

Abstracts of Current Aerospace Medical Literature

I. Acceleration Physiology

1. Methods for describing and quantifying +Gz induced loss of consciousness. Whinnery JE : *Aviat Space Environ Med* 1989; 60 : 798-802

A thorough understanding of +Gz induced loss of consciousness (G-LOC) is enhanced by defining all psychophysiological phenomena associated with G-LOC. Defining the mechanism of G-LOC and investigating methods to reduce the resulting incapacitation are facilitated by determining the kinetics of G-LOC induction, incapacitation, and recovery. Permanent video recording of G-LOC episodes is required to accurately define G-LOC events. A method of measuring the time course of G-LOC events using video recording is developed. The resulting calculated and experimental data allow an accurate description of acceleration exposure, resulting incapacitation, and myoclonic convulsions. Although acute physiologic recovery is included in this quantitative frame work, longer psychophysiological recovery remains to be fully evaluated. As such, the techniques developed are established as an initial step in fulfilling the requirement to completely define G-LOC phenomena.

II. Biodynamics

2. The dynamic response of a subject seated on various cushions. Malcolm HP, Holger B, Tommy H : *Ergonomics* 1989; 32(10): 1155-1166

An impact pendulum was used to examine the dynamic response of the seated subject. The dynamic response is of interest in establishing the relationship between driving and low-back pain. Accelerometers were placed on the seat and in vivo at the L3 vertebra. The transmissibility and phase angle were obtained in the frequency domain for a variety of cushions. Soft cushions were found to increase the gain at the first natural frequency.

III. Clinical Aviation Medicine

3. Allergic rhinitis and aviation. Kaluza CL : *Aviat Space Environ Med* 1989; 60 (10 Suppl) : B83-B85

Allergic rhinitis, or hay fever, is a combination of symptoms that affects

approximately 20% of the US populations. Symptoms include nasal congestion, sneezing, rhinorrhea and sleep aberrations. Patients with mild or seasonal cases of allergic rhinitis are perfectly capable of performing adequately in the aviation field. At present, these people are grounded during symptomatic periods. This grounding is due to both Federal Air Regulations and Navy regulations which preclude flying with nasal congestion or with the use of medications. Current therapy of allergic rhinitis is based on the use of three different basic modalities. The first modality is immuno therapy which requires usually weekly injections, and the patient is grounded for 24 hr after the injections. The second and the most commonly used modality is the use of antihistamine decongestant preparations. The third group of medication is the topical steroids and Cromolyn Sodium which are reviewed in detail because of their improved efficacy and safety. Recommendations are proposed for allowing those persons with allergic rhinitis symptoms that are easily controlled with the topical steroids or Cromolyn Sodium to continue flying.

4. Flying after diving : Still a real hazard. A case report. Charles MJ, Wirjosemito SA : *J Hyperbaric Med* 1989;4(1):23-26

It is well documented that divers who adhere to the standard US Navy no-decompression limits and repetitive group designation table for no-decompression dives, and who also observe at least a 12-h surface interval before flying; are not likely to develop decompression sickness (DCS). We report a type II DCS case which occurred during commercial flight 30 h after an uneventful 4-day diving activity. The dives were conducted with strict adherence to the above standards. This patient was treated on a USAF modified treatment table 6 resulting in complete resolution of the symptoms. This case is discussed with regard to the predisposing factors most frequently cited as being related to DCS.

IV. Environmental Physiology

5. Head Cooling is desirable but not essential for preventing heat strain in pilots. *Frim J : Aviat Space Environ Med 1989; 60 : 1056-1062*

Liquid cooled garments (LCGs) are being considered for reducing heat strain in pilots. While head cooling has been shown to be thermally efficient and subjectively desirable, it is technically difficult to achieve. This laboratory study was carried out to see if head cooling in addition to torso cooling is a necessity. Six male subjects wore a cooling vest and cap under summer flight clothing on three occasions in a climatic chamber set at $T_{db}=42^{\circ}\text{C}$, $T_{wb} 32^{\circ}\text{C}$ ($rh=50\%$), $T_g = 52^{\circ}\text{C}$ at head position $WBGC = 35^{\circ}\text{C}$, cooling conditions were : control (CTRL), no fluid circulation, condition VEST, only torso cooling, condition HEAD, both torso and head cooling. Cooling fluid was circulated from a reservoir maintained at 10°C . Subjective thermal comfort assessments confirmed the desirability of head cooling, but performance measurements and physiological measurements of thermal strain showed no statistically significant differences between conditions VEST and HEAD. It was concluded that head cooling is desirable but not essential.

6. Thermal Function of a clothing ensemble during work : dependency on inner clothing layer fit. Nielsen R, Gavhed DCE, Nilsson H : *Ergonomics 1989; 32(12): 1581-1594*

A tight-fitting crewneck undergarment (U) and a loose-fitting shirt (S) were studied as part of a commonly used clothing ensemble ($I_{tot} = 0.22 \text{ m}^2 \text{ KW}^{-1}$). Ten clothed male subjects performed standardized packing work ($VO_2 = 0.761 \text{ min}^{-1}$) at three climatic conditions, 20°C and $V_a = 0.45 \text{ ms}^{-1}$ (0-30 min), at 5°C and $V_a = 0.39 \text{ ms}^{-1}$ (30-60 min) and at 5°C and $V_a = 1.23 \text{ ms}^{-1}$ (76-90 min). From 60-70 min the subjects rested at 20°C . The physiological and subjective responses varied with the environment from slightly warm to cool. U resulted in warmer responses than S : evaporation rate was higher at 20°C , mean skin temperature was higher during work at 20°C , sweating tended to begin earlier and skin wettedness to be higher with U than with S. No differences were observed in core temperature,

heart rates, and subjective thermal evaluations. It was concluded that a tight-fitting inner layer (U) compared to a loose-fitting one (S) allows for less cooling of the skin in both a cool and a slightly warm environment.

V. Ergonomics

7. The Effect of sustained acceleration and noise on workload in human operators. Albery WB : *Aviat Space Environ Med 1989;60:943-948*

Biodynamic stressors such as acceleration, vibration, heat and cold can affect pilot performance. The objective of this research was to determine the individual effect of two of these stressors, sustained acceleration or high intensity pink noise, on workload in human operators. Combined stressors were not investigated. A total of 13 workload measures, including 1 subjective, 4 performance and 8 physiological were recorded on subjects ($n=9$) performing a dual psychomotor task in the human centrifuge. Increasing noise stress (max 100 db-A weighted) had a significant effect on the subjective workload assessment technique or SWAT scores ($P=0.0001$) and reaction time ($P=0.0189$); acceleration stress (average peak, 3.75 Gz) had significant effect on SWAT ($P=0.0001$), heart rate ($P=0.0001$) total eye blinks ($P=0.0189$), blink duration ($P=0.0017$), and the standard deviation of the EMG on the tracking forearm ($P=0.0452$). Although many of the workload measures were affected by the noise or acceleration, subjects were able to maintain their performance on the primary tracking task. It is concluded that biodynamic stressors, such as noise and acceleration can adversely affect subjective operator workload without affecting objective task performance.

8. The occurrence of the vection illusion among helicopter pilots while flying over water. Unga TJ : *Aviat Space Environ Med 1989; 60:1099-1101*

US Coast Guard helicopter pilots were questioned on the occurrence of the vection illusion while flying over water under different light and sea conditions. A total of 267 (79.9%) pilots completed the study questionnaire. The illusion of vection was experienced by 248 (92.5%), of these pilots. The majority of the pilots, 209 (84.6%), reported that dark rather than light visual

conditions increased the likelihood of experiencing vection. Vection was considered likely to occur over rough seas by more pilots [114 (46.2%)] than over smooth seas [81 (37.8%)]. Several pilots commented that they had responded to the illusion with aircraft movement. The vection illusion is a common experience among helicopter pilots while flying over open water. Low light conditions and rough sea states are conducive to experiencing the vection illusion. Pilots may respond to the illusion with aircraft control movements, which raises flight safety concerns.

9. Fatigue induced by static work. Khan JF, Monod H : *Ergonomics* 1989; 32(7): 839-846

Despite its low energy cost, isometric contraction can result in the onset of local muscle fatigue. The onset of fatigue occurs more rapidly when the relative force exerted is greater than 15-20% of the maximum voluntary contraction (MVC) of the muscle considered, and when the contraction time is increased. The maximum maintenance time (limit-time) and the corresponding relative force are linked by a hyperbolic relation. Ischaemia promotes accumulation of acid metabolites produced during contraction, and hinders their elimination, thus constituting the main casual factor in the onset of local muscle fatigue. The introduction of rest periods of sufficient duration to ensure restoration of normal blood flow through the muscle is an effective way of delaying, or even preventing, the onset of muscle fatigue. Other factors may also be taken into account, such as the position in which the static work is performed, and the nature and number of muscles used simultaneously, etc. Numerous laboratory and field studies have allowed the development of various models that take into account the conditions relating to isometric contractions during static work.

VI. Hyperbaric Medicine

10. Treatment of Migraine with Hyperbaric Oxygen. Fife WP, Fife CE : *J Hyperbaric Med* 1989; 4(1): 7-15

The pathophysiology of migraine headache includes focal cerebral hypoxia and vasodilation. Hyperbaric oxygen (HBO) has been demonstrated to cause cerebral vasoconstriction while

increasing tissue oxygen. Twenty-six patients with migraine headache pain were treated with HBO between 1.3 and 2.4 ATA. All but one obtained complete relief of migraine symptoms within minutes of exposure, including 2 patients with facial hemiparesis, and none had adverse effects from treatment. This preliminary trial suggests that HBO may be a useful treatment for patients with severe migraine symptoms.

11. Effect of hyperbaric oxygenation on spasticity in stroke patients. Jain KK : *J Hyperbaric Med* 1989; 4(2): 55-61

Effect of hyperbaric oxygenation (HBO) at 1.5 ATA on spasticity of stroke was observed in 21 patients undergoing rehabilitation. The patients served as their own controls. HBO reduced spasticity in all the patients, an effect that was more marked than that of physical therapy, hyperbaric air or 100% normobaric air. Initially the effect was transient and subsided within 24 h after treatment, but by conducting physical therapy simultaneously with daily, 45 min HBO sessions, lasting results were achieved after 5 wk and could be maintained by physical therapy alone during the follow up, which varied from 6 m to 1 yr. The exact mechanism of relief of spasticity is not known but it is probably due to improvement of the function of neurons in the penumbra zone of the cerebral hemisphere affected stroke. This concept is supported by documented improvement of cerebral metabolism, EEG, rCBF and motor function in stroke patients after HBO therapy. From the available evidence, HBO is considered to be an invaluable adjunct in the rehabilitation of stroke patients with spastic hemiplegia. Although the effects were documented in the paralyzed limbs, spasticity improved in other groups of muscles as well.

12. Alternative operating instructions for the Sechrist model 500A hyperbaric ventilator. Foust G, Golden EB : *J Hyperbaric Med* 1989; 4(3) : 143-145

The infrequent operation of the Sechrist model 500A hyperbaric oxygen (HBO) ventilator may lead to potential error in setting the ventilator for a particular patient. The lack of calibrated controls, sophisticated monitoring and mode capabilities common on modern-day critical care ventilators are not available on the Sechrist HBO ventilator. Using the methods described in the

manual could in this paper achieves the desired rate and volume settings while maintaining the longest exhalation time compatible with those settings. We recommend this approach to decrease the likelihood of ventilator-induced barotrauma.

13. Use of hyperbaric oxygen in the reanastomosis of the severed ear : A review. Hill RK, Bright DE, Neubauer RA : *J Hyperbaric Med* 1989; 4(4): 163-175

Reconstruction of a severed ear is a difficult surgical problem. The traditional approach is to remove the skin of the severed ear and bury the cartilaginous helix in a retroauricular or abdominal pockets. Staged reconstructive procedures are undertaken at a later date with multiple grafts. Even when successful, the results are often cosmetically poor, and several surgical procedures are needed over an extended period. Five patients, 4 male and 1 female, with severed or near severed ears have been treated with reanastomosis and adjunctive hyperbaric oxygen. Four of the 5 patients required no further surgery and required a single graft for coverage. The results of immediate reanastomosis and adjuvant hyperbaric oxygen in these patients have been cosmetically and cost effective. It is suggested that this may be valid approach to this difficult problem.

14. Effect of hyperbaric oxygen therapy on ischemic liver damage. Kurokawa T, Nonami T, Kuuro K : *Hyperbaric Med* 1989;4(4):197-204

This study was undertaken to determine whether hyperbaric oxygen (HBO) therapy in rats can improve energy metabolism in the post-ischemic liver. Ischemia of the liver for 45 min was accompanied by a remarkable decrease in hepatic adenosine triphosphate (ATP) and mitochondrial respiratory function. The subsequent reperfusion resulted in good recovery of mitochondrial respiratory function, although the increase in ATP was markedly depressed even after 150 min reperfusion. This phenomenon probably was caused by prolonged reduction in hepatic circulation after reperfusion. HBO during reperfusion significantly improved the acid base balance and the recovery of ATP level compared with the control group. Moreover, HBO prevented the increase in serum transaminase. These results indicate HBO can accelerate oxygen

delivery and its utilization in mitochondria in the postischemic liver in a state of disturbed circulation. It was suggested that high energy status in hepatocytes of HBO group provides beneficial effects on the cell metabolism leading to reduction of further cell necrosis.

VII. Space Medicine

15. Work capacity during 30 days of bed rest with isotonic and isokinetic exercise training. Greenleaf JE, Bernauer EM, Ertl CM, et al : *J Appl Physiol* 1989; 67(5):1820-1826

The purpose was to test the hypothesis that twice daily, short-term, variable intensity isotonic and intermittent high-intensity isokinetic leg exercise would maintain peak O_2 uptake (VO_2) and muscular strength levels during 30 days of -6° head down bed rest (BR) deconditioning. Nineteen men (aged 32-42 yr) were divided into exercise control (Peak VO_2 once/wk, $n = 5$) isokinetic (Lido ergometer, $n = 7$), and isotonic (Quinton ergometer, $n = 7$) groups. Exercise training was conducted in the supine position for two 30 min periods/day for 5 days/wk. Isotonic training was at 60-90% of peak VO_2 , and isokinetic training (knee flexion-extension) was at 100%. Mean (\pm SE) changes ($* P < 0.05$) in peak VO_2 ($ml \cdot min^{-1} \cdot kg^{-1}$) from ambulatory control to BR day 28 were 44 ± 4 to $36^* \pm 3$, -18.2%* ($3.27-2.60^* l/min$) for no exercise, 39 ± 4 to $40^* \pm 3$, +2.6% ($3.13-3.14 l/min$) for isotonic, and 44 ± 3 to $40^* \pm 2$, -9.1%* ($3.24 - 2.90^* l/min$) for isokinetic. There were no significant changes in any groups in leg peak torque (right knee flexion or extension), leg mean total work, arm total peak torque, or arm mean total work. Mean energy costs for the isotonic and isokinetic exercise training were 446 kcal/h ($18.8 \pm 1.6 ml \cdot min^{-1} \cdot kg^{-1}$) and 214 kcal/h ($8.9 \pm 0.5 ml \cdot min^{-1} \cdot kg^{-1}$), respectively. Thus near-peak, variable intensity, isotonic leg exercise maintains peak VO_2 during 30 days of BR, while this peak, intermittent, isokinetic leg exercise protocol does not.

16. Hindlimb suspension suppresses muscle growth and satellite cell proliferation. Darr KC, Edward S : *J Appl Physiol* 1989; 67(5): 1827-1834

The effects of long-term hindlimb unweighting by tail suspension on post natal growth of 20 day old rat extensor digitorum longus

(EDL) and soleus muscles were studied. Morphological assay indicated that radial growth of soleus myofibers was completely inhibited between 3 and 10 days of suspension and reduced thereafter, leading to a severe attenuation (-76% from control) over the total experimental period. Longitudinal growth rate, however, was accelerated 40% over weight-bearing controls. In addition, myofibers were arranged parallel to the long axis of the muscle, an orientation associated with chronologically younger muscles, suggesting morphological maturation of soleus muscle had been delayed by suspension. In contrast, radial and longitudinal growth of EDL myofibers were minimally affected under similar conditions and remained within 5% of control at times. Suspension also influenced the normal changes that occur in satellite cell and myonuclear

populations during postnatal growth. Both the number and proliferative activity of satellite cells were severely reduced in individual myofibers after only 3 days in both soleus and EDL muscles. The reduced number of satellite cells within 3 days of initiating hindlimb suspension appeared to be the result of their incorporation into myofibers while the long-lasting reduction appeared to be the added effects of decreased proliferative activity. In the soleus, this reduction in number and proliferation of satellite cells persisted throughout the experimental period and resulted in an overall 43% fewer myonuclei and 45% fewer satellite cells than control at 50 days of age. In contrast, both the total number and mitotic activity of satellite cells in the EDL rapidly returned to weight-bearing control levels by day 10 of suspension, resulting in no overall reduction in myonuclear accretion.