HYPERBARIC PHYSIOLOGY AND MEDICINE
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Clinical hyperbaric oxygenation is becoming much more common with a 10 fold growth in less than 15 years. Areas undergoing intensive research at the present time are the intracellular effects of carbon monoxide, and the effects of HBO on free radicals and repairfusion injury. Preliminary evidence indicates resuscitation injury may play a role in CO poisoning as well as graft survival and crush injury. The mechanism whereby HBO mitigates this phenomenon needs further investigation. Transcutaneous PO2 measurement needs to be further refined and made more accurate. The adjunctive use of HBO in the thrombolytic and myocardial infarction research shows great promise and human series are in progress. Work needs to be done in the area of optimal treatment protocols. Currently, dosage of hyperbaric oxygen is empirically driven with very little information as to the relative efficacy of different treatment frequencies and optimal treatment pressures. Magnetic resonance imaging may provide important information concerning biochemical changes within the tissues following HBO. Randomized clinical studies are needed which seek to define cost effectiveness as well as wound healing. HBO will not become a standard of care unless it can be shown to reduce costs. Looking far in the future, if cheap energy sources can be found for the power requirements, HBO may be one of the leading causes of aircraft mishaps, currently costing on the order of a billion dollars and numerous lives annually. The real contribution of HBO to mishap statistics is clarified by use of fatigue/sleep, team composition, human computer interaction, automation, habitability, and environment stressors. The research questions will be requirement driven, empirically based, focused on specific objectives, and definitive enough to lead to well designed experimental studies.

AEROSPACE HUMAN FACTORS IN THE 21ST CENTURY. S.G. Schifflet*, Armstrong Laboratory, Crew Technology, Brooks AFB, Texas 78235.

At the threshold of the 21st Century, the DOD is challenged with maintaining a superior fighting force in the context of worldwide events having far-reaching and substantive nuclear disarmament and drastic reductions in military personnel. A conceptual strategy will be discussed for identifying research and development requirements to enhance and performance enhancement of the human element in aerospace systems well into the next century. The predominant role that Human Factors, as a scientific discipline, will assume responsibility for in future decades in the acquisition of sophisticated aerospace systems will be highlighted. Critical questions will be postulated by the discussant in such diverse research areas as behavioral processes, performance capabilities, fatigue/sleep, team composition, human computer interaction, automation, habitability, and environmental stressors. The research questions will be requirement driven, empirically based, focused on specific objectives, and definitive enough to lead to well designed experimental studies.

SPATIAL ORIENTATION IN FLIGHT. K.K. Gillingham*, Armstrong Laboratory, Brooks AFB TX 78235-5600.

Spatial Disorientation (SU) has been, is, and will continue to be one of the leading causes of aircraft mishaps, currently costing on the order of a billion dollars and numerous lives annually. The real contribution of SU to mishap statistics is clarified by use of an operational definition of SU: "an erroneous sense of flight parameters displayed by control and performance instruments." KuD to promote spatial orientation in flight has three directions: (1) elucidate basic sensory and cognitive mechanisms of orientation and SU; (2) develop ground-based and inflight training to increase pilots’ awareness of SU and to enhance their ability to avoid or correct SU; and (3) create flight instrument displays that provide efficient processing, continuous, orientational cues. Although some vestibular research still needs to be done, visual-vestibular integration, visual attention, and auditory orientation are becoming fertile areas of investigation in orientational mechanisms research. Exploring the full potential of the Advanced Spatial Disorientation Instrumentation for preventing SU-related aircraft mishaps will occupy SU training KU for years to come. Efforts at optimizing and standardizing head-up and head-down flight instrument displays are ongoing, but the eventual solution to the SU problem is a helmet-mounted display of computer-generated, virtual, visual and auditory spatial environment.

NONTONIZING RADIATION IN AEROSPACE OPERATIONS. R.C. Olsen*, Naval Aerospace Medical Research Laboratory, Pensacola, Fla 32508-5700.

In the past, issues related to nonionizing radiation were mostly concerned with radars and microwave energy. Early research in this area was, therefore, conducted with commonly used radar frequencies above 1.0 GHz (30-cm wavelength). Promulgation of ANSI C95.1-1982, however, widened the spectrum of concern to include the effects of frequencies of human resonant energy absorption. In addition, questions concerning hazards to personnel due to radiofrequency (RF) body current have been raised during the past few years. Moreover, the characterization and quantitation of the RF-burn phenomenon remains essentially unstudied. A new ANSI standard has been drafted to correct former weaknesses, but it is a voluminous, two-tiered document with many questions as a time-dependent feature. Considerable technical effort remains to adapt the ANSI draft to meet the special requirements of the aerospace industry and the military environment. Additional collaborative research is needed to better characterize the important parameters of near-field irradiation and RF body current.

AIRCRAFT ACCIDENT INVESTIGATION IN THE 21ST CENTURY. S.J. Veronneau,*, Civil Aeromedical Institute, Oklahoma City, OK 73129-8066.

This endeavor is a most diverse and multidisciplinary scientific effort. Much research remains to be undertaken in accident investigation within the men-machine-environment interface that is aviation. Most mishaps involve human factors in their causation; all accidents involve human concerns.

Current research includes health outcome analysis of disqualified persons, toxicological analysis of alcohol, drug, or medication involvement in crashes, cabin safety issues and flight attendant performance. Recent breakthroughs in program development include objective function testing, simulator-workshop comparisons, a new medical accident investigation order and mandate, along with a new NTSB relationship for acquiring the medical accident investigator.

Research areas including new interest in military flight and toxicological advances in assessing diabetes and alcohol determinations pre-employment.

Future research will include further development of human performance test capability to study medication effects and flight tasks in a simulated flight environment and to initiate a relationship between the FAA and the NTSB regarding drug studies. Challenges arising from mishaps in the aerospace envelope available to the National Aerospace Plane and space vehicle or habitation will need to be anticipated and met.

Collaborative research in accident investigation is necessary in dealing with these rare, sporadic events in order to deal with the numerous research avenues available to accident researchers. Engineers, psychologists and physicians need to coalesce in the efforts described above in addition to the traditional medical and engineering accident investigation. At the international level ICAO should be encouraged to serve as a repository of pooled data for dissemination and provide online access for constant access. The FAA intends for medical accident investigation/research activities to serve as an example for such an international collaboration.

SPACE MEDICINE RESEARCH: NEEDS FOR THE 21ST CENTURY. L.J. Pepper*, Medical Operations Branch, NASA-Johnson Space Center, Houston, TX 77058.

Space Medicine research in the 21st century will continue to focus on the four major areas including 1) expansion of the current incomplete knowledge base of clinical and subclinical physiological changes due to microgravity, 2) development of countermeasures to extend the capabilities of the human performance envelope in space flight, 3) development of novel methods for delivering all aspects of a comprehensive health care system in space, and 4) development of new transportation vehicles and space habitats.
CLINICAL AEROSPACE MEDICINE IN THE 21ST CENTURY. *S.R. Mohler.* Wright State University, Dayton, Ohio 45401.

INTRODUCTION. Advanced non-invasive diagnostic techniques will characterize the limits of practice for the 21st Century Flight surgeon. Cerebral and cardiovascular disease, even in the incipient stages, will be readily detectable at the time of the periodic physical examination. The same will be true for other potentially disqualifying conditions. Brief, high sensitive and specific cognitive and psychomotor office-based testing will be accomplished at the time of examination, including the assessment of the sensory system. In the 21st century pilot population, the use of addictive substances will be virtually unknown, the result of education and screening (and rehabilitation programs when necessary). The self-destructive, suicidal addictions (including nicotine, alcohol, amphetamines, and others) will be understood as incompatible with those who elect to undertake the privilege of flight. The 21st century approach will be that of individual assessment, emphasizing (1) Freedom from an impairing disease, (2) Capacity to perform as demonstrated by objective flight and high fidelity simulator assessment, and (3) Motivation to fly. CONCLUSION. As a result of advances in medicine, aircraft design and airspace characteristics, various medical standards of the "Golden Age" 20th century will be dropped. These include uncorrected distant vision, color vision, pure tone audiometry (the spoken voice test substituted), upper date-of-birth limits, limits on persons requiring exogenous insulin (insulin pumps will be available), and certain other conditions. The main disqualifying conditions will be in the psychiatric and attitudinal realms.


The initial explorations of the planetary systems beyond the moon are likely to be undertaken in the first four decades of the 21st century. Preparing for the social, psychological, and psychiatric problems to be faced must be initiated now if we are to adequately establish the risks which these matters pose, and the countermeasures to deal with those risks. Previous experience tells us that analyzing these problems would include analysis of complex physiologic, toxicologic, sociologic, and psychological variables that may interact within complex technological systems. This paper will emphasize the nature of the work that must be undertaken in the next two decades.

THERMAL STRESS IN AEROSPACE MEDICINE: HOT ISSUES, COLD FACTS. S.A. Nunneley,"Armstrong Laboratory, Brooks ABF TX 78235.

Heat and cold have beset flight operations since humans first learned to fly. The challenges for today and tomorrow often relate to operational constraints and the whole effects of thermal stress on performance. Some current concerns: 1) Protection from climatic extremes. Survival support for civilian members implies using only minimal equipment or supplies, and providing them in a manner which avoids interference with normal flying operations. An example is the design of antienxposure suits which prevent immersion hypothermia while maintaining comfort in the cockpit. Possibilities include tailoring insulation to specific person-mission profiles and using variable insulation or active heating instead of bulky, conventional materials. 2) Extension of physiological tolerance. Moderates heat or cold may be the "last straw" for human tolerance of a multidimensional in-flight environment. Suits landing after an extended shuttle mission might have to undertake emergency egresses where environmental heat exacerbates the circulatory decompression caused by time in orbit; effective cooling systems will be provided. Suits will be precooled in-flight, plasma volume expansion before reentry, and garments designed to prevent dependent pooling. 3) Prevention of performance effects. Elimination of thermal stress may be required to ensure optimal performance of complex tasks and to maintain maximal tolerance for other environmental stressors such as acceleration and hypoxia. Where thermal control of the work space proves inadequate or impractical, personal cooling systems will be needed. Conclusion: Elimination of thermal stress as an adverse factor in aerospace operations demands collaboration among specialists in aerospace medicine and aircraft design, as well as experts in clothing and personal conditioning, human factors and sustained operations.


Methods to enhance man's survivability in the sustained high or low G environments continue to be at the forefront of aeromedical research. Several acceleration protection research efforts are being actively pursued in programs with high visibility. A new reentry G-suit for NASA which employs uniform pressure across the lower extremities promises to increase G-protection during shuttle reentry without the discomfort of an abdominal bladder (AB). This suit concept should also be adaptable for the National Aerospace Plane's (NASP) reentry G-protection requirements. It is hypothesized that the low G levels encountered in these environments do not significantly increase hematocrit. Thus the requirement for an AB is negated but the need to prevent blood pooling in hypovolemic crewmembers is critical. The same G-protection principle used in these suits, i.e., lower body uniform pressure, is also the basis for a new advanced technology anti-G suit (ATAGS) soon to be flight tested by the USAF. The AB is an absolute necessity in ATAGS since it is to be worn in fighter-type aircraft with high G rates which cause a rapid increase in heart-to-eye distance, decreased eye-level blood pressure and subsequent G-induced loss of consciousness (G-LOC). The ATAGS is now in the process of fielding COMBAT EDGE, an ensemble which uses positive pressure for G-protection (PBG) in combination with the current anti-G suit. PBG offers relief to tactical aircrews from the fatiguing effects of acceleration in air-to-air combat. Preliminary studies have demonstrated that PBG is even more effective when used with ATAGS.

AEROSPACE MEDICINE RESEARCH IN THE 21ST CENTURY AIRCRAFT PROTECTIVE EQUIPMENT. R.H. Harding, RAF Institute of Aviation Medicine, Farnborough, Hampshire, United Kingdom.

In the 21st century, the hazards associated with flight by humans will be just as they have always been, and aircrew protective equipment will still be part of the aeromedical armory. Thus, protection against pressure changes, hypoxia, accelerations, and other flight motion effects will still be needed; and research in these areas will continue to refine our already substantial body of knowledge. In this discussion paper, examples will be presented of the research needs for advanced oxygen systems (eg the innovative ATAGS (G-LOC) suit, an advanced head-mounted devices (eg the relatively simple protective helmet of today could so easily become a behemoth if the requirement for additional systems proceeds unchecked and uncoordinated), for advanced personal protective clothing (eg the needs of pressure garments for altitude and G protection), and for advanced warning systems for disorientation and other human factor influences. But how is all this to be achieved? As human and economic resources continue to be in short supply, there will be an increasingly important place for collaborative research: no longer will it be possible, or desirable, for each laboratory to "go it" entirely alone. Standardization of research tools and methodologies will be essential, and the part played by memoranda of understanding and international bodies such as AGARD, ASCOC and AAM will be vital.


OVERVIEW. Spacelab Life Sciences 1 was the first Space Laboratory dedicated to life sciences research. It was launched into orbit in early June 1991 aboard the space shuttle Columbia. The data from this flight have greatly expanded our knowledge of the effects of microgravity on human physiology and psychology collected in-flight, not just pre and post. Principal goals of that mission were the measurement of rapid and semichronic (8 days) changes in the cardiovascular and neurovestibular systems during flight and then to measure the rate of readaptation following return to Earth. Results from the four teams involved in that flight will be presented in this paper. In addition to the cardiovascular-neurovestibular research, extensive metabolic studies were conducted on the payload crew. These studies encompassed fluid, electrolyte and energy balance, renal function, hematocrit and musculoskeletal changes. Finally, the crew participated in several neurovestibular studies. Overall, the mission was an outstanding success and has provided much new information on man's survivability in space.