Abstracts of Current Aerospace Medicine in Literature

Acceleration Physiology

Forster EM, Cammarota CP. The Effects of G-LOC on Psychomotor Performance and Behaviour. Aviat Space Environ Med 1993;64:132-8.

Acceleration (+Gz) induced loss of consciousness (G-LOC) and its effect upon cognitive and motor performance were evaluated in seven male volunteers who were exposed to closed-loop acceleration exposures at the Naval Air Warfare Center - Aircraft Division, Warminster (NAWCADWAR) human centrifuge (DFS). The +Gz profile consisted of several aerial combat environment simulations (ACES) of up to +12 Gz. In the event of G-LOC, the DFS was brought down to a base +Gz level. As the subject recovered consciousness, he was required to complete various tasks to regain control of the aircraft. Psychomotor performance was measured before, immediately after, and 20-40 min post-G-LOC. These tasks included : 1) extinguishing master caution signals initiated upon G-LOC by an observer; 2) entering a control code on a head-down display to initiate DFS trim mode; and 3) matching own aircraft altitude, airspeed and heading to that of a displayed target. Absolute (6 ± 2 s), relative (5 ± 3 s) and total (12 ± 3 s) incapacitations were briefer than those reported in the literature. The time intervals to execute the performance tasks tended to be longer for post-G-LOC than for pre-G-LOC. Recovery of psychomotor performance, as measured in this study, occurred approximately 60 s post G-LOC. There were no performance decrements during those tasks assigned 20-40 min after G-LOC.

MacDougall JD, Mckelvie RS, Moroz DE, Moroz JS, Buick F. The Effects of Variations in the Anti-G Straining Manoeuver on Blood Pressure at +Gz Acceleration. Aviat Space Environ Med 1993;64:126-31.

The increase in blood pressure provided by the standard AGSM is caused by both the contraction of the muscles of the lower body and by an increased intrathoracic pressure due to a respiratory straining (Valsalva) manoeuver. This study examined the relative effectiveness and fatigability of the two components at +1 Gz and during +Gz acceleration in a human centrifuge. Brachial arterial pressure was recorded from a pressure-tip transducer in six subjects performing isometric leg presses only and on a separate occasion while performing respiratory straining only. Measurements were made over a range of intensities for the leg press contractions and Valsalva manoeuvers and were conducted at +1 Gz and during slow and rapid onset runs upto +5 Gz in a human centrifuge. Blood pressure was also recorded during pulsing or intermittent contractions of the legs. We found it difficult to completely separate the blood pressure response to the leg press component from that of the respiratory straining alone component, since a moderate respiratory straining maneuver usually accompanied forceful contractions of the legs. We conclude, however, that a major portion of the elevation in blood pressure caused by the AGSM can be attributed to contraction of the muscles of the lower body and that this component is less fatiguing than the respiratory straining component. At +1 Gz a pulsing isometric contraction of the legs was no more effective in elevating blood pressure than a constant isometric contraction over the same duration.

Accident Investigation

White BD, Firth JL, Rowles JM. The Effects of Structural Failure on Injuries Sustained in the MI Boeing 737 Disaster, January 1989. Aviat Space Environ Med 1993;64:95-102.

Only 10 occupants escaped uninjured from the wreckage of the East Midlands Boeing 737/400 aircraft accident. The remaining 116 suffered injuries similar in pattern, but ranging in severity from simple bruising to fatal crushing trauma. Overall, the individual's degree of injury and likelihood of death was proportional to the local structural damage of the aircraft. Limb injuries were particularly severe in the forward section of the wreckage where the floor failed. In areas where structural damage appeared to be survivable, a number of passengers suffered disproportionately severe head injuries. Many of

these had trauma to the posterior aspect of their head, some of whom died as a result. It is likely that these injuries were caused by falling overhead lockers or unrestrained cabin furniture. The significance of these injuries and their future prevention is discussed.

White BD, Firth JL, Rowles JM. The Effects of Brace Position on Injuries Sustained in the M1 Boeing 737/400 Disaster, January 1989. Aviat Space Environ Med 1993;64:103-9.

Of the initial 87 survivors of the East Midlands Boeing 737/400 aircraft, 77 sustained head and facial trauma during the crash, 45 of whom were rendered unconscious. There were 21 who received injuries to the back of their head, including 5 of the 6 severely head-injured adults. Those passengers who adopted the fully flexed "brace" position for crash-landing achieved significant protection against head injury, concussion, and injuries from behind irrespective of local aircraft structural damage. A computer graphics simulation developed by a commercial firm (M.W Sructures Ltd) using the predicted crash pulse of the accident has validated these clinical findings and allows theoretical biomechanical modeling for the design of occupant protection systems in the future. Although the major role of structural failure should not be forgotten, bracing maximizes the chance of uninjured survival in the current generation of aircraft and should be demonstrated and practiced as a pre-flight routine.

Aviation Psychology

Gander PH, Nguyen D, Rosekind MR, Connell LJ. Age, Ciracadian Rhythms amd Sleep Loss in Flight Crews. Aviat Space Environ Med 1993;64:189-95.

Age-related changes in trip-induced sleep loss, personality (n=205), and the pre-duty temperature rhythm (n=91) were analyzed in crews from various flight operations. Eveningness decreased with age (subjects aged 20-30 were more evening-type than subjects over 40). The minimum of the baseline temperature rhythm occurred earlier with age (earlier in subjects aged 30-50 than in subjects aged 20-30). The amplitude of the baseline temperature rhythm declined with age (greater in subjects aged 20-30 than in subjects over 40). Average daily percentage sleep loss during trips increased with age. Among crewmembers flying longhaul flight operations, subjects aged 50-60 averaged 3.5 times more sleep loss per day than subjects aged 20-30. These studies support previous findings that evening types and subjects with later peaking temperature rhythms adapt better to shift work and time zone changes. Age and circadian type may be important considerations for duty schedules and fatigue countermeasures.

Giesbrecht GG, Arnett JL, Vela E, Bristow GK. Effect of task complexity on mental performance during immersion hypothermia. Aviat Space Environ Med 1993;64:206-11.

The effect of task complexity on the decrement in mental performance during immersion hypothermia was studied. Psychometric tests of varying length and complexity were administered : 1) priort to cold water immersion (baseline); 2) soon after immersion to the neck in cold (8°C) water but prior to any decrease in core temperature; and 3) after 55 to 80 min of immersion when core temperature had decreased 2-4°C. Results indicated that tests placing relatively minimal cognitive demands on individuals, such as auditory attention, the Benton visual recognition test and forward digit span, were unaffected by either initial cold water immersion or central cooling. On the other hand, tests requiring relatively greater mental manipulation and short term memory (i.e. backward digit span) or processing and analysis (i.e. stroop test) showed a slight improvement upon cold water immersion (perhaps related to increased arousal and/or learning) but a significant decrement following central cooling of 2-4°C. Thus, relatively simple tasks were unaffected by central cooling, whereas more complex tasks were adversely affected. Cold water immersion itself did not interfere with performance of any tasks. Central nervous system cooling probably interferes with mental processing although discomfort and/or the physiological and physical effects of cold on the neuromuscular aspects of speech, required for responses to some of the tasks, may also affect performance.

Mapou RL, Kay GG, Rundell JR, Temoshok L. Measuring Performance Decrements in Aviation Personnel Infected with the Human Immuno-deficiency Virus. Aviat Space Environ Med 1993;64:158-64.

There is controversy over whether cognitive impairment occurs in early human immunodeficiency virus (HIV) disease. When impairment is reported, findings are typically subclinical, affect only a minority, and their relationship to occupational functioning has not been established. Despite such findings, it has been recommended that HIV-seropositive pilots be disqualified from flying. This paper reviews research relevant to measuring performance decrements in HIV-infected aviators. Based upon current data, we conclude that although subtle neurobehavioural dysfunction may occur in some asymptomatic HIV-seropositive individuals, there is no research which has demonstrated associated decrements in aviation-related skills. Thus, it may be premature to recommend medical disqualification of all HIV-seropositive aviators. We propose, instead, that sensitive neurocognitive measures, incorporated into a comprehensive neurodiagnostic evaluation, could be used to evaluate asymptomatic HIV-seropositive aviators. Only those who are impaired on evaluation would be disqualified from flying. Concurrently, research investigating the relationship between abnormalities and aviation abilities would be conducted.

Cardiovascular Physiology

Sagawa S, Shiraki K, Miki K,Tajima F. Cardiovascular Responses to Upright Tilt at a Simulated Altitude of 3,700 m in Men. Aviat Space Environ Med 1993;64:219-23.

To examine the effects of high altitude on cardiovascular responses to orthostasis, 11 healthy males were tested at a 10-min passive 70^{0} head-up tilt at sea level and at a simulated high altitude of 3,700 m. During the control period in the supine position, heart rate and forearm blood flow were higher at high altitude ($p<0.05$). Mean arterial pressure remained unchanged during head-up tilt at sea level, but it reduced from 82 mm Hg to 72 mm Hg ($p<0.05$) during head-up tilt at high altitude. There were no altitude-related changes in the magnitude of the increase in forearm vascular resistance and the reduction in cardiac output and laser-Doppler skin blood flow in response to head-up tilt. The total peripheral resistance increased from 14.4 to 20.5 mm Hg. L^{-1}. min^{-1} ($p<0.05$) during head-up tilt at sea level, but the change was not significant at high altitude. The lack of altitude-related changes in forearm vascular resistance and laser-Doppler skin blood flow during head-up tilt in the presence of attenuated total peripheral resistance response at high altitude may suggest that the orthostatic hypotension at high altitude is associated with a lower magnitude of vasoconstrictor response in the regions other than the limbs and the skin.

Kilgour RD, Ganepy P, Rehel R. Cardiovascular Responses During Recovery from Exercise and Thermal Stress. Aviat Space Environ Med 1993;64:224-9.

Although the central cardiovascular adjustments to exercise in the heat have been identified, little is known about the post-exercise hemodynamics during recovery from exercise and heat stress. This study examined heart rate (HR), stroke index (SI), cardiac index (CI), systemic vascular resistance (SVR), systolic (SBP) and diastolic (DBP) blood pressure in 8 males during 15 min of passive seated recovery preceded by 30 min of cycle ergometry (60% VO_{2max}) on two separate occasions: under control (C) and heat stress (HS) conditions. During both recovery conditions, SI significantly declined ($p<0.05$) to below pre-exercise values. No differences were observed between groups with respect to SI. The decrease in recovery HR was slower ($p<0.05$) in HS than C. The greater elevation in HR during HS accounted for the relative increase in CI above that observed prior to exercise. The estimated SVR measured immediately following exercise in both groups was lower ($p<0.05$) than pre-exercise values. By 5 min of C recovery, SVR returned to baseline values but remained significantly depressed ($p<0.05$) for the entire HS condition. These results indicate that the pressor responses were attenuated during HS; however, CI was maintained above pre-exercise levels due to higher HR responses compensating for the reduction in SI. Stimulation of the baroreceptor reflex and increased myocardial contractility could

possibly explain the maintenance of output at a time when preload and afterload were reduced.

Clinical Aviation Medicine

Smith LH, Broadhurst RS. Retroperitoneal Fibrosis as a Cause of Hypertension in an Aviator: A Case Report. Aviat Space Environ Med 1993;64:234-5.

The authors decribe a case report of a previously healthy rotary-wing aviator who developed hypertension of unknown etiology. His 30 pack/year smoking history and hypercholesterolemia (ranging from 224-268) were significant. The initial evaluation revealed an elevated creatinine of 1.7 (normal to 1.5). Right-sided hydronephrosis was noted on ultrasound and the right kidney was poorly visualized on IVP. A subsequent retrograde cystoureterogram confirmed the hydronephrosis and demonstrated a distal calculus and stenosis, findings which were compatible with retroperitoneal fibrosis (RPF). This diagnosis was confirmed at surgery and the patient's ureters were freed. Following surgery, return of normal kidney function and satis-factory recovery, this aviator returned to full flying duty. A review of RPF is included.

Hyperbaric Medicine

Kol S, Weisz G, Melamed Y. Pulmonary Barotrauma After a Free Dive - A Possible Mechanism. Aviat Space Environ Med 1993;64:236-7.

Pulmonary barotrauma during scuba diving is a life threatening event. In a skin diver, who does not use compressed air, this complication is rare and its pathophysiology is not readily understood. We present a young, healthy skin diver who suffered pneumomediastinum and subcutaneous emphysema after a sequence of free dives to 5 m, and suggest a possible mechanism.

Dowell GL. Rationale for a Hyperbaric Treatment Capability at a Lunar Station. Aviat Space Environ Med 1993;64:243-6.

Missions to establish a permanent presence on the Moon will include a significant amount of extravehicular activity (EVA), which carries the risk of decompression sickness (DCS). Factors which will influence that risk include: cabin and space suit pressure environments, frequency of and activity level during EVA, and the possibility of a loss-of-pressure mishap. These factors were considered for Space Station Freedom (SSF), resulting in the decision to include a hyperbaric airlock capable of treating DCS. Using concepts from operational medicine, the need for such a capability is determined by its influence on mission risk. In comparison to SSF, a Lunar Station will have gravity, a higher EVA rate, physically more DCS provocative EVA, and little, if any, capacity for medical evacuation. Therefore, unless Lunar mission planners can provide pressure environments that offer near zero risk of DCS for nominal operations, a hyperbaric treatment capability should be included.