

Abstracts of Current Aerospace Medical Literature

Acceleration Physiology

Panel of deliberate G-induced loss of consciousness: Introduction. Burton RR. *Aviat Space Environ Med* 1991; 62 : 609-611.

Over the last decade, G-induced loss of consciousness (G-LOC) has been recognised as a significant operational problem for pilots of high performance aircraft in both the US Air Force and US Navy. Consequently, government laboratories have initiated research studies to learn more about the G-LOC phenomenon in an attempt to reduce its hazards. Many of these studies require the occurrence of LOC during their conduct. For this reason, animal models have been developed for use in these studies. However, even though sophisticated animal model such as baboons can be taught to perform tasks before and after G-LOC has occurred, these models have deficiencies that can be overcome only by the use of human volunteers who willingly submit to G-LOC studies on the centrifuge. Such human studies began in World War II and continue today. These studies are presently conducted without guidelines regarding subject selection, number of G-LOCs allowed per subject per unit time, restraint systems, or specific medical examinations required before, during, and after each episode of LOC, or after each completed study. This panel will discuss what is known about the pathophysiology of G-LOC, the limitations of animal models in these types of studies, the possible medical and psychological sequelae, and the legal implications of conducting deliberate G-LOC research. We hope that the information developed by this panel will be useful to laboratory human-use review committees in determining the requirements and the nature of guidelines for conducting such studies.

Aerospace Physiology

Dietary intake and blood lipid profile survey of fighter pilots at Tyndall Air Force Base. Copp EK, Green NR. *Aviat Space Environ Med* 1991; 62 : 837-41.

A 24-hour dietary recall, a food frequency checklist, and a blood lipid profile were collected from 30 USAF fighter pilots. Sample mean intakes of nutrients studied met US military recommended

dietary allowances, except for folic acid, which was 78%. Mean percentages of energy derived from carbohydrate, protein and fat were 48.3, 16.1 and 34.2%, respectively. Of the pilot sample, 63% reported they did not eat breakfast daily. Sample mean blood lipid profile values were total cholesterol = 218 mg/dl, HDL-cholesterol = 45 mg/dl, triglycerides = 109 mg/dl. Based on total cholesterol level, 40% of the pilot sample should have follow-up according to the National cholesterol education program. A significant negative relationship was found between reported exercise frequency and total cholesterol/HDL-cholesterol ratio. Some fighter pilots could benefit from counselling with a dietitian regarding dietary intake patterns, decreasing dietary fats, and the advantages of regular exercise.

Gender-based differences in the cardiovascular response to standing. Gotshall RW, Tsai P-F, Frey MAB. *Aviat Space Environ Med* 1991; 62 : 855-859.

Reduced tolerance to orthostatic stress is a recognised consequence of spaceflight. Both men and women serve as astronauts and staying longer in space. While there are recognised cardiovascular differences in baseline function based on gender, little is known about any gender-based differences in cardiovascular responses to orthostatic stress. The purpose of this study was to compare cardiovascular responses of men and women to the stand test. The subjects were 10 men and 10 women, 20-30 years of age. Heart rate, blood pressure, stroke volume, cardiac output and total peripheral resistance were monitored during 5 min supine and 5 min standing. Men responded similarly in heart rate (39 vs. 35%); but had significantly greater decreases in stroke volume (-53 vs. -40%), cardiac output (-36 vs. -21%), and pulse pressure (-19 vs. -12%); and greater increases in blood pressure (11 vs. 6%) and total peripheral resistance (77 vs. 34%) than did the women. Men and women demonstrated fundamental differences in cardiovascular responses during standing. Differences in the height of the subjects did not account for these differing cardiovascular responses. The mechanisms for these differences are not yet clear. Men and women should be

studied as separate groups until these differences are understood.

Aviation Ophthalmology

Disposal of soft lens ulcerative Keratitis in an Army aviator. A case report : Lattimore MR Jr., Varr WF. *Aviat Space Environ Med* 1991; 62 : 888-889.

A synopsis of Army aviation interest in soft contact lenses is presented. A case report of one volunteer subject's experience with presumed contact lens-associated infectious ulcerative keratitis is then summarised. The clinical significance of this case is highlighted.

Prescriptive eyeglass use by US Navy jet pilots: Effects on air-to-air target detection. Temme LA, Still DI. *Aviat Space Environ Med* 1991; 62 : 823-826

Air-to-air target detection distances, age, career jet flight hours, and total career flight hours were obtained for 167 US Navy fighter pilots participating in air combat manoeuvre training at Naval Air Station, Oceana, VA. Of the pilots sampled, 22 used a prescribed spectacle correction while flying; 145 did not. We compared air-to-air target detection distances between the two groups of pilots, those with corrective glasses and those without. Sunglasses and tinted filters were not factors in the present study. The results strongly suggest that, as a group, the pilots without glasses were able to detect targets at a greater distance than the pilots with glasses. When the pilots were matched on the basis of age and flight experience, the difference in air-to-air target detection capabilities of the two groups increased. The pilots without glasses were able to detect their adversary at distance more than 20% farther than the pilots with glasses.

Visual Acuity of the US Navy Jet Pilot and the Use of the Helmet Sun Visor. Morris A, Temme LA, Hamilton PV. *Aviat Space Environ Med* 1991;62:715-21.

Visor wear habits, evaluative comments and vision test data were obtained from interviews of 126 Navy fighter pilots. The interviews revealed that many pilots use their helmet sun visor whenever they fly, some use it only during certain flight operations, and others never use it. Study 1 (conducted at 343 cd/m²) revealed a decrease in low contrast visual acuity attributable to helmet sun visor use in the presence of a glare source.

These findings prompted a second study of the visual effects of visor transmittance. Low-contrast spot detection, acuity, and contrast sensitivity were measured at an operationally realistic daytime illumination level (6870 cd/m²) in subjects viewing through filters ranging from 6.3% to 50.4% transmission. (Standard visor transmission is 12.4%). Results showed that filter density, and consequently the illuminance reaching the eyes, could be varied over a wide range without critically effecting these visual functions. Prevailing environmental illuminance should be considered when selecting sun visor or sunglasses. These results have implications for optimising visual performance through visors.

Aviation Psychology

Testing the Tests - An Empirical Evaluation of Screening Tests for the Detection of Cognitive Impairment in Aviators. Stokes AF, Barich MT, Elledge VC. *Aviat Space Environ Med* 1991; 62 : 783-788.

The FAA has expressed concern that flight safety could be compromised by undetected cognitive impairment in pilots due to conditions such as substance abuse, mental illness, and neuropsychological problems. Interest has been shown in the possibility of adding a brief "mini-mental exam," or a simple automated test-battery to the standard flight medical to screen for such conditions. The research reported here involved the empirical evaluation of two "mini-mental exams," two paper-and-pencil test batteries, and a prototype version of an automated screening battery. Sensitivity, specificity, and positive predictive value were calculated for each sub-task in a discriminant study of 54 pilots and 62 individuals from a heterogeneous clinical population. Results suggest that the "mini-mental exams" are poor candidates for a screening test. The automated battery showed the best discrimination performance, in part because of the incorporation of dual-task tests of divided attention performance. These tests appear to be particularly sensitive to otherwise difficult-to-detect cognitive impairments of a mild or suitable nature. The use of an automated battery of tests as a screening instrument does appear to be feasible in principle, but the practical success

of a screening program is heavily dependent upon the actual prevalence of cognitive impairment in the medical applicant population.

The effects of alcohol on learning as a function of drinking habits. Salame P : *Ergonomics* 1991;34(9):1231-41.

Thirty-six subjects were categorized as light social drinkers (LSD) and 36 as heavy social drinkers (HSD) on the basis of both biological criteria, gamma-glutamyl transferase (GGT) and the mean corpuscular volume (MCV) and by self-reports of drinking habits. This study examined the effects of alcohol (0.7 ml/kg) and of noise (75 Db(A)) on learning and performance, in choice RT and in immediate memory tasks. Each subject was tested in two consecutive sessions (the time factor) under one of the following experimental conditions: (a) silence + placebo; (b) silence + alcohol; (c) noise + placebo; and (d) noise + alcohol. On immediate memory, there was a strong effect of time which interacted with 'drinker' category, suggesting that HSD subjects learn less rapidly than LSD. Time interacted also with state (sober or intoxicated), showing that learning might be impaired even by a moderate dose of alcohol. On the reaction time task no main effects were found but the time x drinker category interaction was significant; in session 1 LSD's RT were shorter than those of HSD. It is suggested that regular heavy drinking might affect the learning abilities of those who are not yet labelled as alcoholics.

Civil Aviation Medicine

Environmental tobacco smoke (ETS) in airlines - A healthy hazard evaluation. Crawford WA, Holcomb LC. *Aviat Space Environ Med* 1991; 62 : 580-586.

Some passengers and airline attendants have expressed concern about exposure to environmental tobacco smoke (ETS) in commercial airlines. Irritation of the eyes and respiratory tract, odour, and personal sensitivities are often the basis of complaints. Previous studies demonstrated low concentrations of materials, including ETS. Attendants fly some 800 h per year, passengers much less. Based on previous studies and duration of exposures, the absorbed dose of ETS is less than a cigarette equivalent per year. Nicotine absorption of 0.2 to

0.3 mg in 8-10h flights has been reported as unlikely to have physiologic effects. The retained 'dose' in relation to the hypotheses of risks to health based on the conflicting results of studies on 'passive smoking' are discussed. There are additional confounding factors in aircraft. We consider segregation into smoking and non-smoking zones to be reasonably effective in meeting the preferences of passengers.

Clinical Aviation Medicine

Medical causes of in-flight incapacitation : USAF experience 1978-1987. McCormick TJ, Lyons TJ. *Aviat Space Environ Med* 1991; 62 : 884-887.

In-flight incapacitation of a fully trained crewmember due to a serious underlying medical condition is a rather infrequent event. In order to delineate the extent and nature of the incapacitation, problem was reviewed at the data base at the Air Force Safety and Inspection centre for all accidents coded for incapacitation, preexisting disease, or other acute illness occurring during 10 years between 1978 and 1987. During this period there was 23 in-flight incidents of incapacitation due to insignificant underlying medical conditions. In 11 of the incidents the incapacitation resulted in a loss of consciousness. Neurologic conditions were most frequent cause followed by cardiovascular conditions. We calculated a rate of incapacitation as 0.19 per million aircrew flying hours.

Time course and clinical significance of marked left axis deviation in airline pilots. Tamura T, Komatsu C, Asukata I et al. *Aviat Space Environ Med* 1991; 62 : 683-686.

The purpose of this study was to examine the time course and evaluate the clinical significance of marked left axis deviation (LAD) in airline pilots. The study group consisted of 30 Japan Airline pilots with marked LAD, identified from a group of 1700 who are now 35 years of age or older. The mean age of examination was 48.5 ± 5.7 years and the mean observation period was 22.6 ± 5.6 years. The prevalence rate of marked LAD was 1.8%. In 20%, the axis remained unchanged, and in 70% LAD progressed either gradually or suddenly. All subjects were examined by exercise testing and

26 had echocardiograms. Two pilots (6.7%) were found to have organic heart disease (hypertension), which was much lower than the rate reported previously. In these individuals, the onset of Marked LAD was noted more than 10 years before hypertension was detected. No progression to complete left bundle branch block, nor any form of AV block, was observed among these subjects. No cardiac events or death occurred during the study period.

Clinical Medicine

Catheter ablation of accessory atrioventricular pathways (Wolff-Parkinson-White syndrome) by radiofrequency current. Jackman WM, Xunzhang Wang, Friday KJ et al. *N Engl J Med* 1991; 324 : 1605-1611.

Surgical or catheter ablation of accessory pathways by means of high-energy shocks serves as definitive therapy for patients with Wolff-Parkinson-White syndrome but has substantial associated morbidity and mortality. Radiofrequency current, an alternative energy source for ablation, produces smaller lesions without adverse effects remote from the site where current is delivered. We conducted this study to develop catheter techniques for delivering radiofrequency current to reduce morbidity and mortality associated with accessory-pathway ablation.

Radiofrequency current (mean power, $30.95 \pm 3W$) was applied through a catheter electrode positioned against the mitral or tricuspid annulus or a branch of the coronary sinus; when possible, delivery was guided by catheter recording of accessory-pathway activation. Ablation was attempted in 166 patients with 177 accessory pathways (106 pathways in the left free wall, 13 in the anteroseptal region, 43 in the posteroseptal region, and fifteen in the right free wall).

Accessory-pathway conduction was eliminated in 164 of 166 patients (99 percent) by a median of three applications of radiofrequency current. During a mean follow-up (\pm SD) of 8.0 ± 5.4 months, preexcitation or atrioventricular reentrant tachycardia returned in patients (9 percent). All underwent a second, successful ablation. Electrophysiologic study 3.1 ± 1.9

months after ablation in 75 patients verified the absence of accessory-pathway conduction in all. Complications of radiofrequency-current application occurred in three patients (1.8 percent): atrioventricular block (one patient), pericarditis (one), and cardiac tamponade (one) after radiofrequency current was applied in a small branch of coronary sinus.

Radiofrequency current is highly effective in ablating accessory pathways, with low morbidity and no mortality.

Twenty four hour heart rate variability : effects of posture, sleep, and time of day in healthy controls and comparison with bedside tests of autonomic function in diabetic patients. Ewing DJ, Neilson JMM, Shapiro CM et al. *Br. Heart J.* 1991; 65 : 239 - 244.

Heart variability was measured in 77 healthy controls and 343 diabetic patients by a count of the number of beat-to-beat differences greater than 50 ms in the RR interval during a 24 hour ambulatory electrocardiogram. In the healthy controls the lower 95% tolerance limits for total 24 hour RR interval counts were approximately 2000 at age 25, 1000 at 45 and 500 at 65 years. Six controls confined to bed after injury had normal 24 hour patterns of RR counts, while eight other controls showed loss of diurnal variation in both heart rate and RR counts during a period of sleep deprivation. RR counts in ten controls on and off night duty increased during sleep whenever it occurred. Nearly half (146) the 343 diabetic patients had abnormal 24 hour RR counts. The percentage of abnormal RR counts increased with increasing autonomic abnormality assessed by a standard battery of tests function. A quarter of those with normal cardiovascular reflex tests had abnormal 24 hour RR counts. There were close correlations between 24 hour RR count result and the individual heart rate tests ($r = 0.6$).

The assessment of cardiac parasympathetic activity by 24 hour RR counts was reliable. The diurnal variations in RR counts seen in the controls were probably related to sleep rather than either posture or time of day. The method was more sensitive than conventional tests of cardiovascular reflexes.

Exercise Physiology

Exercise metabolism at different time intervals after a meal. Montain, Scott J, Mari K et al. *J. Appl. Physiol* 1991; 70(2): 882-888.

To determine how long a meal will affect the metabolic response to exercise, nine endurance-trained and nine un-trained subjects cycled for 30 min at 70% of peak O_2 consumption ($VO_{2\text{ peak}}$ 2,4,6,8 and 12 h after eating 2 g carbohydrate/Kg body wt. In addition, each subject completed 30 min of cycling 4 h after the meal at an intensity that elicited a respiratory exchange ratio (RER) of 0.94-0.95. During exercise after 2 and 4 h of fasting, carbohydrate oxidation was elevated 13-15% compared with the response to exercise after an 8 and 12-h fast ($p < 0.01$). The increase in blood glycerol concentration during exercise (30 to 0 min) was linearly related to the length of fasting ($r = 0.99$; $p < 0.01$). In all subjects, plasma glucose concentration declined 17-21% during exercise after 2 h of fasting ($p < 0.01$). Plasma glucose concentration also declined (15-25%) during exercise in the trained subjects after 4 and 6 h of fasting ($p < 0.01$) but did not change in the untrained subjects. However, the decline in plasma glucose concentration was similar (14%) in the two groups when the exercise intensity was increased in the trained subjects (i.e., $78 \pm 1\%$ $VO_{2\text{ peak}}$) and decreased in the untrained subjects (i.e., $65 \pm 3\%$ $VO_{2\text{ peak}}$) to elicit a similar RER. The results of this study demonstrate that at least 6 h of fasting are necessary after consuming a 500 to 600-kcal carbohydrate meal before carbohydrate oxidation and plasma glucose homeostasis during exercise at 70% $VO_{2\text{ peak}}$ are similar to values after an 8 to 12-h fast. The progressive increase in blood glycerol accumulation during exercise as fasting increased from 2 to 12 h suggests that adipose tissue lipolysis increases in direct proportion to the length of fasting (i.e., 2-12 h). Finally, the magnitude of decline in plasma glucose concentration after a preexercise meal is dependent on relative exercise intensity.

Influence of eccentric actions on the metabolic cost of resistance exercise. Dudley GA, Tesch PA, Harris RT et al. *Aviat Space Environ Med* 1991; 62: 678-682.

Maintenance of a low energy expenditure during exercise in space is important because of the confined environment of the space craft. Resistance exercise is receiving increasing attention as a exercise countermeasure, and we have shown that training with concentric (con) and eccentric (ecc) muscle action induces greater increases in strength than training with only con actions. This study determined if performance of both actions markedly increased with metabolic cost of resistance exercise. Seventeen middle-aged males performed each repetition of a "warm-up" and four sets of the leg press exercise with only con (Group CON, $n = 8$) or with con and ecc (Group CON/ECC, $n = 9$) actions. Sets were separated by 3 min of rest and each was performed to failure by selecting a resistance that allowed performance of the prescribed number of repetitions (7 to 10). The net energy cost of exercise was estimated from oxygen consumption data that were obtained at rest before exercise, during exercise, and for 20 min of recovery. The total work performed during the con actions was about 290 J Kg^{-1} body weight for both groups. The energy cost for this work was about $3 \times 10^{-3} \text{ cal.J}^{-1}$. The requirement for the CON/ECC group to also lower the load increased (p) the energy cost 14%. These results indicate that con actions are mainly responsible for the metabolic cost resistance exercise. Because ecc actions enhance the resistance training-induced increases in strength that are evident with con actions with minimal additional energy cost, we suggest that they be considered in exercise prescriptions for use in space.

Environmental Physiology

Rapid onset of severe heat illness: a case report. Mitchell GW. *Aviat Space Environ Med* 1991; 62: 779-82.

Aviators flying extended periods in hot environments are known to be at risk for heat related illness. The risk when wearing chemical individual protective equipment (IPE) is increased even at relatively warm temperatures and light workloads. In this paper, we report the physiological responses of an aviator who had been flying a UH-1H helicopter upto 6 h/d clothed in full IPE on six consecutive days prior to the sudden onset of heat illness. His performance

during the study was normal, and no clear physiological derangements were noted prior to his symptoms. The rapid evolution of his symptoms after voicing no complaints provides a graphic illustration of the difficult predictability and initial central nervous system effects of this condition.

High Altitude Physiology

Relationships between symptoms, moods, performance, and acute mountain sickness at 4700 meters. Shukitt-Hale B, Banderet LE, Lieberman HR. *Aviat Space Environ Med* 1991; 62: 865-869.

Ascents above 4,000 m adversely affect symptoms, moods, and performance and cause acute mountain sickness (AMS). It is assumed that individual afflicted with AMS will be more susceptible to change in these other parameters; however, previous studies have suggested that their time courses are different. This investigation analysed the relationship between symptoms, moods, and performances and a measure altitude sickness, the AMS-cerebral (AMS-C) factor of the Environmental symptoms questionnaire (ESQ). We evaluate 20 male soldiers on 11 symptom, 13 mood, and 14 cognitive/motor performance measures after exposure to altitudes of 550 and 4700 h and a difference score was calculated for each measure. The difference scores for 70% of the symptoms, 46.2% of the mood, and 28.6% of the performance measures were significantly correlated with the AMS-C difference score. The difference scores for each measure were then rank ordered (to standardise for differences across measures) and the sum of the ranks was calculated for each subject's symptoms, mood, and performance. The AMS-C factor score calculated significantly 0.90, 0.77, and 0.59% with these composite measures of symptoms, moods, and performance, respectively. Changes in AMS after 5-7 h at 4700 m were correlated best with changes in symptoms, then moods, and finally performance, suggesting that these parameters may be differentially affected at this point in time.

The effect of delay on treatment outcome in altitude-induced decompression sickness. Rudge FW, Shaler MR. *Aviat Space Environ Med* 1991; 62: 687-690.

Records of the USAF School of Aerospace Medicine, Hyperbaric Medicine Division, were

reviewed to determine whether relationship exists between the length of time from development of symptoms of altitude chamber decompression sickness (DCS) to start compression therapy and outcome of treatment. During the five years period from 1 January 1984 to 31 December 1988, 233 cases of altitude chamber DCS were treated in USAF hyperbaric chambers. Information obtained from each record included age, sex, time from exposure to symptom onset, time from symptom onset to start of compression therapy, time required for resolution of symptoms, and number of treatment failures (failure to resolve during first treatment dive or recurrence of symptoms of the first dive). Analysis of the data obtained from treatment records reveals a direct relationship between length of delay to treatment with compression therapy and outcome of treatment. Patients successfully treated with a single treatment dive had an average delay to treatment of 10.6 h. Patients that failed treatment after one dive (failed to resolve or recurred) had an average delay to treatment of 18.2 h. The difference between these groups is significant ($p < 0.05$). Outcome of treatment was not significantly related to a patient age, sex, or type of symptoms. A discussion of factors causing delays in treatment of decompression sickness is included.

Attenuated carotid body hypoxic sensitivity after prolonged hypoxic exposure. Tatsumi, Koichiro, Cheryl K. et al. *J. Appl. Physiol.* 1991; 70 (2): 748-755.

Prolonged exposure to hypoxia is accompanied by decreased hypoxic ventilatory response (HVR), but the relative importance of peripheral and central mechanisms of this hypoxic desensitization remain unclear. To determine whether the hypoxic sensitivity of peripheral chemoreceptors decreases during chronic hypoxia, we measured ventilatory and carotid sinus nerve (CSN) response to isocapnic hypoxia in five cats exposed to simulated altitude of 5500 m (barometric pressure 375 Torr) for 3-4 wk. Exposure to 3-4 week of hypobaric hypoxia produced a decrease in HVR, measured as the shape parameter A in cats both awake (from 53.9 ± 10.1 to 14.8 ± 1.8 ; $p < 0.05$) and anesthetized (from 50.2 ± 8.2 to 8.5 ± 1.8 ; $p < 0.05$). Sustained hypoxic exposure decreased end-tidal CO_2 tension (PET_{CO_2} , 33.3 ± 1.2 to 28.1 ± 1.3

Torr) during room-air breathing in awake cats. To determine whether hypocapnia contributed to observed depression in HVR, we also measured eucapnic HVR (PET_{CO_2} , 33.3 ± 0.9 Torr) and found that HVR after hypoxic exposure remained lower than preexposed value ($A = 17.4 \pm 4.2$ vs 53.9 ± 10.1 in awake cats; $p < 0.05$). A control group ($n=5$) was selected for hypoxic ventilatory response matched to the baseline measurements of the experimental group. The decreased HVR after hypoxic exposure was associated with parallel decrease in the carotid body response to hypoxia ($A=20.6 \pm 4.8$) compared with that of control cats ($A=46.9 \pm 6.3$; $p < 0.05$). The cross-plot of the simultaneously measured CSN activity and ventilation during progressive hypoxia revealed a decrement in slope in the hypoxia-exposed compared with control animals, suggesting that central nervous system transduction of CSN output into ventilation was decreased by sustained hypoxia. These results suggest that sustained exposure to severe hypoxia leads to decreased peripheral chemoreceptor responsiveness to hypoxia and attenuated central nervous system chemosensory translation, which together may contribute to the attenuation of HVR in chronic hypoxia.

Human Engineering

Work-related aviation fatalities in Colorado 1982-1987. Wiant CJ, Baker SP, Marine WM et al. *Aviat Space Environ Med* 1991; 62: 827-830.

On-the-job deaths related to aviation are seventh leading cause of fatal occupational injury in the United States. In Colorado, they comprise 37% of all air transport deaths. A review of all occupational aviation-related fatalities in Colorado during 1982-1987 identified 86 deaths. Data sources were death certificates, Workers' compensation records, and National Transportation Safety Board reports. Of the fatalities, 5 involved commercial air service, 16 were military personnel, and 65 (76%) were associated with general aviation. Non-military occupations included 21 pilots, 5 flight instructors, 4 crop sprayers, and 3 search and rescue workers or firefighters. There were 18 people going to or from work sites. The 15 weather cases, 7 aircraft malfunctions, and 4 power transmission wire

strikes were the most significant factors in two-third of the crashes of civilian aircraft. Even experienced pilots exercised poor judgement. The prominence of general aviation in work-related aviation fatalities indicates a need for greater attention to the safety of workers whose jobs entail flying.

The design of manual handling tasks: revised tables of maximum acceptable weights and forces. Snook SH, Ciriello VM. *Ergonomics* 1991; 34(9):1197-1213.

Four new manual handling experiments are reviewed. The experiment used male and female subjects to study lifting, lowering, pushing, pulling, and carrying tasks. Each experiment used a psychophysical methodology with measurements of oxygen consumption, heart rate, and anthropometric characteristics. Independent variables included task frequency, distance, height and duration; object size and handles; experiments were integrated with the results of seven similar experiments published previously by this laboratory. The integrated data were used to revise maximum acceptable weights and forces originally published in 1978. The revised tables are presented and compared with the original tables.

Space Medicine

Effect of microgravity on the respiratory system. Engel LA. *J. Appl. Physiol* 1991; 70(5):1907-1911.

Because the pleural pressure gradient and regional distribution of pulmonary function are gravity dependent, substantial changes may be expected during weightlessness. Although very few measurements have been made during spaceflights, a number of observations during brief periods of weightlessness inside aircraft flying with parabolic trajectories confirm these predictions. Single-breath N_2 washouts suggest a marked reduction in the inequality of ventilation distribution seen at 1 G. Similarly, inferences made from cardiogenic oscillations during single-breath washouts suggest a greater uniformity or perfusion during weightlessness. This is supported by changes seen on chest radiographs as well as by more direct measurements of regional blood flow distribution using radioactive iodine-labeled macro-

aggregates. Vital capacity is only slightly reduced, but functional residual capacity decreases by ~10% and maximum expiratory flow rates are slightly decreased, especially at low lung volumes. Weightlessness decreases abdominal girth, increases abdominal compliance, and substantially increases the abdominal contribution to total volume during resting breathing. Despite these changes, there does not appear to be any alteration in the temporal pattern of breathing. However, disposition of inhaled medium-sized aerosol particles is substantially reduced, as predicted by model analyses of gravitational sedimentation. Virtually all these observations describe effects at the very onset of weightlessness. Practically nothing is known of slower functional changes and adaptations to prolonged weightlessness. Systematic repeated measurements during manned spaceflights will hopefully begin to provide some information on this subject in the near future.

Altered sensorimotor control of the body as an etiological factor in space motion sickness. Lackner JR, Graybiel A, Dizio PA. *Aviat Space Environ Med* 1991;62:765-71.

Exposure to nonterrestrial force levels affects the activity of gravito-inertial force sensitive receptors of the body, both of labyrinthine and nonlabyrinthine origin. It also disrupts the normal patterning of motor control of body orientation and

movement. The patterns and levels of muscle innervation necessary to achieve particular body configurations and to bring about particular body movements are greatly affected by background force level and body orientation relative to the force vector. The present studies demonstrate that such altered sensorimotor control of head and body posture along with altered vestibulomotor control are evocative of motion sickness. This observation has explanatory significance both for space motion sickness and the re-entry disturbances that occur after prolonged spaceflight.

Microgravity testing a surgical isolation containment system for space station use. Markham SM, Rock JA. *Aviat Space Environ Med* 1991; 62 : 691-693.

Anticipated hazards for crewmembers in future long term space flights may result in a variety of injuries including trauma and burns. Management of these injuries will require special techniques because of the lack of gravity, limitation of space and environmental restrictions. A small surgical isolation containment system was developed and tested in microgravity. The chamber provided both protection of the injury and cabin environment and is felt to be the most effective means of trauma and burn care in future Health Maintenance Facilities planned for prolonged space exposure.