fatalities.

[353] USAF HSI REQUIREMENTS GENERATION - SCIENTIFIC INVOLVEMENT

P. B. MAPES

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Introduction: The USAF has created an AIRPRINT Office to superintend Air Force HSI policy. This landmark step matches similar programs in the Army and the Navy but the USAF initiative is placed directly under the Vice Chief of Staff. The current model for AIRPRINT

does not include bioscientists with human expertise interfacing in the requirement generation process. Once requirements are set, changes or modifications to systems in production become unaffordable. **Methods:** The author reviews the recent history of the AIRPRINT effort illustrating both the current concept and what would be required to make a meaningful impact on requirement generation for major force systems. **Results:** The discussion will center on qualitative improvements and notional manpower requirements to create an effective HSI oversight process at the requirements generation level. **Discussion:** Effective HSI is absolutely essential for the USAF to be able to lower production and operational cost of major force systems and optimize the human performance of people working with those systems. HSI cannot be effective if viewed as an 'afterthought' and must be built in to the generation of all major force systems and subsequent modifications. In the Air Force, this means placing bioscientists with human expertise in Anatomy, Physiology and Cognition at USAF Product Centers and requiring MAJCOM High Performance Teams to include bioscientists with human expertise during the requirement generation process. This concept is proposed as the way to meet HSI requirement generation needs with the fewest number of personnel and making the most effective use of those personnel. **Disclaimer:** The material in this presentation is the opinion of the author or available in open sources.

Learning Objectives: 1. Understand Current USAF HSI Proposals. 2. Understand the importance of requirements. 3. Understand a template for putting HSI in the requirements process of major force systems.

Tuesday, May 13

4:00 PM

PANEL: Aviation Color Vision II

(Sponsored by the Aerospace Human Factors Association)

[354] RISK ASSESSMENT OF COLOUR CRITICAL TASKS IN MILITARY AND CIVILIAN AVIATION ENVIRONMENTS

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Introduction: The increase in the use and complexity of colour coding in aviation environments raises the question of the criticality of colour tasks, particularly in the light of information competition and redundancy. **Method:** Colour tasks in military (air force, maritime and army; both peacetime and operational) and civilian aviation environments are described and compared. Australian aviation environments are presented as an example. The colour tasks are classified into the traditional colour tasks: recognition of signal lights, recognition of surface colour codes, colour organizing of complex displays and visual search. They are also described in terms of colour attributes, difficulty, complexity, time available for recognition, size, presentation, placement, and redundancy. **Results:** An overall graded risk assessment is presented regarding the criticality of colour vision aviation tasks, particularly in relation to overall safety and mission achievement. **Discussion:** The implications of the criticality of colour vision tasks in relation to the assessment of "adequate colour perception" are discussed.

Learning Objectives: 1. To understand the classification of colour critical tasks in civilian and military aviation environments. 2. To be able to grade the criticality of colour vision tasks in aviation environments.

[355] AEROMEDICAL ASPECTS OF MESOPIC COLOUR VISION - GENDER AND SCREENING

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A previous report documented an effect of mild hypoxia, equivalent to breathing air at 3048 m (10,000 ft), to compromise Y-B and R-G chromatic sensitivity progressively with decreasing mesopic luminance (Connolly, D. M., 2006, Mesopic colour perception thresholds are impaired by mild hypoxia and corrected with 100% oxygen. *Aviat Space Environ Med*; 77(3): 283). The study assessed 12 healthy trichromats (6M, 6F) using the City University Colour Assessment and Diagnosis test, identifying an unexpected, statistically significant main effect of gender. This results from the consistent, orthogonal influences of one minimally deuteranomalous male and one female with tritan deficiency, their data compromising group R-G and Y-B sensitivity respectively. The exclusion of their data eliminated the effect of gender while preserving statistically significant effects of decreasing luminance, monocular viewing and hypoxia to

impair chromatic sensitivity along both Y-B and R-G axes. The normal trichromats exhibited an asymmetry of Y-B thresholds at mid-mesopic luminance, supporting greater metabolic vulnerability of the S-cone system. At photopic and upper mesopic luminance, the deuteranomalous male exhibits marginally worse R-G sensitivity and somewhat better Y-B sensitivity than normal trichromats, but an exaggerated, asymmetric loss of sensitivity to yellow at mid-mesopic luminance. The tritan deficiency may represent an acquired loss in the only female using hormonal contraception during the study. Her loss of Y-B sensitivity was only apparent in the mesopic range and included more obvious loss of sensitivity to blue. Thus, both anomalous subjects' deficiencies were essentially 'covert' at photopic luminance and uncovered only at mesopic luminance. Both 'passed' colour vision screening for the study, comprising Ishihara's pseudoisochromatic plates and the Nagel Type I anomaloscope. The findings will be discussed in relation to aircrew colour vision during night flying in the mesopic cockpit/flight deck and with respect to screening candidates for entry to flying training.

Learning Objectives: 1. An understanding of the many factors that affect colour sensitivity in the mesopic range.

[356] WHAT LEVEL OF COLOR DEFICIENCY CAN BE CONSIDERED SAFE FOR PROFESSIONAL FLIGHT CREW?

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Concern has been expressed over many years that the current color vision standards tend to screen for normal trichromacy and may not therefore relate directly to the actual color vision requirements within the aviation environment. A visual task analysis carried out by the Civil Aviation Authority has identified the Precision Approach Path Indicator (PAPI) lights and the recognition of signal light colors as the most important color-critical tasks when no redundancy is involved and the discrimination of color differences is most difficult. **Methods:** The color vision of 178 participants (65 color normals, 73 deuterans, 40 protans) was assessed using a battery of tests, including the Nagel anomaloscope, Aviation Lights Test (ALT), CAD (Color Assessment & Diagnosis) test, simulated PAPI and NSLT (Navigation Signals Lights Test). The results have been used to derive a measure of red-green (RG) color discrimination performance for each test. The color discrimination limits beyond which color deficient observers behave differently to the group of normal trichromats on the simulated PAPI and the NSLT has been established using standard normal (SN) CAD units (i.e., the median RG color discrimination threshold as measured on the CAD test). **Results:** Deutan subjects with CAD thresholds < 6 SN units and protan subjects with CAD thresholds < 12 SN units performed the PAPI test as well as normal trichromats. A small number of deutan and protan observers with thresholds higher than 6 and 12 SN units, respectively, passed the PAPI test, but these subjects exhibit poor, overall chromatic sensitivity on most other color discrimination tasks including the NSLT. **Conclusions:** The results suggest that subjects with minimum deutan and protan color deficiency that do not exceed 6 and 12 SN units, respectively, perform the most safety critical tasks as well as normal trichromats. If these findings were adopted as pass / fail limits for pilots, ~30% of color deficient applicants would be classed as safe to fly.

Learning Objectives: 1. The audience will learn about the most safety critical conditions of color discrimination when there are no redundant cues. 2. The audience will learn about the large variability in color vision deficiencies, from minimal to severe, and the importance of an accurate assessment of color vision loss.

[357] THE EFFICIENCY OF THE DVORINE PSEUDOISCHROMATIC PLATE TEST AND THE AVIATION LIGHTS TEST TO SCREEN PILOTS' ABILITY TO IDENTIFY SIMULATED PRECISION APPROACH PATH INDICATOR (PAPI) LIGHTS

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There is a world-wide concern among aviation oversight organizations, which must ensure that pilots possess the necessary color vision skills and abilities to safely perform their tasks, that the current screening tests are accurate predictors of color-interpretation performance. After an extensive task analysis of pilots' color tasks, Casson (2005) concluded that correct interpretation of the precision approach path indicator (PAPI) lights was an important safety-critical, non-redundant color-coded task. Therefore, the efficiency of two tests, the Dvorine Pseudoisochromatic Plate test and the Aviation Lights Test (ALT, a modified Farnsworth lantern), was examined to test pilots' ability to perceive simulated PAPI lights. **Method:** 176 participants (65 color normals, 72 deuterans, 39 protans as determined by the Nagel anomaloscope) identified the red, green, and white lights of the ALT, the red and white lights of the simulated PAPI lights test, and the Dvorine. The passing criterion for each test is as follows: PAPI lights 100% correct, ALT 26 of 27 correct, and two separate passing scores were examined for the Dvorine, 12 of 15 correct and 8 of 15. **Results:** Using the Federal Aviation Administration's current pass criterion for the Dvorine (8 of 15) for pilots, the Dvorine successfully predicted pass/fail performance of 83.5% of the participants, compared to 79.5% correctly predicted using the ALT. However, using the more stringent pass criterion used by the US military (12 of 15), the Dvorine successfully predicted performance of 79.5% of the participants passing the PAPI lights, a decrease in correct predictions because of an increased number of false negatives (from 15 to 29 individuals). **Conclusions:** The Dvorine and the ALT can predict performance on the PAPI lights for most individuals; but an improved approach to screening is needed.

Learning Objectives: 1. The efficiency of 2 color vision tests for screening pilots' ability to identify PAPI lights will be discussed.

[358] A HUMAN COLOUR VISION MODEL FOR PREDICTING OCULAR PERFORMANCE

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Aircrew must be able to see and correctly interpret their instrumentation in order to safely fly their aircraft. Colour is increasingly used in cockpit displays to code information for presentation to aircrew. It is important therefore to be able to both understand and also predict how well such colour information can be discriminated and how the perception of colour coded information is likely to be degraded if, for example, viewing conditions change or ocular protection devices are deployed. In order to better understand and quantify the effects of new and proposed technologies, we have developed a prototype image-based human vision model. This builds upon a previous, basic, parametric cockpit conspicuity model and incorporates many of the key elements of a physiologically derived multi-stage model proposed by DeValois and DeValois (De Valois, R.L. & De Valois, K.K., 'A multi-stage color model', Vision Research 33:1053-1065, (1993)). In particular, the new model addresses key elements relevant to the cockpit environment including vision under low light levels and the conspicuity of cockpit displays and warning lights, as well as allowing the simulation of the performance of mild colour defectives. In addition to photometric and spectral components, the model, because it incorporates spatial vision components, can be helpful in informing cockpit viewing conditions where redundancy may be built in via combined positional and colour cues. In this paper we will provide a review of the elements of the model and demonstrate how the model can be applied to assess the colour visual effects of different technologies within the cockpit environment.

Learning Objectives: 1. Understanding and Modelling the characteristics of human vision within the context of the cockpit environment. 2. The audience will learn about the utility of image based colour vision models. 3. The effects of mild defective colour vision analysed by a vision model will be discussed.

[359] DESIGNING COLOUR CODES FOR CONGENITAL COLOUR VISION DEFICIENT WORKERS

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There are two principal ways that persons with congenital red-green colour vision deficiencies (CVDs) may be dealt with occupationally. They may be examined using clinical tests, practical tests and/or simulated practical tests to determine their suitability for a particular occupation. On the other hand, the working environment may be modified to take, at least partial, account of their deficiency. In this paper the latter course will be

highlighted. CVDs confuse colours in characteristic ways. The problems they have with colour codes are predictable and it is possible to design colour codes to minimise errors given some relatively simple guidelines. It is then possible to test the colour codes using software intended to simulate CVDs. In this paper we review the characteristics of congenital CVDs. We will use the confusion lines of congenital dichromats to justify the choice of basic 3 colour code and render it, using the Vischeck plug-in to Adobe Photoshop, to show that they are seen distinctly as blue, grey and yellow. We will then add total reflectance as another dimension to expand the use of colours. We can then add white and black (as long as dark red or maroon is not included). The concept of redundant coding, using non-colour clues, will be discussed. Finally, the Commission Internationale de l'Eclairage documents on signal colours and surface colours will be highlighted as useful resources in designing colour codes.

Learning Objectives: 1. The design principles of simple colour codes for those with congenital colour vision will be explained. 2. Methods of checking colour codes and actual tasks for good design principles using freely available software will be outlined. 3. The possibilities in design for the colour vision deficient will be highlighted.

Wednesday, May 14

8:30 AM

PANEL: Lunar Surface EVA: Early Suit Configuration

(Sponsored by the Space Medicine Association)

[360] ENABLING PHYSIOLOGICAL AND BIOMECHANICAL SCIENCE FOR LUNAR SURFACE EVA

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The Constellation Program is currently writing the concept of operations and surface architecture requirements for missions to the lunar surface. Lunar surface exploration will require a new extravehicular activity (EVA) suit for the suit to don to conduct lunar surface tasks. The Constellation EVA Project Office intends to improve the functionality and wearability of the lunar surface suit, relative to its predecessor used during Apollo, the AL7B. The EVA Physiology System and Performance Project (EPSP), under the auspices of the Human Research Program (HRP) at JSC has the responsibility to coordinate the physiologic, metabolic, and biomechanical studies necessary to define the requirements to optimize human function in surface exploration suits. This panel session will discuss the results of EPSP-directed analog and partial gravity tests conducted to date in support of that effort.

Learning Objectives: 1. Understand the factors affecting crewmember performance during EVA2. Understand the drivers for spacesuit design.

[361] FEASIBILITY OF SUITED 10 KM AMBULATION ON THE MOON

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Introduction: As exploration extravehicular activity (EVA) suit requirements mature, a critical question for NASA is the maximal distance and duration that an EVA astronaut would be able to ambulate during lunar surface operations in the event of a rover breakdown. The purpose of this study was to evaluate the feasibility of performing a suited 10 km ambulation in simulated lunar gravity. **Methods:** Six male astronauts completed a graded exercise test to determine peak oxygen consumption ($\text{VO}_{2\text{pk}}$). On a separate day, subjects donned the MK III EVA suit, a prototype designed for multi-axial mobility in planetary environments, and were connected to a pneumatic partial-gravity simulator designed to offload weight. Subjects were instructed to attempt to translate 10 km on a level treadmill at a rapid but sustainable pace using a self-selected gait strategy and speed. Oxygen consumption (VO_2), ratings of perceived exertion (RPE) and completion time were measured for each trial. **Results:** All subjects completed the 10 km ambulation. Average completion time was 95.6 ± 13.0 (mean $\pm$ SD) min with maximum and minimum times of 118 and 84 min, respectively. Average VO_2 was 24.6 ± 3.0 mL/kg/min (51% $\text{VO}_{2\text{pk}}$). Average RPE was 11.8 ± 1.6 . **Discussion:** Each subject completed 10 km without difficulty as the average RPE equated to a feeling between "light" and "somewhat hard". Although different gait strategies were employed, subjects typically experimented with a loping run to find the fastest speed tolerable without thermal or physical discomfort. Most subjects said they

would have gone faster, except for the suit's limited cooling capacity. This study indicates that ambulating 10 km on the Moon may be possible in a planetary EVA suit; however, factors including grade, terrain, suit cooling capability, and real-time navigation must be evaluated to more accurately determine the maximal EVA-excursion distance from the lunar habitat.

Learning Objectives: 1. The feasibility of performing a 10 km ambulation during EVA on the Moon will be discussed.

[362] METABOLIC RESPONSES TO VARIED EXTRA VEHICULAR ACTIVITY SUIT WEIGHTS AND PRESSURES DURING LOCOMOTION IN SIMULATED LUNAR GRAVITY

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Purpose: This study compared the metabolic responses to different extra vehicular activity (EVA) suit weights and pressures during treadmill ambulation in simulated lunar gravity. **Methods:** Six male astronauts were tested at the Johnson Space Center on a level treadmill while connected to the partial gravity simulator (PGS), a pneumatic device designed to offload weight. Using a framework gimbal, the subject was connected to the PGS in the MK III Advanced EVA Suit Technology Demonstrator, a preliminary design for multi-axial suit mobility in planetary environments. To evaluate suit weight, 1-g equivalent suit weights of 61, 121, 186, 247 and 306 kg were tested in simulated lunar gravity, while suit mass remained constant. Suit pressures of 6.9, 20.7, 29.6, 34.5 and 44.8 kPa were tested at a 1-g equivalent weight and suit mass of 121 kg. Ambulation speeds were individualized using each subject's preferred transition speed (PTS) from walk to run while unsuited at lunar gravity. Speeds were adjusted to include three below and three above PTS. **Results:** Oxygen consumption (VO_2) increased as suit weight increased, but showed little variation and no consistent trend with increased pressure. At walking speeds under 4 km/h, suit weight made little difference in metabolic rate. However, as speed increased, VO_2 increased at a greater rate relative to speed at heavier suit weights. The difference in VO_2 between the lightest and heaviest suit weight varied from ~ 6 mL/kg/min at speeds between 4.0-5.0 km/h to ~ 15 mL/kg/min at speeds between 6.1-8.0 km/h. **Discussion:** Suit pressure variation had little effect, whereas suit weight considerably altered VO_2 . For ambulation, a large range of suit weights would be acceptable within proposed operational concepts of future exploration missions. Characterization of exploration tasks and lunar surface terrain are needed to further understand suit pressure and weight requirements.

Learning Objectives: 1. The relationship between planetary suit weight and operating pressure to metabolic rate in simulated lunar gravity will be discussed.

[363] THE EFFECTS OF TERRAIN AND NAVIGATION ON HUMAN EXTRAVEHICULAR ACTIVITY WALKBACK PERFORMANCE ON THE MOON

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Introduction: Results of previous research showed that 6 male astronauts were able to ambulate 10 km on a level treadmill while wearing a prototype extravehicular activity (EVA) suit in simulated lunar gravity. However, the effects of lunar terrain, topography, and real-time navigational requirements on ambulation performance are unknown. This study characterized the effect of lunar-like terrain and navigation on oxygen consumption (VO_2) and distance travelled during an unsuited 10 km (straight-line distance) ambulatory return in earth gravity. **Methods:** Three subjects completed simulated returns under two different conditions. The first condition was a navigation over lunar-like terrain at Haughton Crater, Canada (10K_{NAV}). For 10K_{NAV}, unsuited subjects began at a location 10 km from the finish point and were instructed to return at a rapid but sustainable pace using a global positioning system receiver for navigation and tracking speed and grade. Three separate starting points, each 10 km from the finish point, were defined and subjects completed each route once. The second condition was a single unsuited trial on a treadmill (10K_{TM}) that reproduced the grade and speed from one of their 10K_{NAV} trials. VO_2 was measured during all conditions. **Results:** 10K_{NAV} was completed with an average time of 126.5 ± 28.7 min and VO_2 of 27.8 ± 5.1 mL/kg/min. Straight line distance between starting and ending points was 9.91 ± 0.22 km (mean $\pm$ SD) and actual distance travelled was $10.61 \pm$