

Abstracts from Current Aerospace Medical Literature

I. Acceleration Physiology

1. High +Gz Centrifuge Training: The Electrocardiographic Responses to +Gz-Induced Loss of Consciousness. Whinnery AM, Whinnery JE, Hickman JR. *Aviat Space Environ Med* 1990;61:609-614

Neural control of the heart involves complex interconnections within the central nervous system (CNS). Although various CNS abnormalities and processes (acute cerebrovascular accidents, cerebral ischemia, subarachnoid hemorrhages, and seizures) have been associated with alteration of cardiac electrophysiology, the effect of +Gz-induced loss of consciousness (G-LOC) on autonomic control of the heart is unknown. From a group of 59 healthy subjects undergoing centrifuge high +Gz training, 15 suffered G-LOC episodes. The +Gz training profiles included gradual (0.1 G/s) and rapid (6 G/s) exposures to levels as high as +9Gz. Electrocardiographic rate and rhythm disturbances were evaluated during each of the +Gz training profiles. Rate and rhythm disturbances associated with the +Gz stress exposures were observed in 73% of the subjects. When considering only the period when the subjects were exposed to +Gz (During G), 67% of the individuals had atrial or ventricular ectopy. When considering the period of unconsciousness (During -LOC), which lasted an average of 12.6 s, 33% of the individuals had atrial or ventricular ectopy. Electrocardiographic changes were related to +Gz stress and unrelated to the period of occurrence of G-LOC. Significant ectopy (ventricular tachycardia and supraventricular tachycardia) was observed only during +Gz stress and not related to the G-LOC period. The results of the study do not indicate that G-LOC alters the electrocardiographic response to +Gz stress.

2. The Electrocardiographic Response to High +Gz Centrifuge Training. Whinnery JE. *Aviat Space Environ Med* 1990;61:716-21

The electrocardiographic (ECG) responses of 59 asymptomatic, healthy flight surgeons to the acceleration profiles included in current US Air Force and US Navy high-G centrifuge training programs are documented. ECG dysrhythmias

were frequently observed during exposure to both gradual and rapid onset training profiles. Short self-limited episodes of ventricular tachycardia occurred in 5 subjects. Advanced Low grade ventricular ectopy occurred in 13 subjects. The type of cardiac ectopy and the frequency of occurrence for each of the training profiles is described. The results suggest that significant ectopy frequently occurs during exposure of healthy, asymptomatic individuals to centrifuge training profiles. Since aircrew are expected to undergo high +Gz as part of their usual flying duties, ECG monitoring during high-G centrifuge training has not universally been a required part of the training exposures. Aircrew have not always accepted ECG monitoring during centrifuge training, fearing detection of certain cardiac dysrhythmias, which current aeromedical standards consider disqualifying for continued flying duties without clinical aeromedical evaluation. Based on the results of this study, and previous documentation of the occurrence of significant +Gz-induced cardiac dysrhythmias (both in flight and on the centrifuge), ECG monitoring might be considered appropriate to ensure optimum medical safety during high G centrifuge training. The current inconsistency between 1) not monitoring ECG because of the aeromedical standards for flying qualification relating to the ECG response to +Gz stress, and 2) the need to monitor ECG to assure optimum safety during centrifuge training, deserves resolution.

II. Aviation ENT

3. Acupressure and motion sickness. Bruce DG, Golding JF, Hockenfull N, et al. *Aviat Space Environ Med* 1990;61:361-365.

The effectiveness of the "Sea Band" acupressure band compared with placebo and hyoscine (0.6 mg), also known as scopolamine, to increase tolerance to a laboratory nauseogenic cross-coupled motion challenge was assessed using 18 subjects. The results showed that the subjects had a significant increase in tolerance with hyoscine but had no increase in tolerance with the "Sea Band" or placebo. Possible reasons

for the failure to show any significant protection from the use of these acupressure bands are insufficient movement of the wrist to provide continuous stimulation, and/or the likelihood that only a minority of the population would show non-negligible benefits as experience with medical acupressure would suggest. The application of transcutaneous electrical nerve stimulation may be worthy of study.

III Aviation Ophthalmology

4. Cataracts, Intra-Ocular Lens Implants, and a Flying Career, Liddy BSt L, Boyd K, Takahashi GY. *Aviat Space Environ Med.* 1990; 61:660-1

The successful correction of cataracts by intra-ocular lens implantation (pseudophakia) restores relatively normal physiological vision to cataract victims. In 1976, Canadian Aviation Authority began to restore flight status to pilots, who had developed cataracts and had such surgery. In 1987, a follow-up study was done on the first 75 relicensed pilots. No aircraft incident was related to pseudophakic vision in 16,338 h post-surgery flight time. Air Transport Rated, Senior Commercial, and Private Pilots were included in the study, which covered the whole range of flight activity and all the variations in climatic conditions that are part of Canadian aviation. We conclude that pseudophakic correction of post-surgical cataract vision does not pose any significant hazard in a flight environment.

IV. Environmental Physiology

5. Heat-exercise performance of pyridostigmine-treated subjects wearing chemical protective clothing. Epstein Y, Seidman Ds, Moran D, et al. *Aviat Space Environ Med* 1990; 61:310-313

Pyridostigmine bromide is currently the pretreatment of choice for operation in chemical warfare (CW) environment. Under CW conditions, subjects are exposed to thermal stress caused by CW protective clothing. This investigation was conducted to determine if pyridostigmine affects various physiological and biophysical parameters of human temperature regulation in subjects wearing CW protective clothing. Pyridostigmine was administered orally in a randomized double-blind cross-over study in four doses of 30

mg every 8 h. An average of 33% whole blood cholinesterase inhibition was induced in the pyridostigmine treated group 4 h after ingestion of last tablet. The subjects were exposed to 170 min exercise-heat stress ($T_{db} = 33^{\circ}\text{C}$; $rh = 60\%$) consisting of 60 min in a sitting position and two 50-min walks ($1.39 \text{ m}\cdot\text{s}^{-1}$, 5% grade) separated by 10 min of rest. Non-evaporative heat exchange was significantly higher, -14.0 and $-10.6 \text{ W}\cdot\text{m}^{-2}$ (p), for the pyridostigmine treated subjects. No additional differences were found between treated subjects in the physiological responses and heat balance parameters at the end of exposure: heart rate (HR) was (mean \pm S.D.) 154 ± 16 and 151 ± 24 bpm, rectal temperature (T_{re}) was 39.0 and $38.9^{\circ} \pm 0.2^{\circ}\text{C}$, heat storage over the 2 h of exercise was 62 ± 15 and $70 \pm 15 \text{ W}\cdot\text{m}^{-2}$, and sweat rate was 832 ± 185 and $748 \pm 52 \text{ g}\cdot\text{h}^{-1}$, in the pyridostigmine and placebo treatments, respectively. We conclude that pyridostigmine, in the dosage used in this study, does not increase the physiological strain resulting from CW protective garments worn during exercise in hot conditions.

V. Ergonomics

6. Abrupt visual onsets and selective attention: Voluntary versus automatic allocation. Yantis S, Jonides J. *J Exper Psychol: Human Perception and Performance* 1990; 16:121-134

The hypothesis that abrupt visual onsets capture attention automatically, as suggested by Yantis and Jonides (1984) was tested in four experiments. A centrally located cue directed attention to one of several stimulus positions in preparation for identification of a target letter embedded in an array of distractor letters. In all experiments, one stimulus (either the target or one of the distractors) had an abrupt onset; the remaining letters did not. The effectiveness of the cue was manipulated (varying either its duration or its predictive validity) to see whether abrupt onsets capture attention even when subjects are in a highly focused attentional state. Results showed that onsets do not necessarily capture attention in violation of an observer's intentions. A mechanism for partially automatic attentional capture by abrupt onset is proposed, and the diagnosticity of the intentionality criterion for automaticity is discussed.

7. On the locus of visual selection : Evidence from focussed attention tasks. Yantis S, Johnston JC. *J Exper Psychol: Human Perception and Performance* 1990; 16:135-149

Early and late selection models of attention disagree about whether visual objects are identified before or after selection, with recent evidence of interference from to-be-ignored stimuli favoring late selection over early selection accounts. However, these tests may not have permitted optimal attentional focussing. In 4 experiments subjects identified an attentionally cued target letter embedded among distractors. Only minimal effects of information appearing in to-be-ignored locations were observed. This striking efficiency of selection provides support for early selection theories and calls into question some late selection theories holding that stimuli throughout the display are immediately and fully identified prior to attentional selection. In order to explain the larger pattern of results across a variety of focussed- and divided-attention paradigms, a hybrid model is advanced with a flexible locus for visual selection.

8. Effects of whole-body vibration waveform and display collimation on the performance of a complex manual control task. McLeod RW, Griffin MJ. *Aviat Space Environ Med* 1990; 61:211-219

An experiment is described in which two independent groups of eight subjects each performed a combined continuous and discrete tracking task during exposure to vertical whole-body vibration. Both groups received sinusoidal and random vibration at preferred third-octave centre frequencies of 0.5-10 Hz. One group performed the task with the display collimated by a convex lens. Without the collimation, performance was disrupted by both types of vibration at all vibration frequencies; collimation removed the disruption at frequencies above 1.6 Hz. There were differences in the effects of random and sinusoidal vibration at 2.0 and 2.5 Hz, suggesting that compensatory eye movements were assisting performance during exposure to the predictable sinusoidal motion. The results show that continuous control performance was disrupted by visual interference frequencies above 1.6 Hz; closed-loop system transfer functions showed that visual interference

increased the phase lags which impaired control performance. Possible mechanisms explaining the disruption in performance at lower frequencies are discussed.

9. Eye-Hand Coordination : Oculomotor Control in Rapid Aimed Limb Movements. Abrams RA, Meyer DE, Kornblum S. *J Exper Psychol: Human Perception and Performance* 1990; 16:248-267

Three experiments are reported in which Subjects (Ss) produced rapid wrist rotations to a target while the position of their eyes was being monitored. In Experiment 1, Ss spontaneously executed a saccadic eye movement to the target around the same time as the wrist began to move. Experiment 2 revealed that wrist-rotation accuracy suffered if Ss were not allowed to move their eyes to the target, even when visual feedback about the moving wrist was unavailable. In Experiment 3, wrist rotations were equally accurate when Ss produced either a saccadic or a smooth-pursuit eye movement to the target. However, differences were observed in the initial-impulse and error-corrections phases of the wrist rotations, depending on the type of eye movement involved. The results suggest that aimed limb movements use information from the oculomotor system about both the static position of the eyes and the dynamic characteristics of eye movements. Furthermore, the information that governs the initial impulse is different from that which guides final error corrections.

10. Attentional Limits on the perception and memory of visual information. Palmer J. *J Exper Psychol: Human Perception and Performance* 1990; 16:332-350

Attentional limits on perception and memory were measured by the decline in performance with increasing numbers of objects in a display. Multiple objects were presented to Subjects (Ss) who discriminated visual attributes. In a representative condition, 4 lines were briefly presented followed by single line in 1 of the same locations. Ss were required to judge if the single line in the 2nd display was longer or shorter than the line in the corresponding location of 1st display. The length difference threshold was calculated as a function of the number of objects. The differences thresholds doubled when the number of objects was increased from 1 to 4. This

effect was generalized in several ways, and nonattentive explanations were ruled out. Further analyses showed that the attentional processes must share information from at least 4 objects and can be described by a simple model.

VI. Exercise Physiology

11. Motion sickness susceptibility and aerobic fitness : A longitudinal study. Cheung BSK, Money KE, Jacobs I. *Aviat Space Environ Med* 1990; 61:201-204

A longitudinal study evaluated the susceptibility to motion sickness in initially unfit subjects before and after an endurance training program. Motion stimulation was provided by the Precision Angular Mover, in which the subject was tumbled head over heels about an Earth-horizontal axis at 20 cycles per minute in darkness. Maximal aerobic power and the blood lactate response to submaximal exercise were evaluated with cycle ergometry. The training program caused significant improvements in Vo_2 max and endurance capacity, and a significant decrease in percent body fat. There was a significant (p) increase in motion sickness susceptibility after the physical training, suggesting that increased physical fitness caused increased susceptibility to motion sickness in some individuals.

VII. High Altitude Physiology

12. Threshold altitude resulting in decompression sickness. Kumar KV, Wallgora JM, Calkins DG. *Aviat Space Environ Med.* 1990 ; 61 : 685-9

A review of case reports, hypobaric chamber training data, and experimental evidence indicated that the threshold for incidence of Altitude Decompression Sickness (DCS) was influenced by various factors such as prior denitrogenation, exercise or rest and period of exposure, in addition to individual susceptibility. Fitting these data with appropriate statistical models has the potential for estimating the frequency of occurrence of DCS at various altitudes under different experimental conditions and allows us to examine the influence of various factors on threshold for DCS. This approach was illustrated by logistic regression analysis on the incidence of DCS below 9, 144 m (30,000 ft). Estimations using these regressions showed that

under a no-prebreathe, 6-h exposure, simulated extravehicular activity profile, the threshold for symptoms occurred at approximately 3,353 m (11,000 ft); while under a no-prebreathe, 2-h exposure profile with knee-bends exercise, the threshold occurred at 7,295 m (26,000 ft). These examples showed that definition of threshold altitude should be qualified by the particular combination of experimental variables under which it was observed.

13. Rapid Decompression to 50,000 Feet : Effect on Heart Rate Response. Chopp CS, Bomar JB Jr, Harding RM, Holden RD, Bauer DH. *Aviat. Space Environ. Med.* 1990; 61:604-8

Interest in Molecular Sieve Oxygen Generation Systems (MSOGS) for use in military aircraft has demonstrated a need to study physiological effects of MSOGS product gas in the worst case scenario, a rapid decompression (RD). In this paper we report the heart rate (HR) response to positive pressure breathing (PPB) during and after RD from 6,096 to 15,239 m (20,000 to 50,000 ft) in a hypobaric chamber while breathing gas mixtures that simulate the product gas from MSOGS. Interbeat (R-R) intervals were recorded in 10 subjects while they breathed either Aviators' Breathing Oxygen (ABO), that is 99.5% oxygen, or 93% oxygen at two regulator settings: dilution and non dilution. Additional experimental profiles on six subjects isolated the effects of hypoxia, anxiety, and PPB on HR changes after RD. Anxiety appeared to have the greatest effect. Most of the subjects showed increased HR and reduced HR variability after the onset of pressure breathing (immediately after decompression). As the exposure continued, HR variability increased as the HR began to decline. No consistent change in the HR response could be attributed to the modest increase in hypoxia produced by substitution of 93% oxygen for ABO.

VIII Hyperbaric Medicine

14. Transient effect of hyperbaric oxygen on cerebral blood flow and intracranial pressure. Ohta H, Hadeishi H, Nemoto M, et al. *J Hyperbaric Med* 1990;5(1):3-13

The effect of hyperbaric oxygen (HBO) on cerebral blood flow (CBF) and intracranial pressure (ICP) was studied to evaluate its

usefulness in the treatment of patients with increased ICP. Of the 7 patients studied, 6 had subarachnoid hemorrhage due to rupture of an intracranial aneurysm and 1 had an intracerebral hematoma secondary to hypertension. CBF measurements using the ^{133}Xe intravenous injection method were performed before HBO (baseline), under 2 absolute atmospheres with 100% oxygen inhalation (HBO:2 ATA. O_2) and after decompression while breathing room air (posttreatment). ICP was monitored continuously through out the study. Baseline CBF, as evaluated by the initial slope index, was 38.2 ± 6.3 and the ICP was 24 ± 8 mm Hg (mean \pm SD). Under HBO, CBF decreased to 32.0 ± 7.7 (P) and the ICP to 18 ± 6 mm Hg (P). Posttreatment CBF was 37.8 ± 5.7 and the ICP was 28 ± 8 mm Hg. These values were almost the same as the baseline values. Some patients showed a rebound increase in ICP after HBO. Hyperoxemia during HBO presumably caused vasoconstriction of the cerebral vessels which reduced CBF and ICP. These results confirmed that HBO therapy can reduce intracranial hypertension, but its efficacy is only transient.

IX Neurophysiology

15. EEG amplitudes in healthy, late-middle-aged and elderly adults: normality of the distributions and correlations with age. Pollock VE, Schneider LS, Lyness SA. *Electroencephalography Clin Neurophysiol* 1990; 75:276-288.

The interindividual distributions of EEG amplitudes were evaluated in 60 healthy subjects, aged 56-76. Skew and kurtosis were used to assess the normality of the amplitude distributions in 5 frequency bands (delta, theta, alpha and 2 beta ranges) and 28 scalp derivations while the subjects were awake and rested with their eyes closed and opened. Most of the interindividual EEG amplitude distributions were not normally distributed. Two transformations were applied to the EEG amplitudes: the square root and the natural logarithm. Evaluation of skew and kurtosis indicated that the natural logarithmic transformation was more effective than the square root in reducing the positive skew and leptokurtosis that characterized the untransformed interindividual EEG amplitude distributions. For all

frequency bands except theta, the log transformation rendered the distributions approximately normal in form. Correlations between log transformed EEG amplitudes and age were not statistically significant. These findings are discussed in the context of previous research, aging, and methodological features.

X. Space Medicine

16. Energy absorption, lean body mass, and total body fat changes during 5 weeks of continuous bed rest. Krebs JM, Schneider VS, Evans H, et al. *Aviat Space Environ Med* 1990; 61:314-318.

Inactivity causes profound changes. We determined the nature of the body composition changes due to inactivity, and sought to determine if these changes are secondary to changes in energy absorption. Volunteers were 15 healthy males who lived on a metabolic research ward under close staff supervision for 11 weeks. Subjects were ambulatory during the first 6 weeks of the study. Six male volunteers (age 24-61 years, height 175.7 ± 4.2 cm) were selected for body composition measurements. Nine different male volunteers (age 21-60 years, height 177.7 ± 5.0 cm) were selected for energy absorption measurements. The volunteers were fed weighed conventional foods on a constant 7-d rotation menu. The average daily caloric content was 2,592 kcal. Comparing the weeks of continuous bed rest with the previous 6 weeks of ambulation we observed: no change in energy absorption or total body weight during bed rest, but a significant decrease in lean body mass and a significant increase in total body fat (p).

17. Effectiveness of the Space Shuttle Anti-Exposure System in a Cold Water Environment. Baglan JP, Kaufman JW. *Aviat Space Environ Med*. 1990; 61:753-7.

The purpose of this study was to evaluate the National Aeronautics and Space Administration (NASA) Space Shuttle Launch Entry Suit (LES) and raft for 24 h of protection against cold water immersion. Two configurations, the LES and the LES with raft (Navy LRU-18/U with NASA spray shield) were evaluated for anti-exposure protection. Conditions were selected to simulate worst case water and air temperatures along projected Space Shuttle

ground tracks; i.e., water temperatures = 4.4°C (40°F), air temperature = 5.6°C (42°F), 1 foot waves (chop), and constant spray. Four males, 31-44 years of age, and one 32-year-old female, were studied once in each configuration. Trials with and without a raft were scheduled for up to 24 and 6 h, respectively. Mean LES trial durations were 150 ± 9 min and final rectal temperature ($T_{re, f}$) = $36.5^\circ \pm 0.3^\circ\text{C}$. Mean LES with raft (LES/r) trial durations were 398 ± 126 min and final rectal temperature ($T_{re, f}$) = $35.6^\circ \pm 0.4^\circ\text{C}$. LES and LES/r trials were terminated for reaching

$T_{re} = 35.0^\circ\text{C}$; or subject-requested termination due to discomfort. The longest LES and LES/r trials were terminated due to subject discomfort. Although not achieving the desired durations, the LES and LES/r did prove capable of protecting individuals, respectively, for up to 3 and 13.5 h. Since the longest LES and LES/r runs were terminated due to subjective tolerance and not physical incapacitation, actual survival times greater than 3 and 13.5 h, respectively, could be expected for individuals in these ensembles.