Abstracts from Current Aerospace Medical Literature

I Acceleration Physiology

1. High G stress and orientational stress : Physiologic effects of aerial maneuvering. Gillingham KK : Aviat Space Environ Med 1988; 59 (11 Suppl): A 10-20.

G stress can readily incapacitate pilots of modern fighter aircraft and result in mishaps due to G-induced loss of consciousness (GLC). The physiologic effects of high G stress, including decreased head-level blood pressure due to hydrostatic pressure drop and decreased cardiac output due to inadequate venous return, result in the symptoms of visual loss and GLC. The body s primary natural defenses against the effects of G stress in flight, ie., the neural tissue energy reserve and the cardiovascular baroceptor reflexes, determine the characteristic shape of the G-time tolerance curve, which is presented. Means of raising G tolerance fall into three categories; mechanical, physiological, and educational. Mechanical means include anti-G suits and valves, assisted positive-pressure breathing (APPB) systems, and special seats in which the seatback is reclined and/or the pilot's legs are elevted. Physiological means include frequent exposure to G stress, physical conditioning (weight training and moderate aerobic conditioning), selection of pilots for high natural tolerance, and performance of vigorous and efficient anti-G straining maneuver. Educational means include briefings on methods of enhancing tolerance, and high G training in a centrifuge to allow the pilot to perfect his anti-G straining maneuver. An improved anti-G valve, physical conditioning, high-G awareness briefing, and centrifuge training are now being applied in efforts to prevent GLC in current fighter aircraft. Future generations of even more maneuverable aircraft will probably necessitate the use of APPB, pilot selection and high-G seats for protection of pilots, from the effect of sustained high G forces.

2. Anti G suit inflation rate requirements. Burton RR : Aviat Space Environ Med 1988; 59 (7): 601-605

Relaxed +Gz rapid onset tolerances were measured on the human use centrifuge at the USAF school of Aerospace Medicine, using male research subjects with and without inflated anti-G suits. Tolerance at 6 G.s -1 onset rates were 0.2-0.33 G lower than those measured with 1 G.s -1. onset rates, thus suggesting the existence of another relaxed G tolerance measurement called very high onset G. Baroceptor effect was considered the reason for this difference. Delays of a mean of 3.3 s in inflating the anti-G suit did not change relaxed G tolerances at 6 G.s -1 onset rates; however, with a 4.2 s mean delay, light loss tolerance criteria occurred sooner during the G exposure. Tolerances to 7 G with 6 G.s -1 onset rates, during which the subjects had to perform the anti-G straining maneuver (AGSM), required a mean delay of 2.8 s in six subjects before a noticeable change in light loss criteria occured - a mean delay of 2.0 s resulted in no change in light loss criteria from zero delay control inflation rates. These results clearly indicate that the inflation of the anti G suit can be delayed by at least 1 s without compromising anti-G suit protection.

3. A comparative study of G induced neck injury in pilots of the F/A-18,A-7 and A-4. Knudson R, McMillan D, Doucette D,Seidel M : Aviat Space Environ Med 1988; 59 (8): 758-760

The introduction of the high performance F/A 18 into the Navy and Marine Corps units has brought attention to the problem of high +Gz induced neck pain and injury. Aviators from the Light Attack Wing, Pacific were surveyed and the results were categorized by aircraft type. We found that 74% of F/A 18 aviators surveyed reported neck injury, 11 required removal from flight status averaging 3 days. The inability to function effectively during high G flight and the impact of lost pilot days highlight the need for further study into prevalence and solutions for high +Gz induced neck injury.

4. A preliminary report on a new anti-G maneuver. Guo H-z, Zhang S-x, Jing B-s, Zhang L-m : Aviat Space Environ Med 1988; 59 (10): 968-972

Inspired by traditional chinese medicine and Qigong, we designed a new anti-G maneuver, the Q-G maneuver, which has proved promising. This maneuver consists of volition mobilization, stepwise tensing of leg and abdominal muscles, and maintenance of a shallow thoracic respiration throughout. It was tested on 24 pilots on the ground and 3 pilots on a centrifuge. All pilots were monitored with heart level blood pressure, oximetry, ear lobe pulse, CO2 concentration in exhaled gas, EEG and ECG; in centrifuge runs, peripheral vision was also monitored. Blood pressure was maintained at 180 - 240 mm Hg for more than 30 s without fatigue. On the centrifuge the pilots tolerated a G load 2.25 - 3.0 G higher than without the maneuver, without any visual disturbance. Oximetry readings were 96 - 97% and there was no evidence of hyperventilation. The ear lobe pulse was even enhanced during G load with the maneuver. Follow-up visits to 18 out of 24 pilots with 455 inflight applications of the maneuver showed that the maneuver is feasible and can be used effectively during high-G load.

II Aerospace Toxicology

5. Toxicity assessment of hydrazine fuels. Keller WC : Aviat Space Environ Med 1988; 59(11 Suppl): A 100-106

The major health aspects of exposure to hydrazine propellants are reviewed. Toxic effects of hydrazine fuels on humans and animals as well as in vitro studies are discussed with emphasis on recent findings and USAF studies. Propellant hydrazines have been found to be genotoxic in vitro studies and oncogenic in animal studies. Embryo toxicity has been demonstrated at very high exposures but not at occupationally encountered levels for hydrazine and *unsymmetrical dimethylhydrazine. Epidemiologic* evidence to support these findings is lacking; however, the results of animal and in vitro studies have resulted in lowering both time weighted average threshold limit values and short term exposure limits for these propellants.

III Clinical Aviation Medicine

6. Aircrew selection systems. Kantor JE, Carretta TR : Aviat Space Environ Med 1988; 59(11 Suppl) : A 32-38

Research was conducted to develop and validate a computerised battery of psychomotor and cognitive tests to identify candidates who would not either complete pilot training or be recommended for a fighter assignment after training. All or part of the battery of 15 tests was given to 1,622 Air Force pilot candidates prior to training and their test scores were regressed against various flying performance measures. Two psychomotor tests and tests of perceptual speed, decision making speed, and memory function were found to be significant predictors of flying performance. An experimental pilot selection system using these results was found to have substantial practical value in reducing attrition from pilot training. Future research on computerised test development is discussed.

7. IgA nephropathy in a student naval aviator. Voge VM, Salmond R : Aviat Space Environ Med 1988; 59 (7): 655-656

Microscopic hematuria is not infrequently seen in the aviator population. After appropriate evaluation, excluding renal biopsy, such a finding is commonly diagnosed as "benign microscopic hematuria", and no further action is taken. The clinical case presented here involves a student naval aviator whose only findings were microscopic hematuria and a unilateral high frequency hearing loss. A renal biopsy was performed to rule out another diagnosis and IgA nephropathy was found incidentally. He was *subsequently denied clearance to fly* because of the uncertain outcome of the disease. Berger's disease is discussed fully as to its clinical picture, diagnosis, treatment, and prognosis.

8. A proposal for a diagnostic colour vision standard for civil airmen. Zentner AB : Aviat Space Environ Med 1988; 59 (8): 770-775

Advances in medical technology, aviation technology and operational procedures have created a rapidly changing background against which assessment of fitness to fly must be made. The current paper examines such changes in relation to the colour perception standard. The necessity for adequate colour perception in the modern aviation environment is reviewed and a rational sequence of tests to define aviation safe colour perception is proposed.

IV Environmental Physiology

9. Quantifying the effects of clothing for models of human response to the thermal environment. Haslam RA and Parsons KC : Ergonomics 1988; 31(12): 1787-1806

Models that predict human responses to the thermal enviornment must be able to account adequately for the insulative effects of clothing in order to be of practical use. The mechanisms of heat transfer between the human body and the environment and the resistive effects of clothing on this heat transfer are reviewed. The widely used two parameter method for quantifying the resistance of clothing to dry and evaporative heat transfer is described and the limitations of this description are noted. However, it is argued that not enough information exists to allow other more complex methods to be used for practical applications. Until further information becomes available enough data exist for the two parameter description to enable its use by the models of human response. An example of the ISO/DIS 7933 model's predictions is given to demonstrate the effect that using different methods of describing the insulative effects of clothing can have on a model's predictions.

10. Visual field influence on manual roll and pitch stabilization. Huang J-K, Young LR : Aviat Space Environ Med 1988; 59 (7): 611-619

Human control performance in nulling perceived tilt angles was investigated for combinations of pseduo random vestibular disturbances and different wave forms of low frequency wide visual field motions. For both roll and pitch axes, subjects tilted the trainer in which they were seated in the direction of field rotation. This visual bias was much stronger for pitch backwards with upward field rotation. Frequency response analysis showed the dominance of visual cues at low frequencies (below 0.06Hz) and the reliance on vestibular information in the high frequency range for both the axes. Models suggest that operator balancing responses at high frequencies are mainly processed by the semicircular canals rather than the otolith organs. The results also suggest that the subject tends to rely less on the otolith organs for pitch perception than for roll.

11. The effects of VDT work on urinary excretion of catecholamines. Tanaka T, Fukumoto T, Yamamoto S, Noro K : Ergonomics 1988; 31(12); 1753-1763

The mental components of 2 hours of VDT work for three age groups of volunteers were investigated using urinary excretion of noradrenaline and adrenaline. After the work of searching for target words, the noradrenaline excretion showed a tendency to decrease in the young group, a significant increase in the middle aged and a tendency to increase in the elderly. There was no change in adrenaline excretion in any age group. The elderly had a slower work speed than the young or middle-aged.

Noradrenaline excretion showed a significant increase after VDT work using small letters, no significant change with large letters and a tendency to decrease after hard-copy work. The adrenaline excretion did not change. The work speed was slower during the VDT work with small letters than during the hard-copy work.

These data suggest that the elevated level of sympathetic nervous activity resulting from VDT work is not caused by the VDT itself but by the intensity of the VDT work, and suggest that the effect of the VDT work may be exacerbated by aging.

V Ergonomics

12. Performance of a complex manual control task during exposure to vertical whole body vibration between 0.5 and 5.0 Hz. McLeod RW and Griffin MJ : Ergonomics 1988; 31(8):1193-1203

An experiment is described in which seated subjects performed first order pursuit tracking with a simultaneous discrete task; performance with the discrete task was dependent on performance of the continuous task. Vertical z-axis, whole-body sinusoidal vibration was presented at frequencies from 0.5 to 5.0 Hz at an acceleration magnitude of 2.0 ms-2 r.m.s. in three separate sessions. In the first session, inter-subject and intra-subject variability masked any disruption caused by the vibration. After further training, all vibration frequencies disrupted performance of the continuous task. Disruption was independent of vibration frequency below 3.15 Hz and increased at 4.0 and 5.0 Hz. A visual mechanism was assumed to account for the increased disruption at these higher frequencies. Mechanisms which may have been responsible for the disruption below 3.15 Hz are discussed. Effects of vibration on the discrete task were attributable to disruption in performance of the continuous task. The result illustrate the importance of adequately training subjects prior to investigating vibration effects.

VI Exercise Physiology

13. Blood pressure regulation during cardiac autonomic blockade: effect of fitness. Smith ML, Hudson DL, Graitzer HM et al: J Appl Physiol 1988; 65(4): 1789-1795

The purpose of this study was to determine the role of the autonomic nervous system's control of the heart in fitness related differences in blood pressure regulation. The cardiovascular responses to progressive lower body negative pressure (LBNP) were studied during unblocked (control) and full blockade (experimental) conditions in 10 endurance - trained (T) and 10 untrained (UT) men, aged 20 - 31 yr. The experimental conditions included B1 adrenergic blockade (metoprolol tartrate), parasympathetic blockade (atropine sulfate), or complete blockade (metroprolol and atropine). Heart rate, blood pressure, forearm blood flow and cardiac output were measured at rest and -16 and -40 Torr LBNP. Forearm vascular resistance, peripheral vascular resistance, and stroke volume were calculated form these measurements at each stage of LBNP. Blood pressure was maintained, primarily by augmented vasoconstriction, equally in T and UT subjects complete and atropine blockade. The fall in systolic and mean pressure from 0 - 40 Torr was greater ($P < 0.05$) in the T subjects during the unblocked and metoprolol blockade conditions. This reduced blood pressure control during unblocked condition was attributable to attenuated vasoconstrictor and chronotropic responses in the T subjects. We hypothesize that an autonomic imbalance (elevated base-line parasympathetic activity) in highly trained subjects restricts reflex cardiac responses, which accompanied by an attenuated vasoconstrictor response, results in attenuated blood pressure control during a steady state hypotensive stress.

VII Space Medicine

14. Early hormonal effects of head-down tilt in 10 humans. Gharib C, Gauquelin G, Prequignot JM et al : Aviat Space Environ Med 1988; 59 (7): 624-629

The aim of this study was to determined the effects of a 5-h weightlessness simulation (using supine bed rest or head-down tilt at -10° HDT) on plasma renin activity (PRA), aldosterone (PA), and catecholamines (epinephrine-E, norepinephrine-NE and dopamine-DA) and to compare the results with those obtained with horizontal bed rest (BR), which is often taken as a control situation for simulation studies. Ten healthy young volunteers submitted to the three following postural tests; 7 h sitting; 1 h sitting, 5 h supine and 1 h sitting; 1 hr sitting , 5 h HDT, and 1 h sitting. Our results show that a 5-h HDT or BR induced a significant progressive increase in plasma volume (14.5% for HDT and 7% for BR) and a decrease in diastolic blood pressure (18% for HDT and 17% for BR), PRA (60% for HDT

and 40% for BR), PA (63% for HDT and 60% for BR) and NE (20% for HDT and 25% for BR) compared to the sitting position. E decreased only in HDT, and DA was unchanged. We concluded that the main part of the cephalad shift is achieved by bed rest as reflected by changes in hematocrit and plasma protein concentration. The decrease in diastolic blood pressure, the inhibition of the renin-angiotensin aldosterone system (in part explained by a decrease in NE) are similar in BR and HDT. We demonstrate that the use of a relevant body position as control is a major concern when investigating the hormonal effects of HDT. If recumbency is chosen as the control situation in HDT studies, it is not surprising to observe only few changes when HDT is applied.

15. The homodynamic effects of repeated bed rest exposure. Sandler H, Popp RL and Harrison DC : Aviat Space Environ Med 1988; 59 (11): 1047-1054

Hemodynamic changes were measured during stepwise exposure to lower body negative pressure (LBNP) (5 min, -20, -30, and -40 mm Hg) in a group of seven physically active subjects before and after consecutive exposure to three 2-week bed rest periods. Bed rest exposures were separated by 3-week periods of ambulatory recovery. Dynamic exercise (68% max O2, 30 min each day) and isometric exercise (21% max leg extension, 30 min each day) performed during bed rest and reambulation failed to prevent deconditioning or accelerate the recovery process between bed rest exposures. Heart rate (HR) and end diastolic volume index (EDVI) proved to be parameters showing greatest changes during LBNP, heart rate increases at -40 mm Hg LBNP (compared to respective pre-LBNP levels) were 13.3%, 35.1% and 51.0% for each of the pre-bed rest exposures, while respective changes after bed rest were 57.8%, 57.2% and 75.5%. The significantly elevated HR responses during subsequent pre-bed rest (control) periods indicated incomplete recovery despite mild exercise and ambulation. Comparison of EDVI and HR revealed a similar linear regression relationship during LBNP before and after bed rest so that EDVI = 112.5 - 0.85 x HR, r = 0.97. We conclude from these findings that cardiovascular deconditioning for physically active individuals involve factors other than simple loss of plasma volume, requires at least 3 weeks or longer to return to the pre-bed rest state, and is not counteracted by the levels of aerobic and/or isometric exercise used in the present study.

16. Space motion sickness during 24 flights of the space shuttle. Davis JR, Vanderploeg JM, Santy PA et al : Aviat Space Environ Med 1988; 59 (12): 1185-1189

The incidence and severity of space motion sickness(SMS) were determined from 24 flights of the space shuttle. A standardized questionnaire developed at the NASA-Johnson Space Centre (JSC) was administered to all crew members postflight during an oral debriefing with the examining flight surgeon. Cases of SMS were graded mild, moderate or severe using criteria developed at the JSC. The incidence of SMS during a first shuttle flight for 85 crew members was 67% (57 cases). There were 26 mild cases (30%), 20 moderate (24%), and 11 severe (13%). Difference were found between males and females, crew positions (Commander, Pilot, Mission Specialist etc.), and age groups, which were not statistically significant ($p > 0.05$), but would suggest future research into the mechanism, prevention, and treatment of SMS. The 26 crew members with a second flight showed a reduction in SMS incidence to 46% but the change was not significant compared with the first flight. Nine crew members (35%) showed a reduction in SMS severity comparing first and second flights, yet there was no significant difference in the mean time between flights for crew members with SMS versus asymptomatic crew members. Variability in crew members training and flight experience may explain some of the differences observed.