

Abstracts of Current Aviation Medicine Literature



I ACCELERATION PHYSIOLOGY

1. Acceleration stress-induced Wolff-Parkinson White Syndrome with marked ST-segment depression

Exercise can affect pre-excitation in several ways. The possible presence of a catecholamine-sensitive bypass, stimulated during periods of high stress, was recently reported. In addition to a direct effect on the pre-excitation, when the pre-excitation pattern exists, exercise-induced ST-segment changes may occur which preclude stress testing for coronary artery disease detection. Current high-performance fighter pilots, flying new generation aircraft, are under severe stress during aerial combat manoeuvring when they are exposed to high sustained +Gz (head-to-foot) acceleration stress. The author reports the occurrence of a +Gz acceleration-induced episode of pre-excitation with marked ST-segment depression in a healthy asymptomatic aircrewman. Autonomic imbalance, with high catecholamine levels developed during +Gz stress may be the aetiology of this pre-excitation episode.

[Whinnery, JE. *Aviat Space Environ Med.* 52 (11) : 654, 1981.]

II AVIATION NEUROPSYCHIATRY

2. Instructor pilot teaching behaviour and student pilot stress in flight training

The purpose of this study was to investigate the relationship between instructor pilot behaviour and student pilot stress. Six instructor pilots and 12 undergraduate pilot training students served as subjects. Two students were assigned to each ins-

tructor. Ten categories of instructor pilot behaviour were coded from audio cassette tapes made during four sorties from the initial instrument phase of undergraduate pilot training in the T-50 Instrument Flight Simulator. Behaviours were tallied to a rate per minute; inter-recorder agreement was 87%. Instructors who relied heavily on acceptance and praise behaviours were placed in a positive group (N=4), while those relying on criticism and scolding were placed in a negative group (N=2). Student stress was estimated from timed urine samples used to quantify catecholamine excretion. Results indicated that missions in the T-50 Instrument Flight Simulator produced a significant stress response in the subjects and that the stress response was greater in lessons taught by the instructor pilots in the negative group.

[Krahenbuhl, GS, Darst, PW, Marett, JR, Reuther, LC, Constable, SH, Swingford, ME and Reid, GB. *Aviat Space Environ. Med.* 52 (10) : 594, 1981.]

3. The individual's vs the organisation's doctor-value conflict in psychiatric aeromedical evaluation

Physicians who perform aeromedical evaluations are aware of the value conflicts inherent in being both a physician and a social agent. This paper examines some of the conflicts which occur when the psychiatrist acts as an aeromedical examiner. Five areas are examined: (1) the use by the psychiatrist of the authority delegated by the social system (2) issues of confidentiality (3) efforts of the social system to influence the psychiatrist's findings (4) the requirements to make decisions in areas

where scientific data is lacking, and (5) the physician's imperative to "do no harm" to his patient. Recommendations to minimize the impact of these factors through recognition, open discussion, and thoughtful structuring of the physician-patient relationship are made.

[Ursano, RJ and Jones, DR. *Aviat Space Environ Med.* 52 (11) : 704, 1981.]

III AVIATION OPHTHALMOLOGY

4. Lasers and protection of the eyes

The applications and characteristics of some of the lasers currently available are discussed and these parameters are related to the ocular tissues at risk. The probable visual consequences of laser induced pathology are considered together with the advantages of protective devices. Accident procedures, codes of conduct, and a hazard related examination protocol are also described.

[Brennan, DH *in* AGARD Personal Visual Aids for Aircrew Jun 1981]

IV AVIATION OTOLARYNGOLOGY

5. Total energy and critical intensity concepts in noise damage

Groups of chinchillas were given a series of noise exposures of approximately equal energy ranging from 22 min at 120dB SPL to 150 days at 82 dB. For all exposures involving levels of 112 dB or less, the same average permanent hearing losses (15-20dB) and degree of outer hair cell destruction (8-10%) resulted, thus confirming the validity of the total energy principal for assessing the hazard associated with single continuous exposures at moderate levels. The 22-minute, 120dB exposure, however, produced a 60dB hearing loss and massive hair cell destruction (70-80%), indicating that some critical level had been exceeded, thus producing acoustic trauma. Further histological study suggests that the massive destruction is a result of breaks in the organ of Corti, produced by severe mechanical stress, that permit the mixture of endolymph with perilymph, thus creating a hostile environment for the hair cells.

[Ward, WD, Duvall, AJ, Santi, PA, Christopher, W and Turner, MS. *Annals of Otolaryngology.* 90 : 584, 1981]

6. Time course of acoustic intra-aural muscle reflex in non-anaesthetized rabbits, normative data

The dynamic properties of the intra-aural reflex in response to tones of 2000 Hz in non-anaesthetized rabbits is described. Rise time (time from start of stimulus to response has reached half of its steady-state amplitude) decreased from about 300 msec at threshold to 54 msec at high level for the ipsilateral and 60 msec for the contralateral reflex. Offset time (time from end of stimulus to relaxation to 50% of steady state amplitude) increased from 100-150 msec at threshold to 250-300 msec at high level, being longer for the crossed than for the ipsilateral reflex. Impulse response (response to 16 msec burst of pure tone) reached its peak after about 60 msec, a value independent of sound level. The ipsilateral reflex had a 5-8 msec shorter time lag than the contralateral reflex, after correction for difference in response amplitude. This difference is compatible with additional synapses and a longer neural pathway for the crossed reflex. It has been pointed out that the intensity dependence of rise time has to be carefully considered when evaluating 'normal ranges' of temporal parameters for reflex responses. The rise time is suggested as a suitable parameter for quantification of supra-threshold stapedius responses.

[Borg, E. *Acta Otolaryngol.* 93 : 161, 1982].

7. Reliability in tests of the eustachian tube function

With the aid of a quantitative impedance method and a pressure chamber, the capacity of the eustachian tube to equilibrate pressure differences across the tympanic membrane was repeatedly determined in 20 otologically healthy men. The test-retest reliability was calculated from five determinations of static pressure equilibration of over- and underpressures of 10 cm H₂O and 10 determinations of equilibration of dynamic pressure changes. The pressure opening level of the tube during pressure increase in the middle ear was significantly lowered in the middle ear after maximum equilibrating efforts during pressure increase in the chamber

was also significantly lowered. For the rest, the test-retest reliability was good. Ears with perfect tubal function had better test-retest reliability for all parameters tested than ears with poorer function. The significance of repeated measurements and the value of reliability determinations are discussed.

[Groth, P. *Acta Otolaryngol.* 93 : 261, 1982].

V AVIATION PATHOLOGY

8. Occurrence of pre-existing disease in aircrew killed in flying accidents

A review of the occurrence of pre-existing disease found in 809 military, professional, and private aircrew killed in 525 flying accidents in the United Kingdom from 1955 to 1979. In the author's experience, the most common disease encountered included coronary atherosclerosis, pathology of the liver, psychiatric or adverse medical histories, upper respiratory tract infections, and defective vision. The role of these diseases in accident causation and the need for caution in the interpretation of asymptomatic disease is discussed. The importance of histological examination in death due to trauma and of circumstantial evidence is emphasised.

[Underwood Ground, K.E. *Aviat Space Environ Med.* 52(11) : 672, 1981].

9. Liver pathology in apparently healthy United Kingdom aircrew

The aim of this review is to determine the incidence and aetiology of fatty liver and other liver pathology in aircrew. A review of 525 fatal aircraft accidents resulted in deaths of 776 aircrew. Histology of liver, available in 423 aircrew, was reviewed and 118 found abnormal. There were 66 cases (15.6%) of fatty livers. In 11 of the fatty livers and 8 of the 52 non-fatty liver there was histopathologic evidence compatible with alcohol abuse (4.5%). The histopathologic appearances are discussed.

[Underwood Ground, KE. *Aviat Space Environ Med.* 53(1) : 14, 1982].

10. Hepato-splenic injury in aircraft accidents

The incidence of hepatosplenic injury is greater in fatally injured victims than it is in survivors, though there is some variation in the literature, depending upon the author's experience. In fatal aircraft accidents, hepatic injury is more common than is splenic injury. There is a direct association with damage to the lower chest and injury to these organs. Injury scoring is a good mathematical tool, for studying the severity of injuries in aircraft accidents, and gives an indication of the severity of injury in relation to the intensity of impact.

[Hill, IR. *Aviat Space Environ Med.* 53(1) : 19, 1982].

VI BIORHYTHM

11. Diurnal variation in vigilance efficiency

Five sets of data are presented, obtained from studies that examined the influence of time of day on auditory vigilance performance during the normal waking day. Although both hits and false alarms exhibited a fairly consistent tendency to be lowest at first time in the morning, 1 or 2 hours after awakening from sleep, and to increase in parallel thereafter, the magnitude of change was modest and the time-of-day effect was statistically reliable in only a minority of the analyses. The slight changes that did occur seemed largely attributable to shifts in response criterion rather than to altered levels of signal detectability. In admonitory contrast with these findings, which have reassuring implications for vigilance efficiency during normal day-work, additional evidence is presented indicating that detectability levels may alter within the day light span when the normal sleep-work-rest routine is disturbed.

[Craig, A, Wilkinson, RT and Colquhoun, WP. *Ergonomics* 24(8) : 841, 1981].

12. Sleep loss, recovery sleep, and military performance

Ten experienced infantry soldiers completed a 9 day (216 hours) tactical defensive exercise, the

aim of which was to determine whether soldiers are likely to remain military effective during a period of partial sleep loss following a period and no scheduled sleep at all. Assessments were made of shooting, vigilance, cognitive functioning, EEG activity and physical fitness. The results indicated that tasks with a vigilance and cognitive component began to deteriorate after one night without scheduled sleep. After 3 3/4 days (90 hours) with no scheduled (and very little unscheduled) sleep, 4 hours block sleep had a marked beneficial effect upon performance. After a total of 12 hours sleep over 3 days (72 hours), performance had recovered (except for scores at 05.45 hours) from an approximate average level of 50 to 88% of control values. One and a quarter days (30 hours) of rest, of which an average amount of 19 1/2 hours was spent asleep, eliminated any remaining decrement.

Electroencephalography (EEG) recordings indicated that on the six nights following total sleep loss there was an increased percentage of stage 4 sleep. Stage REM percentage remained virtually unchanged, except for the first night after total sleep loss, when there was 8% less. The EEG results are discussed in relation to the work of other investigators.

[Haslam, DR. *Ergonomics* 25 (2) : 163, 1982].

VII CLINICAL AVIATION MEDICINE

13. Sympathoadrenal and cardiovascular responses to mental stress, isometric handgrip and cold pressor test in asymptomatic young men with primary T wave abnormalities in the electrocardiogram

Sympathoadrenal activity was evaluated by the determination of plasma catecholamines at rest and during stressful provocations in 12 young asymptomatic men with primary T wave abnormalities in the electrocardiogram and without a history or signs of cardiac disease (group T) and in 13 matched controls. The T wave abnormalities consisted of flattening, or inversion without concomitant ST depression in leads II, V4 and V6. At rest, plasma noradrenaline was approximately twice as high in group T as in the controls, whereas plasma adrenaline and dopamine levels were similar in two groups. Non-

invasive haemodynamic monitoring (blood pressure and impedance cardio-graphy) showed a significantly higher systolic blood pressure and impedance signs of increased cardiac contractility without tachycardia in group T. A standardised mental stress test, isometric handgrip, and a cold pressor test all significantly increased blood pressure as well as noradrenaline and adrenaline in both groups. The increase in diastolic blood pressure and adrenaline tended to be larger in group T in connection with stressful provocation, indicating increased sympathoadrenal reactivity. The increases in systolic blood pressure and noradrenaline persisted during provocation. In both groups the cold pressor test, which raises blood pressure mainly by vasoconstriction, increases more than did the other two tests, which are believed to act mainly by cardiac stimulation. Because of the low adrenaline levels found, neurogenic mechanism appears to be of greater importance than adrenaline for the circulatory responses to each of these provocations. The study provides evidence in favour of increased sympathetic activity at rest and enhanced sympathoadrenal reactivity during stress in subjects with primary T wave abnormalities. These electrocardiographic findings may therefore be explained by increased sympathoadrenal activity.

[Jan-Henrik, Atterhog, Elisson, K and Hjemdahl, P. *Brit Heart J.* 46(3) : Sep. 1981].

14. Clinical use of beta blockers in hypertension

Recent work on the use of beta blockade in the treatment of mild hypertension is reviewed. It is clear from these studies that this form of antihypertensive therapy can exercise a protective influence on cerebrovascular events and on fatal and nonfatal myocardial infarction. In particular, there is evidence of reduced rate of reinfarction when beta-blocking agents are started soon after the first event. The comparative efficacy and side effects profile of the various clinically available beta blockers are discussed, as differences between these are now becoming more apparent. In particular, the degree of water or lipid solubility may determine which will penetrate into brain tissue with resultant central effect; the more water soluble, the less

likely this is to occur. It is also important that those which are not metabolised by the liver can be more easily titrated as they do not require large changes in dosage; some may be given once daily. The use of beta blockade in the presence of airway resistance is strongly contraindicated but, if it has to be used, this should be started in hospital with a cardioselective agent.

[Sleight, P. *Aviat Space Environ Med.* 52(11) : 52, 1981].

15. Treatment of refractory hypertension

126 patients with blood pressure, which was unacceptably high despite a conventional stepped-care regimen (diuretic, betablocker, and vasodilator) took part in a comparative assessment of different approaches to the treatment of refractory hypertension. One of four regimens was used: oral diazoxide, minoxidil, captopril, or quadruple therapy (diuretic + beta adrenoceptor blocker + hydralazine + prazosin). Despite the severity of hypertension, blood pressure could be controlled in almost all these patients, and no patient died from cerebrovascular disease while on treatment. 2 patients died of renal failure and 5 patients required long-term haemodialysis. Ischaemic heart disease remained a problem and caused the death of 10 patients. Diazoxide was the most effective treatment but was the most difficult and unpleasant to use. Captopril was the best-tolerated but failed to control blood pressure in 6 of 15 patients. Authors conclude that there are now sufficient therapeutic alternatives to achieve acceptable blood pressure control in almost all patients with "refractory" hypertension, although no treatment is ideal.

[Swales, JD, Heagerty, A, Russell, GI, Bing, RF, Pohl, JEF and Thurston, H. *Lancet* 1 : 17 Apr. 82].

VIII ENVIRONMENTAL PHYSIOLOGY

16. Haemodilution, vasopressin suppression, and diuresis during water immersion in man

Authors hypothesize that hemodilution in the early stages of water immersion plays an important role in vasopressin (AVP) suppression and subsequent diuresis. Ten men (19-24 years) were

immersed to the neck in a semireclining position for 8 h in 34.6°C tap water. After 8 h of immersion there were decreases ($p < 0.05$) in plasma volume (PV) of 15.6%, extracellular volume (ECV) of 18.8%, interstitial volume (ISV) of 19.6% and red cell volume of 10.7%. Haemodilution (hyposmolemia of 4 mosmol/Kg H₂O) and near maximal suppression of AVP (to 0.5 pg/ml) and plasma renin activity (to 0.4 ng Ang 1·ml⁻¹h⁻¹) were evident by hour 2 of immersion. The early haemodilution (0-2h) was due to a slight increase in PV with no change in plasma Na or osmotic content, even though urine volume and Uosm·V increased significantly. The hyposmolemia and PRA suppression continued throughout immersion in spite of the progressively increasing diuresis and decreasing PV. These findings suggest the transfer of hypotonic fluid into the vascular system. This fluid does not appear to come from the intracellular volume. The authors conclude that hyposmolemia is an important part of the mechanism contributing to AVP suppression during water immersion.

[Greenleaf, JE, Shvartz, E and Keil, LC. *Aviat Space Environ Med.* 52 : 329, 1981].

17. Heat stress in the A-10 cockpit: flights over desert

Heat stress is a significant problem during low-level flight in hot climates, especially in aircraft that impose high task loads and repetitive manoeuvring forces. The A-10 close-support aircraft presents such a combined-stress environment. This report summarizes data from 15 low-level flights over desert. Ground dry-bulb temperature ($T_{db,g}$) was 26-42°C. Cockpit temperature ($T_{db,c}$) was commonly over 40°C on the ground and tended to drop progressively from taxi-out through flight to the range and return; for any given phase it was a linear function of $T_{db,g}$. Small (50-mm) black globe temperature ($T_{bg,s}$) exceeded $T_{db,c}$ by 2-5°C on the ground and by 4-8°C in flight. The pilot's mean skin temperature was a linear function of $T_{db,c}$ in each phase. Auditory canal temperature (T_{ac}) rose from a control value of 37.0 to a mean of 37.4°C in flight, with one pilot reaching 37.8°C. Sweat rate was a linear function of $T_{db,g}$ with weight loss up to 2.3%. These data are compared to earlier studies

of the F-4 and F-11 aircraft. Although the performance of the A-10's cooling system resembles that in other aircraft and is somewhat better than the F-4 on the ground, the effects of cockpit heat are exacerbated by its close-support role. Pilots noted lowered 'G' tolerance and increased general fatigue on the hotter flights. The foot and leg-area temperatures exceeded those at the head; planned changes in air distribution should partly alleviate that situation.

[Nunnely, SA and Flick, CF. *Aviat Space Environ Med.* 52 (9) : 513, 1981].

IX ERGONOMICS

18. Effects of beta blockers on psychomotor performance—a review

There is a possibility that beta-receptor blocking drugs may modify psychomotor performance, either peripherally or centrally. The inherent problems in evaluating the effects of drugs on performance are mainly due to interpretation of what is meant by "psychomotor" as the term embraces many mental and physical skills. In addition, statistical validation is often difficult. The current literature is reviewed with these provisos in mind and 24 studies of the effects of beta blockade are discussed. Of these 15 could be assessed as showing "no effect" and, of the remaining 9, improved performance was reported in 6 and impairment in 3. There is a wide variation in the results of such studies but, in general, it would appear that while the clinical use of beta blocking drugs in aviation may produce an adverse effect on performance, it should be no greater than ordinary day-to-day variation.

[Claister, DH. *Aviat Space Environ Med.* 52(11) : 623, 1981].

19. A viscoelastic model for the mechanical properties of biological materials

An attempt has been made to propose a theoretical model to explain the viscoelastic behaviour of biological materials. The creep and stress relaxation predicted using the theoretical model were found to be very close to the experimental results observed.

[Sanjeevi, R. *Journal of Biomechanics* 15(2) : 107, 1982].

20. External and internal attentional environments—the utilization of cardiac deceleratory and acceleratory response data for evaluating differences in mental workload between machine-paced and self-paced work

Previous evidence has suggested that self-paced (SP) task performance may constitute a higher mental workload than machine-paced (MP) performance. These differences in mental workload were thought to be due to the presence, when working SP, of an internal pacing mechanism serving to maintain the worker's rhythm. In MP tasks, this function would be maintained externally by the machine. The present investigation attempted to directly test this hypothesis. For this purpose, Lacey's psychophysiological model relating changes in heart rate (HR) to attentional demands was employed. Differences in cardiac deceleratory and acceleratory activity between MP and SP performance were evaluated for each of two tasks. In one task, the emphasis was predominantly on visual detection. Based on the suspected direction of attentional demands, this task was characterized as external. The other task required mental solution to arithmetic problems and was categorized accordingly as internal. Psychophysiological findings were consistent with Lacey's basic model and offered no support for the existence of an internal pacing mechanism under SP conditions. Instead, they suggested the presence of uncertainty factors reflecting higher mental workload during the MP performance of both tasks. Performance data, however, did not support the casual interpretation given by Lacey for his psychophysiological model, and were explained in terms of a complex interplay between HR level HR change.

[Sharit, J, Salvendy, G and Doisenroth, MP. *Ergonomics* 25(2) : 107, 1982].

21. Visual scanning behaviour and mental workload in aircraft pilots

This paper describes an experimental paradigm and a set of preliminary results which demonstrate a relationship between the level of performance on a skilled man-machine control task, the skill of the operator, the level of mental difficulty induced by

an additional task imposed on the basic control task, and visual scanning performance. During a constant, simulated piloting task, visual scanning of instruments was found to vary as a function of the level of difficulty of a verbal loading task. The average dwell time of each fixation on the pilot's primary instrument increased as a function of the loading. The scanning behaviour was also a function of the estimated skill level of the pilots, with novices being affected by the loading task much more than experts. The results suggest that visual scanning of instruments in a controlled task may be an indicator of both workload and skill.

[Tolo, JR, Stephens, AT, Harris Sr RL and Ephrath, AR. *Aviat Space Environ Med.* 53(1) : 54, 1982].

X EXERCISE PHYSIOLOGY

22. Pattern of breathing and ventilatory response to CO₂ in subjects practising Hatha-yoga

Eight Belgian subjects well advanced in the practice of hatha-yoga were studied compared with eight sex-age and height-matched control subjects. Practice of yoga (range 4-12 years) involves control of posture and manipulation of breathing including slow near-vital capacity manoeuvres accompanied by apnea at end inspiration and end expiration. Average values for the yoga and the control group (in parentheses) are as follows: ventilation (VE) 5.53 l.min⁻¹ (7.07); tidal volume (VT), 1.03 liters (0.56); rate of breathing, 5.5 min⁻¹ (13.4); end-tidal PCO₂, 39.0 Torr (35.3). All differences are significant (P<0.05). Ventilatory response to CO₂ (rebreathing technique) was significantly lower in the yoga group (P<0.01). The regression relating VE to VT during rebreathing of CO₂ was VE = 8.1 (VT - 0.23) for the yoga group and VE = 15.8 (VT - 0.16) for the control group (P<0.005). The authors attribute these changes to chronic manipulation of respiration.

[Stanescu, DC, Nemety, B, Variter, C and Marechal, C. *J Appl Physiol Respirat Environ Exercise Physiol.* 51(6) : 1625 1981].

23. Maximal Oxygen uptake in boys

Maximal oxygen uptake (VO₂ max) was determined in 65 boys, 10 to 19 years of age, by uphill treadmill running test. The mean value of VO₂ max increased from 0.96 l/min at 10 years to 2.22 l/min at 19 years showing rapid spurts of increase at 13 to 16 years of age. VO₂ max per kilogram of body weight showed mean values varying between 40.9 to 46.9 ml/min/kg in different age groups, the peak being observed at 17-18 years of age. Maximal exercise ventilation (VE max) increased from 38.1 l/min at 10 years to 69.8 l/min at 17-18 years with spurts of increase similar to that seen with VO₂ max. VE max per kilogram body weight, however, declined with age, whereas the economy of ventilation improved in the older boys. Heart rate responses during maximal exercise did not reveal any age bound change. VO₂ values of the subjects studied, when expressed per unit body weight, were found to match those reported for their counterparts in various countries except in North America and Sweden where the reported values are found to be 10-30 per cent higher. The logarithmic relationship of VO₂ max with height revealed its increase in proportion to height indicating an increasing maturity of this function through the formative period of adolescence, the maturity rate being well matched with that observed in the very fit child population of Sweden.

[Banerjee, PK, Chatterjee, S, Chatterjee, P and Maitra, SR. *Indian J Med Res.* 75 : 380, 1982].

XI HIGH ALTITUDE PHYSIOLOGY

24. Onboard oxygen generation systems

During the 1970s, the development of onboard oxygen generation systems (OBOGS) progressed through ground and flight test phases to the point where a second-generation concept is now production qualified and additional alternatives are being evaluated. This paper reviews the development of OBOGS and assesses the current state of the art of these systems. High-purity fluomine systems, deve-

loped for flight demonstration and qualified for production application, are discussed. Development of enriched air molecular sieve systems for laboratory and flight applications is described, along with a recent study of a permeable membrane-based aircraft oxygen enrichment concept. Capabilities and characteristics of the various OBOGS concepts are compared, showing the greater compliance of high-purity fluomine systems with the current oxygen military standards while noting the advan-

tages of the reduced interface complexity of enriched air systems. Recommendations for future OBOGS development are presented, emphasizing the need to coordinate the development of specifications and hardware so the optimum compromises between physiological requirements and engineering feasibility can result in OBOGS that best satisfy the metabolic needs of aircrew members.

[Manatt, SA. Aviat Space Environ Med. 52(11) : 645, 1981].