

ABSTRACTS OF CURRENT AEROMEDICAL LITERATURE

Acceleration Physiology

1. Induction and prevention of acceleration atelectasis. Taoku WA, Ballidin UI, Burton RR, Glaistes DH, Gillingham KK, and Meroer JR: *Aviat Space Environ Med* 58(1):69, 1987.

Acceleration atelectasis has been known for a long time. It is brought about as a result of +Gz forces, anti-G suit inflation and 100% oxygen inhalation. The symptoms are chest pain, coughing and shortness of breath. The development of OBOGS giving 95% oxygen and 5% argon and its effects on aircrew breathing undiluted OBOGS output stimulated this study. The experiments were conducted on 12 subjects using Simulated Air Combat Manoeuvres (SACM) with G peaks of 4.5 G and 9.0 G for 45 sec. A decrease in vital capacity (VC) was used for quantification of atelectasis produced. There were two types of reduction in VC - labile and stable. The former amounted to a 28% reduction in VC with 4.5 G SACM and 25% with a 9 G SACM. Stable reduction in VC was of about 20% seen in both. Subjective rating of severity of symptoms was much greater with 4.5 G than with 9.0 G. Acceleration atelectasis was reduced by inspiration of oxygen diluted with nitrogen or argon and by addition of PPB of +30 mm Hg to the breathing mask on performance of an Anti-G Straining Manoeuvre (AGSM). Since PPB has proved useful in increasing +Gz tolerance from 4.5 to 7.0 Gz without fatigue associated with an AGSM, this is being incorporated in advanced life support system of future aircraft. Thus a solution to atelectasis would be to use PPB which increases intra alveolar pressure and lung volumes, thus decreasing the severity of acceleration atelectasis.

2. The effects of long-term aerobic conditioning on +Gz tolerance. Whinnery JE and Parnell MJ: *Aviat Space Environ Med* 58:199, 1987.

The authors studied +Gz tolerance in 27 long-term (2 years of running) aerobically conditioned subjects and compared the results with established USAF SAM standards for normal tolerance. They found increased aerobic conditioning ($\dot{V}O_{2\max}$) with long term running but their result did not show any enhancement in +Gz tolerance with long term running. They found increased susceptibility to motion sickness with long-term aerobic conditioning. In certain individuals they found a pre-disposition to cardiac rate and rhythm disturbances which could potentially alter +Gz tolerance. In their opinion specificity of exercise and absence of exaggerated cardiovascular response to +Gz stress resulting from physiologic alteration of autonomic tone are critical in the design of any physical training programmes for fighter aircrew.

Behavioural Sciences

3. Noise, vibration and changes in wakefulness during helicopter flights. Landstrom U and Lofstedt P: *Aviat Space Environ Med* 58:109, 1987.

Helicopter flying has long been known to be uncomfortable and tiring, exposing the pilots to a high degree of physical as well as psychological stress. The authors studied the effects of noise, vibration and changes in wakefulness during helicopter flights in pilots of two different types of helicopters - HKP3 and HKP6. They found that the helicopter noise and vibrations are dominated by low frequencies (below 10 Hz) and are responsible for a physiological and psychological state called "pilot fatigue", "flight fatigue" or "operation fatigue". Levels of wakefulness based on EEG and EKG recordings during long distance flights (about 4 h) and short distance flights (less than 2 h), were also found to be influenced by the stress upon pilots. Increased levels of wakefulness were recorded

during take offs and landings and were attributed to increased psychological load on the pilots during these occasions.

4. Efficacy of transdermal scopolamine against sea sickness - A 3-day study at sea. Attias J, Gordon C, Ribak J, Binah O and Rolnick A: *Aviat Space Environ Med* 58:60, 1987.

Scopolamine, effective against seasickness cannot be used in subjects who require high degree of performance because of its side effects like sedation and blurred vision. Transdermal Therapeutic System for Scopolamine (TTSS) which overcomes some of the unwanted effects of conventional scopolamine was tested and found successful in short term sailings lasting for 4-12 h in previous studies. The authors evaluated the above drug and its side effects during a three day cruise on 38 volunteers with sea states 2-3 using control and experimental groups. TTSS provided a protection index against sea sickness of 73% on the first two days and 39% on the third day. The symptoms of seasickness were significantly higher in the control group. The side effects associated with TTSS administration were few and tolerable and do not affect human performance at sea. The above findings make TTSS suitable for long term use by sailing crews.

5. Aerobic fitness and susceptibility to motion sickness. Banta GR, Ridley WC, Mc Hugh J, Grisset TD and Guerdy FE: *Aviat Space Environ Med* 58(2):105, 1987.

There are benefits from aerobic exercise which include cardiovascular fitness, reduced coronary risk factor, fatigue, improved cognitive function and enhanced work performance. There have been reports of aerobic training leading to a significant amount of motion sickness. The authors evaluated 29 male subjects with high, moderate and low levels of physical (aerobic) fitness, to susceptibility to motion sickness. All the subjects underwent coriolis (cross coupled) vestibular stimulation. The parameters evaluated were spin time (ST) before

aborting, heart rate, respiratory rate, mean skin temperature, subject observation values (SV) and observation values. There was an inverse relationship between ST and aerobic fitness, with aerobically fit persons showing a lower ST and a higher SV. This increased susceptibility was attributed to:- (a) Altered physiological state, i.e., enhanced vagal tone and an increased level of stress hormones, (b) Conditioned alertness to sensory inputs indicating deviations from expected body motions and/or (c) Aerobic fitness acquired without habituation to a range of nauseogenic motion stimulus. Thus there is heightened motion sickness susceptibility in high aerobic fitness.

6. Some effects of alcohol and simulated altitude and complex performance scores and breathalyser readings. Collins WE, Mertens HW and Higgins EA: *Aviat Space Environ Med* 58:328, 1987.

A total of 17 men between the ages of 21 and 35 were trained on seven tasks in the Civil Aeromedical Institute Multiple Task Performance Battery (MTPB) and then performed over a two week period in four experimental sessions: ground level with and without alcohol and simulated altitude of 3,810 m with and without alcohol. Subjects breathed appropriate gas mixtures through oxygen masks at both ground level and altitude. Alcohol doses of 100-proof vodka mixed with juice 2.2 ml/kg of body weight was given to some subjects and placebo drink to others. Breath alcohol level was assessed by an Omicron intoxilyser. Performance under all conditions was assessed by using MTPB. The seven tasks used in the study were red warning lights, green warning lights, meters, mental arithmetic, two-dimensional compensatory tracking, problem solving, and pattern discrimination.

The ingestion of alcohol resulted in significant impairment in complex performance tasks for the first 3-4 h after the drinking period. As a separate effect, the simulated altitude of 3,810 m produced a smaller, but statistically significant decrement

in performance scores under both placebo and alcohol conditions. Thus performance was adversely affected by both altitude and alcohol but there was no synergistic action between the two. Also the breathalyser recordings showed no differences between ground and simulated altitude conditions.

The data from this and other studies suggested the following:- (1) Blood alcohol level (BAL) of 0.100% or less was not differently affected at altitudes of 3,650 - 3,810 m when compared with ground level. (2) There was no synergistic interaction on performance between those altitudes and BALs although performance was adversely affected by alcohol at ground level and at altitude. (3) Altitudes of 3,650 - 3,810 m may of themselves produce performance decrements in some subjects or under some conditions. (4) When the latter occurred the deleterious effect of alcohol appeared to be additive.

7. Atropine sulphate effects on aviator performance and on respiratory-heart period interactions. Dellinger JA, Taylor HL and Forges SW: *Aviat Space Environ Med* 58:333, 1987.

The potential for the use of organophosphorous (OP) compounds in chemical warfare has implications for the safety of military pilots. Military personnel in high threat environments are issued atropine sulphate for self administration as an antidote. Both the toxic OP compound and the antidote can pose serious problems for the pilot. In this study 20 human volunteers received a placebo and atropine doses of 0.5, 1.0, 2.0 and 4.0 mg in a Latin Square double blind design, and effects were monitored for 3 h post-injection. The 2.0 mg and 4.0 mg doses resulted in significant flight simulator performance decrements beginning at 1 h post-injection with only minimal recovery by 3 h post-injection. Electrocardiogram data were used to estimate the amplitude of respiratory sinus arrhythmia (RSA) which was more sensitive than mean heart period or mean heart period variance to the effects of

atropine. The parasympathetic effects were relatively rapid in onset and peaked within the first 40-min period for the 2.0 and 4.0 mg doses. The onset of performance effects were delayed 1 h 40 min for the 2.0 mg and 1 h for the 4.0 mg treatments.

The early physiological symptoms that occur prior to the performance decrements can be used as an alerting signal to the military pilot who injects atropine sulphate, but has not been exposed to a chemical agent, allowing him time to land safely. Based on the authors' results, if a pilot injects 4.0 mg of atropine and experiences the effects of atropine (eg., tachycardia and dry mouth), it is expected that performance decrements will follow.

Clinical Aerospace Medicine

8. How useful are the cold pressor test and sustained isometric handgrip exercise with radionuclide ventriculography in the evaluation of patients with coronary artery disease? Northcote RJ and Cooke MBD: *Brit Heart J* 57:319, 1987.

Sustained isometric handgrip test as well as cold pressor test have been found to be useful for stressing the heart and assessing its level of performance and have been used to evaluate subjects with coronary artery disease (CAD). In this study, after recording basal heart rate, blood pressure and left ventricular ejection fraction (by radionuclide ventriculography), the subjects were asked to carry out the sustained isometric handgrip test using the right hand with a handgrip dynamometer maintaining 30% of the optimal voluntary contraction (which was previously determined) for 5 1/2 min. The heart rate, BP and LV ejection fraction were recorded 30 sec after the start of the test and continued for 5 min. Each subject was given 10 min rest after the handgrip test to allow the parameters to return to normal. The cold pressor test was then conducted by immersing the right hand into ice-mixed water for 5 1/2 min, the heart

rate, BP and LV performance being recorded as earlier. The authors found consistent response to these stresses and recommend them for cardiovascular assessment in proven cases of CAD for rehabilitation, but feel that these tests have no value as diagnostic techniques.

9. Fish and coronary artery disease. Sanders TAB: *Brit Heart J* 57:214, 1987.

Coronary artery disease (CAD) is comparatively rarer in Eskimos as well as in Japanese fishermen who consume fish in excess than the rest of population. Marine fish and fish oil provide polyunsaturated fatty acids eicosapentaenoic acid and docosahexaenoic acid. These two acids influence the metabolism of lipoproteins and eicosanoids (prostaglandins, thromboxanes, prostacyclins and leukotrienes) in such a way as to afford protection from CAD. Whitefish (cod, coley, plaice, haddock) have much less fat (1%) as compared to oily fish (trout, salmon, mackerel, herring, pilchard, sardine) which contain 5-25% fat by weight. Oily fish, therefore, are richer source of eicosapentaenoic acid and docosahexaenoic acid. Studies of total fat and lipoprotein fraction of Eskimos who use the oily fish as their main food show low concentrations of low density lipoprotein (LDL) cholesterol, low density lipoprotein (VLDL) triglycerides and high concentration of high density lipoprotein (HDL) - proportions ideal for prevention of CAD. Fish oil and fish-diet also prevent CAD by anti-thrombotic and anti-inflammatory effects. Thus, fish eating should be advocated for prevention of CAD. However, fried or salted fish should be avoided as these would increase the caloric intake and auger hypertension. The author recommends 200 gm oily fish or 10 gm fish oil per day in place of/as substitute to cheese, meat products, fatty meats and other saturated fats.

10. Electrical injury causing ventricular arrhythmias. Jenson PJ, Thomsen PEB, Bagger JP, et al. *Brit Heart J* 57:279, 1987.

Lightning injuries are known to produce

sudden deaths or instant cardiac injuries. Late manifestations are rare. The authors describe three cases who developed ventricular arrhythmia after 8-12 hours of lightning injury which lasted for long duration (two years). Two patients had ventricular tachycardia and fibrillation who recovered after appropriate antiarrhythmic therapy whereas the third patient developed ventricular parasystole which disappeared spontaneously within two years. There was no enzymatic evidence of myocardial necrosis but endomyocardial biopsy carried out in two out of the three subjects showed local myocardial fibrosis and increased numbers of Na-K-pumps.

Patients sustaining electrical injury in which current passes through the thorax with possibility of myocardial injury should be kept under observation even if they have no complaints or symptoms immediately after the episode. They should be preferably monitored electrocardiographically for at least 24 h to detect delayed onset of ventricular arrhythmias. The authors also suggest that patients with chronic/intermittent ventricular arrhythmias must be asked for electrical/lightning injury in the past for aetiological diagnosis.

11. Restless Legs Syndrome. Cybulska E and Rucinski J: *J Appl Med* 13:343, 1987.

An unpleasant creeping sensation deep in the legs while at rest in the evenings and at night is the salient feature of this syndrome. Also known as Ekbom's Syndrome, *asthenia crurum parasthetica*, *anxietas tibiaram* and *irritable legs*, this disorder is one of the major causes of sleeplessness especially at night. Hysteria, anxiety or depressive states, deficiency of iron and/or folic acid, recent gastric resection and caffeineism have been described as aetiological factors. Peripheral vascular diseases, infections like pulmonary tuberculosis, hepatitis and poliomyelitis, metabolic disorders like diabetes and uraemia, especially after dialysis, etc., have also been blamed. Management of this condition as outlined by the authors includes:

(1) massage of legs, flexion-extension movements and walking about to relieve mild degree of affection, (2) ascorbic acid, folic acid and iron preparations along with tranquillisers to moderately affected patients and (3) vasodilators along with antidepressant drugs in severe cases.

A recent study on 274 cases of Restless Legs Syndrome by Telstaad et al (1984) with double blind administration of specific drugs and placebo has shown significant improvement in large number of cases with placebo alone. This underlines the hysterical background as aetiology in majority of cases, especially those who are free from the above described diseases.

12. Effect of legumes on blood sugar in Diabetes Mellitus. Dilawari JB, Kumar VKA, Khurana S, Bhatnagar R and Dash RJ: *Ind J Med Res* 85:184, 1987.

The authors have studied 25 cases of maturity onset Diabetes Mellitus to evaluate effect of leguminous food on the blood sugar. Oral glucose tolerance test with 75 gm glucose was done in each case on the first day. Two days later the subjects were fed 75 gm rajmah (*phaseolus vulgaris*), channa (*cicer arietinum*), green gram (*phaseolus aureus roxb*), rice (*oryza sativa*) and wheat (*triticum aestivum*) in groups of 5 subjects each and blood sugar estimations were repeated as in glucose tolerance test. The blood sugar values showed highly significant reduction - maximal in case of rajmah, then green gram, channa, wheat and minimal in case of rice as compared to glucose administration.

Several explanations have been advocated for this beneficial effect: (1) Legumes are rich source of dietary fibres which are highly viscous, (2) Viscous agents reduce gastric emptying time, thereby delaying glucose absorption, (3) rajmah contains amylase inhibitor which inactivate amylase enzyme and delay starch digestion. The diabetic's diet, therefore, should include rajmah, channa and green gram in excess in place of rice or wheat.

Environmental Physiology

13. Effectiveness of an air cooled vest using selected air temperature and humidity combinations. Pimental NA, Cosmini HM, Sawka MN, Wenger CB: *Aviat Space Environ Med* 58:119, 1987.

The authors evaluated the effectiveness of an aircooled vest in reducing thermal strain of subjects exercising in the heat, 49 deg C dry bulb (db) 20 deg C dewpoint (dp), in chemical protective clothing. Four male subjects attempted 300 min heat exposures at two metabolic rates (175 and 315 watts) with six cooling combinations - control (no vest) and five different db and dp combinations. Air supplied to the vest at 15 sofm ranged from 20-27 deg db, 7-18 deg dp; theoretical cooling capacities were 498-687 w. Without the vest, endurance times were 118 min (175 w) and 73 min (315 w). Endurance times with the vest were 300 min (175 w) and 242-300 min (315 w). The five cooling combinations were similarly effective in reducing thermal strain and extending endurance time, although there was a trend for the vest to be more effective when supplied with air at the lower dry bulb temperature. At 175 w, subjects maintained a constant body temperature; at 315 w, the vest's ability to extend endurance is limited to about 5 h.

Space Medicine

14. Cardiovascular dynamics during the initial period of head-down-tilt. Tomaselli CM, Kenney RA, Frey MAB and Hottler GW: *Aviat Space Environ Med* 58:3, 1987.

The cardiovascular response to one hour of 6 deg head-down-tilt (HDT) was studied in 12 male subjects, aged 30-39 years, to simulate the early effects of weightlessness, as HDT was reported to give the same subjective sensations as weightlessness of space by the Soviet Cosmonauts. In this study, fluid shifts, haemodynamic measurements and indices of myocardial contractility were evaluated by utilising electrocardiography, systolic time intervals,

impedance cardiography, sphygmomanometry and measurement of calf circumference. Most cardiovascular variables remained stable throughout the initial 30 min of the protocol, even though translocation of fluid from the legs to the thorax commenced immediately with the onset of the head-down-tilt. In contrast, minutes 30-60 were characterized by reduced stroke volume, cardiac output, mean stroke ejection rate and Heather Index, concomitant with an elevation in mean arterial pressure. Intrathoracic fluid volume continued to increase while leg volume continued to decrease. This latter response suggests intrathoracic sequestrations of fluid volume; blood was apparently redistributed to the pulmonary circulation rather than being retained in the great veins.

15. Skeletal response to simulated weightlessness: A comparison of suspension techniques. Wronski TJ and Morey-Holton ER: *Aviat Space Environ Med* 58:63, 1987.

The skeletal response to simulated weightlessness was studied in rats subjected to two different methods of suspension. Skeletal unloading of the hind limb for a two week period was achieved by use of either a back harness or tail suspension. In comparison to pair fed control rats, back suspended rats failed to gain weight whereas tail suspended rats exhibited normal weight gain. Quantitative bone histomorphometry revealed marked skeletal abnormalities in the proximal tibial metaphysis of back-suspended rats. Loss of trabecular zone mass in longitudinal bone growth, decreased bone formation, and increased bone resorption. In contrast, the proximal tibia of tail suspended rats was relatively normal by their histological

criteria. However, a significant reduction in trabecular bone volume occurred during two weeks of tail suspension, possibly due to a transient inhibition of bone formation during the early stages of skeletal unloading. Lack of weight gains in back suspended rats may be indicative of a pronounced stress response during which corticosteroids adversely affected the skeleton. Maintenance of normal weight gain by tail suspended rats provides evidence for the less traumatic nature of this method of suspension. The findings indicate that tail suspension is a more appropriate model for evaluating the effects of simulated weightlessness on skeletal homeostasis.

16. Vital capacity and airflow measured from partial flow volume curves during 5 deg head-down-tilt. Dikshit MB and Patrick JM: *Aviat Space Environ Med* 58:343, 1987.

The authors studied the effect of 5 deg head down tilt on the respiratory functions including vital capacity and airflow on ten healthy young male subjects. The period of tilt lasted for seven minutes during which their forced vital capacity, peak flow rate (from complete flow-volume curves) and mid expiratory flow 40% and 25% (airflows at which 40% and 25% of the vital capacity remains in the lungs) were measured from the partial curves. The values of these variables and the heart rate and blood pressure were not found to be significantly different from the values obtained in the supine position. In view of these findings, it was concluded that the increase in intrathoracic blood volume, known to occur with 5 deg head-down-tilt used as a model of simulating weightlessness, does not compromise respiratory mechanics.