

Abstracts of Current Aviation Medicine Literature

I. ACCELERATION PHYSIOLOGY

1. **Physiological and anti-G suit performance data from YF-16 flight tests.** KENT K. GILLINGHAM and WILLIAM R. WINTER. *Aviation Space and Environmental Medicine*, Vol. 47, Jun. 1976, P. 672-673, 2 Refs.

Biomedical data were collected during high-G portions of 11 YF-16 test flights. Test pilots monitored revealed increased respiratory rate and volume, decreased tidal volume, and various cardiac arrhythmias. Anti-G suit inflation and pressurization lags varied inversely with G-onset rate, and suit pressurization slope was near the design value.

2. **Prolonged visual loss and bradycardia following deceleration from +6GZ acceleration: A case report.** JOHN S. KIRKLAND and JAMES A. KENNEALY. *Aviation Space & Environmental Medicine*, Vol. 47, March 1976, P. 310-311, 5 Refs.

Visual blackout during high +GZ acceleration is not an unusual phenomenon. Bradycardia is often seen following similar acceleration exposure. An instance of prolonged visual loss associated with bradycardia following a +6GZ acceleration is described. Possible mechanisms are proposed, and significance in the study of high acceleration is discussed.

3. **Cardiovascular function during sustained +GZ stress.** HOWARD H. ERICKSON, HAROLD SANDLER and HUBERT L. STONE. *Aviation Space & Environmental Medicine*, Vol. 47, July 1976, P. 750-758, 29 Refs.

The development of aerospace systems capable of very high levels of positive (+GZ) stress, has created a need for a better understanding of the cardiovascular responses to acceleration. Using a canine model, the heart and cardiovascular system were instrumented to continuously measure coronary blood flow, cardiac output, left ventricular and aortic root pressure, and oxygen saturation in the aorta, coronary sinus, and right ventricle. The animals were exposed to acceleration profiles up to +6GZ, 120 s at peak G; a seatback angle

of 45° was simulated in some experiments. Radioopaque contrast medium was injected to visualize the left ventricular chamber, coronary vasculature, aorta, and branches of the aorta. The results suggest mechanisms responsible for arrhythmias which may occur, and subendocardial hemorrhage which has been reported in other animals.

4. **Cardiac Pathology Associated with High Sustained +GZ: I. Subendocardial hemorrhage.** RR BURTON and WF MACKENZIE. *Aviation Space & Environmental Medicine*, Vol. 17, July 1976, P. 711-717, 19 Refs.

Adult miniature swine were exposed to various levels and durations of +GZ. After exposure, all swine were euthanized and necropsied. Gross, histologic, and electronmicroscopic observations were made on the heart tissue. Subendocardial hemorrhage (SEH) was commonly found in the left ventricle, rarely in the right ventricle, and its severity was directly related to: (a) level and duration of G exposure, (b) heart rate, and (c) catecholamine activity. SEH was made more severe with i.v. atropine 4 mg. and prevented with i.v. propranolol 20 mg. Heart hemorrhage was usually limited to the immediate subendocardial region and frequently surrounded Purkinje's fibres. In severe cases, however, hemorrhages penetrated several millimeters into the heart muscle and sometimes penetrated Purkinje's fibres. Restraint of unanesthetized swine in the centrifuge couch low G-levels, and/or i.v. injections of atropine or epinephrine produced minimal SEH lesions.

5. **Cardiac Pathology associated with high sustained +GZ: II. Stress cardiomyopathy.** WF MACKENZIE, RR BURTON and WI BUTCHER. *Aviation Space & Environmental Medicine*, Vol. 17, July, 1976, P. 718-724, 45 Refs.

The myocardial pathology of 14 pigs exposed to HSG, stress of 9 and 15, or 3, 7 and 9 GZ was studied; six control pigs were used as comparisons. Four pigs received propranolol prior to centrifugation and four pigs received atropine. Hearts were studied by light and electron microscopy. Myo-

cardium from stressed pigs showed myofibrillar degeneration, pooling of mitochondria and cell death. Lesions occurred in random cells of the subendocardium and papillary muscles. Purkinje fibres were also involved. Pretreatment with atropine increased the number of dead cells found and propranolol increased the number of cells showing myofibrillar degeneration. It is postulated that this is a pluricausal cardiomyopathy similar to several experimental conditions. Significance to aerospace medicine is briefly discussed.

6. **Systolic time intervals during +GZ acceleration.** THOMAS B. GRABOYS and EDWARD D. MICHAELSON. *Journal of Applied Physiology*, Vol. 41, July 1976, P. 52-56, 18 Refs.

Systolic time intervals (STI) were recorded in 8 healthy male volunteers before, during, and after 30-s exposures to +3GZ, +5GZ, and 7GZ acceleration. Heart rate (HR) increased at all +GZ levels, as did the HR corrected QS, interval, left ventricular ejection time (LVET), pre-ejection period (PEP) and PEP/LVET. These changes in STI were also proportional to the +GZ level. At the higher +GZ levels, PEP, and PEP/LVET continued to increase early in the recovery period, but HR and all STI returned to control after 60s of recovery. Although physiological variables other than myocardial contractility, such as preload and afterload, may influence STI during +GZ the effects of +GZ on stroke volume (SV) and cardiac output (CO) were estimated using previously described relationships between STI and invasively determined indices of cardiovascular function. In general, CO increased as SV decreased. During recovery, HR and CO fell and CO remained slightly below control levels, primarily because estimated SV remained low. This study demonstrates the feasibility of using STI to estimate non-invasively the transient changes in cardiovascular function during +GZ acceleration.

7. **Gas exchange in man during combined +GZ acceleration and exercise.** S. A. NUNNELEY. *Journal of Applied Physiology*, Vol. 40, April 1976, P. 491-495, 21 Refs.

Gravity and acceleration from head to foot (+GZ) handicap gas exchange by shifting blood from thorax to dependent veins and creating a ventilation/perfusion (V/Q) mismatch in the lung.

At 1 G leg exercise improves V/Q matching. Gas exchange was measured in six subjects at +1, +2, and +3 GZ during rest and two levels of exercise, either unloaded pedaling or 600 kpm/min. The $\dot{V}O_2$ for pedaling was clearly related to G level, but work efficiency was unaffected. Acceleration lowered resting Pa_{O_2} while raising $VE/\dot{V}O_2$, HR, $AaDO_2$, VD and VD/VT. Unloaded pedaling returned $VE/\dot{V}O_2$ and HR toward their 1-G values. In contrast at 3G each increase in $\dot{V}O_2$ caused a fall in Pa_{O_2} , and a rise in $AaDO_2$. The VD showed no further change with exercise, while VD/VT decreased at all G levels. It thus appears that only some of the effects of acceleration are counteracted by exercise, probably by the peripheral muscle pump. Any accompanying rise in $\dot{V}O_2$ adds to the stress of acceleration, due to limitations on gas transport.

II. CIRCADIAN RHYTHM

8. **Physiological index as an aid in developing airline pilot scheduling patterns.** STANLEY R. MOHLER, *Aviation Space & Environmental Medicine*, Vol. 47, March 1976, P. 238-247, 10 Refs.

A multiplicative and additive formula has been developed for assisting in the development of schedules for airline pilots and flight engineers. The formula is based on freshness/tiredness data derived from aircrews on world flights. It should materially assist those who develop the schedules to avoid, where possible, finalizing those crew patterns that would impose a severe physiologic load on cockpit personnel. The objective of the application of the formula is to assure that crew members retain adequate "physiologic reserve" in the course of flying various segments of a pattern. This enables them to absorb the stresses of schedule delays or disruptions, as well as unforeseen operational problems and flight emergencies.

9. **Air operations and circadian performance rhythms.** KARL E. KLEIN, HANS M. WEGMANN, GEORGIOS ATHANASSENAS, HANS HOHLWECK, and PAUL KUKLINSKI, *Aviation Space & Environmental Medicine*, Vol. 47, March 1976, P. 221-230, 61 Refs.

This paper reviews experimental results and pertinent data from the literature on circadian behavioural rhythms and their modifications through

various factors. It relates them to the operation of aircrews "round the clock" and on transmeridian routes and discusses some possibilities of an appropriate scheduling.

10. **Effects of Time zone changes on performance and physiology of airline personnel.** F. S. PRESTON, S. C. BATEMAN, F. W. MEICHEN, R. WILKINSON, and R. V. SHORT. *Aviation Space & Environmental Medicine*, Vol. 47, July 1976, P. 763-769, 5 Refs.

This study is the second of a series of experiments describing the effects of time zone changes on the performance and menstrual cycle changes in a group of 16 female airline personnel. Four groups of four subjects each spent 4 d in the isolation unit of the University of Manchester. One group acted as control; the other three groups were subjected to two 8-h retardations in time, representing Westerly flight. All groups were required to complete an identical battery of workload tasks. In addition, the effects of a therapeutic preparation (mepiprazole hydrochloride) were studied in a double-blind experiment. The results of the study confirmed previous experiments in that there was impaired performance in individuals subjected to time zone changes when work was carried out in local time, but the results very difficult to compare with those obtained in Easterly shifts. The therapeutic agent appeared to have little influence on the effect of time zone changes upon subjects, although they reported favourably on its use.

11. **Man in transit: Biochemical and Physiological changes during intercontinental flights.** MALCOLM CARRUTHERS *The Lancet*, Vol. 1, May, 1976, P. 977-980, 11 Refs.

Fifteen members of the passengers and crew of a plane flying from Buenos Aires to London have been studied, before, during, and after the 20-hour flight. Even allowing for circadian variation, there were clear rises in the urinary excretion of noradrenaline in the first part of the flight, and of both noradrenaline and adrenaline in the 2 days afterwards. Plasmacortisol levels were normal during the flight, but decreased on the 1st day afterwards, and returned towards normal levels on the 2nd day. Though there were increases in plasma triglyceride and glucose during the flight, cholesterol and free fatty acid levels were unchanged. The subjects

passed small volumes of highly concentrated urine during the flight, though urine volume and osmolarity returned to normal on the 2 post flight days. This suggests rehydration following the very low humidity of the flight and the change from a summer heat-wave in Argentina to the cold and damp of an English winter. Electrocardiographic recordings obtained from the three pilots during the flight showed the expected heart-rate peaks during landing and takeoff at the various airports along the route, with mean rates of about 90 beats per min throughout their periods at the controls. Their high level of adrenaline excretion was also reflected in the ST-T changes seen in these traces but absent at rest. Electroencephalographic recordings also obtained on five members of the flight-deck crew showed occasional tendency to mass synchronisation and microsleep pattern indicative of fatigue and drowsiness. Though the crew had all been off duty for at least 24 hours before the flight, these biochemical and physiological changes indicate that climatic conditions can prestress an aircrew before a flight, and lead to impaired adaptation to the additional strains of exacting work in rapidly changing surroundings of temperatures, humidity, and time. Methods of minimising these changes are considered in relation to "time-lock" hotels and Concorde.

III. ENVIRONMENTAL PHYSIOLOGY

12. **Sustained venoconstriction in man supplemented with CO₂ at high altitude.** JULIO C. CRUZ, ROBERT F. GROVER, JOHN T. REEVES, JOHN T. MAHER, ALLEN GYMERMAN and JOSEPH C. DENNISTON, *Journal of Applied Physiology*, Vol. 40, Jan 1976, P. 96.00, 29 Refs.

Venoconstriction occurs at high altitude. This study sought to determine whether hypoxia or hypocapnia is the cause of the venoconstriction. Five male subjects were exposed to 4,000-4,400 m (P_B 449-465 mmHg) with supplemental 3.77 ± 0.02% CO₂ in a hypobaric chamber for 4 days. Similar alveolar O₂ tensions were obtained in four control subjects exposed to 3,500-4,100m (P_B 445-492 mmHg) without CO₂. A water-filled plethysmograph was used to determine forearm flow and venous compliance. Systemic blood pressure was measured with the cuff procedure. Catecholamines were measured in 24-h urine collections. Venous compliance fell at high altitude in both groups and was less (P 0.01) than control values. Forearm flow and resistance were unaltered at altitude in the

group with CO₂ supplementation while forearm flow decreased and resistance increased in the hypocapnia group at 72 h of exposure. Urinary catecholamines increased in the group with CO₂ and remained unaltered in the hypocapnic group. It is concluded that hypoxia is responsible for decreasing venous compliance and hypocapnia for increasing resistance and decreasing flow. Group differences observed in urinary catecholamines may be explained by differences in arterial pH.

13. **Hypoxia and Auditory Thresholds.** PB BURKETT and WALLACE F. PERRIN. *Aviation Space and Environmental Medicine*, Vol. 47, Jun. 1976, P. 649-651, 13 Refs.

This paper reports the effects of hypoxia on hearing. Pure tone hearing and speech discrimination were tested at ground level and during hypoxia states at simulated altitudes of 4,600 m (15,000 ft) and 6,100 m (20,000 ft) in a high altitude chamber. Pure tone hearing was not significantly altered during hypoxia produced by this method. Speech discrimination showed alterations, possibly due to central nervous system hypoxia. It was concluded that hypoxia does not cause significant deterioration of hearing for pure tones.

14. **Effects of hypoxia, heat, and humidity on physical performance.** S. LAHIRI, CA WEITZ, JS MILLEDGE and MC FISHMAN. *Journal of Applied Physiology*, Vol. 40, February 1976, P. 206-210, 15 Refs.

The effects of hot, humid environment were compared with the effects of high altitude on the physical performance capacity of Nepalese residents by measuring oxygen uptakes and heart rates at various work rates. The following groups of men were selected: 66 residents of a hot and humid environment in the Terai at sea level: 24 residents and 16 sojourners at 3,800 m. The maximal oxygen uptake of the sea-level residents was, on the average, 2.55 l·min⁻¹, at which a maximal heart rate of about 200 beats/min was reached. The sojourners at 3,800 m showed a higher maximal oxygen uptake (2.94 l·min⁻¹) at their maximal heart rate of about 175 beats/min. The residents of 3,800 m achieved a similar oxygen uptake as the sojourners, but did not show a similar maximal heart rate limitation, suggesting that they were capable of achieving a

higher maximal oxygen uptake. This study shows that hot, humid environment at sea level is as much incapacitating as is hypoxia at high altitude.

15. **Muscle water and electrolytes following varied levels of dehydration in man.** D. L. COSTILL, R. COFFE, and W. FINK, *Journal of Applied Physiology*, Vol. 40, Jan. 1976, P. 6-11, 24 Refs.

In an effort to assess the effects of dehydration on the contents of water and electrolytes (Na⁺, K⁺, Cl⁻ and Mg²⁺) in plasma and muscle tissue, eight men exercised in the heat (39.5°C, 25%). Blood urine, and muscle biopsy samples were obtained before exercise and after the subjects had reduced their body weight by 2.2, 4.1 and 5.8%. On the average, plasma and muscle water (H₂O_m) contents were found to decline 2.4 and 1.2% for each percent decrease in body weight. Muscle sodium (Na⁺_m) and chloride (Cl⁻_m) content remained unchanged with dehydration, while muscle magnesium (Mg²⁺_m) declined 12% as a result of the 5.8% dehydration. In terms of intracellular concentrations, K⁺_i increased 7.2 and 10.6% at the 2.2 and 4.1% dehydration levels, respectively. Calculations of the resting membrane potential suggest that the water and electrolyte losses observed in these studies do not significantly alter the excitability of the muscle cell membrane.

16. **Heat Stroke: A Review.** SHLOMO SHIBOLET, MALCOLM C. LANCASTER and YEUDA DANON, *Aviation Space & Environmental Medicine*, Vol. 47, March 1976, P. 280-301, 270 Refs.

Heat stroke is a complex clinical picture caused by extreme elevation of body temperature and is especially prevalent in hot climates. The danger of heat stroke has apparently always accompanied unacclimatized man on his way through arid zones, and was often the cause of man's fatal adventures in the desert. Large numbers of unacclimatized urban dwellers have suffered when the urban areas have been involved in heat waves. Heat stroke has also been a major problem in hot industrial environments. This paper is a review of pertinent literature on this subject.

17. **Ejection of Pilots from Combat Aircrafts.** ROLAND-PAUL DELAHAYE, ROBERT AUFFRET, ROBERT DEMANGE & PIERRE.

JEAN METGES. *International Review of the Army Navy and Air Force Medical Services*, Vol. 48, No. 12 1975, P 769-775 (In French)

A systematic radiological examination of the spinal column is performed in several Air Forces at the initial medical examination of aircrew candidates.

However, some flight surgeons are against this technique. They neglect to consider the numerous advantages of this reference file. This one is, for the authors, the initial base for a study of occupational pathology; furthermore, it offers the possibility of following the evolution of normal radiological aspects of the spine of young candidates. A large number of little modifications in the frontal normal posture of the dorso-lumbar spine exists, but without any pathological significance.

Concerning congenital abnormalities, localization and radiological aspect must be considered. The authors believe that spondylosis and discrete spondylolysis thesis are not disqualifying factors for combat pilots.

IV. EJECTION ESCAPE PROBLEMS

18. **Ejection of Pilots from Combat Aircrafts.** ROLAND-PAUL DELAHAYE, ROBERT AUFFRET, ROBERT DEMANGE & PIERRE-JEAN METGES. *International Review of the Army, Navy and Air Force Medical Services*, Vol. 49, No. 3, 1976, P. 213-219, 93 Refs (In French)

The fundamental rules to be followed for the cases of combat pilots suffering from spinal disease or abnormality are reviewed. There is no precise and typical line of procedure. Each patient is a special case and frequently decisions can be made only by collaboration of specialists belonging to different clinical specialities, after consideration of the clinical and psychological aspects of the case.

It is necessary and sometimes difficult to safeguard the interest of the flying personnel and of the government. Problems of fitness criteria are also changing over a period of time since surgical advances and new aeronautical procedures and tactics must be taken into account.

V. CLINICAL AVIATION MEDICINE

19. **ECG Monitoring of heart failure and Pilot load/overload by the vesla seat pad.** C. W. SEM-JACOBSEN. *Aviation Space & Environmental Medicine*, Vol. 4, April 1976, P. 441-444, 4 Refs.

Heart failure has caused sudden incapacitation of pilots in command of commercial airliners. These fatal episodes have occurred in connection with takeoffs and landings, and have resulted in incidents as well as major accidents in which more than 300 people have been killed. Coronary attack may be verified later at autopsy. Sudden cardiac arrest or serious episodes, such as ventricular tachycardia, usually cannot be detected at autopsy. A number of accidents due to unknown reasons or to "pilot error" can be due to, and some probably are, cardiac breakdown. It is today possible, with the Vesla Seat Pad to monitor the pilot's ECG. The Vesla Seat Pad is a device for biomedical monitoring of ECG signals from human subjects without attachment to the subjects to any leads or sensor devices. The Vesla pad on which a human subject may rest, requires no power source. It is capable of obtaining appropriate ECG signals, transmitted to the pad through the medium of the subject's perspiration, for monitoring the subject's heart action. ECG signals, together with other data, can be electronically processed and used to warn the co-pilot and tower of impending hazard. The "dead man's button" with an OVERLOAD warning system could greatly, when taken into use, improve flying safety.

20. **Aircrew Medical standards and their application in the Royal Australian Air Force.** ROY L. DEHART, EE STEPHENSON and EF KRAMER. *Aviation Space and Environmental Medicine*, Vol. 47, Jan. 1976, P. 70-76, 7. Refs.

Aircrew selection and health maintenance are key factors in the Aviation Medicine Programme of the Royal Australian Air Force. The physical standards employed by the RAAF in selecting aircrew are reviewed. The aircrew selection process for the 5 years 1969 to 1973 are presented with emphasis given to medical causes for rejection. A careful analysis of reasons for failure to complete aircrew training was conducted. The results of this analysis are presented with special emphasis being given to medical wastage. The process of medical evaluation of trained aircrew is discussed along

with the 1969-1973 experience with aircrew duty restrictions and waivers granted for medical conditions. The RAAF experience with medical wastage of trained aircrew is similar in the experience of other nations, both as to wastage rates and body systems involved.

21. Pre-employment and periodic physical examination of Airline Pilots at the Mayo Clinic, 1939-1974. *Aviation Space and Environmental Medicine*, Vol. 47, Feb. 1976, P. 180-184, Refs. 15.

A descriptive study of medical disqualifications and deaths in an airline pilot population revealed that, of 2,751 pilot applicants, 145 (5.3%) were rejected by the pre-employment company medical examination. Of the 145, 117 were rejected because of a primary disqualifying "laboratory" abnormality. During the lifetime of the airline, 103 pilots have retired because of medical reasons, primarily cardiovascular, and 120 have died, the majority in aircraft accidents. The rate of medical disqualification is minimal before the age of 45 years, but it increases rapidly thereafter. By use of the actuarial survivorship method, it was determined that the chance of a pilot reaching retirement age in this airline company was less than 50%, although his chance of not reaching retirement age because of medical reasons was only 20%. Based on the results of this study, a departure from the "traditional" periodic company medical examination programme is suggested.

22. Five-Year Study of emergency aeromedical evacuation in the United States. ALBERT JOHNSON, Jr. JAMES T. COOPER and FAYE E. ELLEGOOD. *Aviation Space and Environmental Medicine*, Vol. 47, June, 1976, P. 662-666, 6 Refs.

During the time period, 1 July 1969 - 30 June 1974, a total of 7056 patients were moved on the C-9A Nightingale on an "urgent" or "priority" basis. In support of the request for urgent airlift, an average of 21 C-9A aircraft were launched monthly. The domestic aeromedical evacuation missions were highly flexible and productive, yet inexpensive when compared with other means of moving patients. A means for determining precedence for the pickup and movement of patients is essential for an aeromedical evacuation system. When

the patient is properly evaluated and the urgency for flight movement determined, unnecessary, costly, hazardous, or special flights are avoided. More than 50% of the "urgent" patients airlifted during this 5-year span originated in the central part of the United States. The Northeast and Far West were each responsible for less than 10% of the patients requiring urgent evacuation over the same period. More than 50% of the urgent patients moved were in the categories of newborn complications, burns and neurological problems. During this period, no patient was moved on an urgent basis for a psychiatric problem-aeromedical evacuation simply becomes a very effective tool in ensuring complete health care for seriously ill patients.

VI. AVIATION NEURO PSYCHIATRY

23. Alpha Index and personality traits of Pilots. JAN TERELAK. *Aviation Space and Environmental Medicine*, Vol. 47, Feb. 1976, P. 133-136, Refs. 20.

This investigation was instituted to provide information regarding the relationship between individuals with radically different alpha indices (low vs high) and personality traits of the subjects. EEG recordings were obtained and acceptable diagnostic personality testing techniques administered. The results indicate that the group with low alpha index revealed a significantly higher level of anxiety and neuroticism.

24. Psychotherapy and return to flying duties. CARL B STEINBACHER and CARLOS JG PERRY. *Aviation Space & Environmental Medicine*, Vol. 47, July 1976, P. 770-772, 10 Refs.

The medical records of a group of 112 successive cases referred for psychiatric consultation to the USAF School of Aerospace Medicine were reviewed. Fifty-eight (52%) of these were psychiatrically disqualified but felt to be amenable to psychotherapy, which was recommended. Follow-up contact was possible in 49 of these cases to show that 38 did, in fact, receive treatment. Of this later group, 18 were successfully returned to flying duties along with six more, who had no formal treatment beyond several consultative visits, for a total salvage rate of 49%. Psychotherapy had previously been proven to be effective under conditions of major wartime mobilization. Its use in peace-time and during limited warfare has been

studied only sparsely, except in the German Air Force, and only for specific condition in the Royal Air Force. Results of this study support the contention that psychotherapy is feasibly effective in allowing otherwise, disqualified fliers to return to flying duties.

25. **Ethnic variations in psychological performance under altitude stress.** V. M. SHARMA and M.S. MALHOTRA, *Aviation Space & Environmental Medicine*, Vol. 47, March 1976, P. 248-251, 14 Refs.

Sea-level performance of 120 subjects equally drawn from Gorkha, Madrasi and Rajput groups was compared with that at an altitude of 4,000 m after 10 months' stay. Alterations in concentration, eye-hand coordination, anxiety, depression, and social interaction were recorded to ascertain ethnic differences in withstanding the altitude stress. Results showed a uniform fall in the scores for eye-hand coordination and social interaction at altitude for the three ethnic groups. However, the effects on concentration, anxiety and depression were differential for these groups indicating a better toleration of altitude stress by Gorkhas. Climatic similarity between the region of natural habitat of Gorkhas and altitude environment has been suggested to be responsible for their better performance over the other two groups.

26. **Syncope.** PJ O'CONNOR, *The Practitioner*, Vol. 216, March 1976, P. 276-280, 3, Refs.

A FAINT or syncope is a loss of consciousness due to rapid reduction of the blood supply to the brain. The physiology of syncope has been greatly clarified by the work of Professor Sharpey-Shafer (1956). Cerebral blood flow depends mainly upon the supply pressure and to a much lesser extent on cerebrovascular resistance. The supply pressure is the difference between the arterial pressure and the venous pressure. If this figure falls below 50 mmHg, syncope usually results. The arterial pressure in its turn depends upon cardiac output and total peripheral resistance, which normally act in opposite directions mediated via the baroreceptor reflexes. These baroreceptor reflexes, previously known as baroreceptors, are situated in the carotid sinus and the arch of the aorta probably in other arterial sites as well; they coordinate cardiac output and total peripheral resistance so as to ensure a constant

supply pressure to the essential organs such as the brain, kidneys and liver. Whenever the effective supply pressure to the brain falls below 50 mmHg, syncope is likely to occur.

VII. SPACE MEDICINE

27. **Pulmonary function evaluation during the Skylab and Apollo-Soyuz Missions.** CF SAWIN, AE NICOGOSSIAN, JA RUMMEL and EL MICHEL, *Aviation Space & Environmental Medicine*, Vol. 47, Feb 1976, P. 168-172, 18 Refs.

Previous experience during Apollo postflight exercise testing indicated no major changes in pulmonary function. Pulmonary function has been studied in detail following exposure to hypoxic and hyperoxic normal gravity environments, but no previous study has reported on men exposed to an environment that was both normoxic at 258 torr total pressure and at null gravity as encountered in Skylab. Forced vital capacity (FVC) was measured during the preflight and postflight periods of the Skylab 2 mission. Inflight measurements of vital capacity (VC) were obtained during the last 2 weeks of the second manned mission (Skylab 3). More detailed pulmonary function screening was accomplished during the Skylab 4 mission. The primary measurements made during Skylab 4 testing included residual volume determination (RV) closing volume (CV), VC, FVC and its derivatives. In addition VC was measured in flight at regular intervals during the Skylab 4 mission. Vital capacity was decreased slightly (-10%) in flight in all Skylab 4 crewmen. No major preflight-to-postflight changes were observed. The Apollo-Soyuz Test project (ASTP) crewmen were studied using equipment and procedures similar to those employed during Skylab 4. Post-flight evaluation of the ASTP crewmen was complicated by their inadvertent exposure to nitrogen tetroxide gas fumes upon reentry.

28. **Medical legacy of Skylab as of May 9, 1974: The manned Skylab missions.** CHARLES A. BERRY, *Aviation Space & Environmental Medicine*, Vol. 4, April 1976, P. 418-424.

The purpose of these summary remarks is to put into proper focus the magnificent achievement created by the Skylab Medical Team in concert with their engineering colleagues and most importantly, the astronauts who had to serve as both

investigators and subjects. Indeed, by their ingenuity and capability of handling the numerous problems encountered due to engineering deficiencies, they have shown man to be indispensable in long-duration space flight.

- 29. Changes in Glucose, Insulin, and Growth hormone levels associated with bedrest.** JOAN VERNIKOS-DANELIS, CAROLY S. LEACH, CHARLES M. WINGET, ANNE L. GOODWIN and PC RAMBAUT. *Aviation Space and Environmental Medicine*, Vol. 47, Jun 1976, P. 583-587, 26 Refs.

Changes in plasma glucose, insulin and growth hormone (HGH) resulting from exposure to 56 d of bedrest were determined in five healthy young male subjects. Blood samples were collected by repeated venous puncture at 4-h intervals for 48-h periods before bedrest, at 10, 20, 30, 42 and 54 d after confinement to bed and at 10 and 20 d after bedrest. Changes in the daily levels of these factors for each subject were expressed as the mean of the six samples per 24-h period. The level of HGH dropped after 10 d of bedrest, then showed a 1.5 fold increase at 20 d ($p < 0.05$) and subsequently decreased gradually reaching level of 2.5mg/ml/24 h, well below pre-bedrest controls of 4.2 mg/ml/24 h, by the 54th d. In spite of a marked increase in the daily plasma insulin levels during the first 30 d of bedrest glucose levels remained unchanged. Beyond 30 d of bedrest, insulin began decreasing toward pre-bedrest levels and glucose followed with a similar reduction to below the control levels of 75 mg/100ml/24 h on day 54. The daily means changes reflect a change in the amplitude of the diurnal variation. The daily peak in plasma insulin shifted progressively to the late evening during the bedrest period.

VIII. AVIATION TOXICOLOGY

- 30. Effects of Organophosphate pesticides and other drugs on subcortical mechanisms of visual integration.** ALVIN M. REVZIN. *Aviation Space and Environmental Medicine*, Vol. 47, Jun 1976, P. 627-629, 10 Refs.

Atropine, scopolamine, mevinphos and eserine selectively block directional sensitivity of visual integrative neurones in the thalamus. Cholinergic drugs that do not penetrate the blood-brain barrier are without effect. The neurones studied are important links in reflex brain systems controlling

visual attention and eye movements. The results suggest that any cholinergic drugs that can get into the brain will disturb visual functions. Since the changes are qualitative and the system is reflex, the affected individual may be unaware of dysfunction. The resultant dangers to aerial applicator personnel are discussed, particularly with respect to Atropine, which is necessary in the therapy of organophosphate and carbamate poisoning but is potentially harmful if self-administered for either prophylaxis or treatment.

IX OXYGEN THERAPY

- 31. Application of hyperbaric oxygen therapy in a case of prolonged cerebral hypoxia following rapid decompression.** PAUL L. SHEFFIELD and JEFFERSON C. DAVIS. *Aviation Space & Environmental Medicine*, Vol. 47 July 1976, P. 759-762, 20 Refs.

The first known and previously unpublished report of the use of hyperbaric oxygen (HBO) in the treatment of prolonged cerebral hypoxia is reported in an incident involving a USAF T-39 aircraft that underwent rapid decompression from 753 mb (2,438 m or 8,000 ft) to 148 mb (13,716 m or 45,000 ft). Within 5 to 8 s, the pilot lost consciousness because he did not don his oxygen mask, and, therefore, was unable to obtain supplemental oxygen immediately. After a delay of 6 to 8 min, he was given supplemental oxygen at and below 697 mb (3,048 m or 10,000 ft). On the ground, the pilot was blind and disoriented. This condition persisted for 6.5 h, at which time HBO was administered. Orientation and vision were regained; neurologic findings were negative. It is concluded that HBO therapy was effective in treating this case of prolonged cerebral hypoxia. The report shows (1) the potential application of HBO in the treatment of prolonged cerebral hypoxia and (2) the need for developing safe procedures for descent of passenger aircraft following such decompression.

- 32. Biochemistry and hematology of decompression sickness: A case report.** MICHAEL J. JACEY, ELLY HEYDER, ROGER A. WILLIANSO, and DONALD V. TAPPAN. *Aviation Space and Environmental Medicine*, Vol. 47, Jun 1976, P. 657-661, 17 Refs.

A 24-year old hospital corpsman, a volunteer in a series of dry chamber air dives to a simulated pressure equivalent to 188 FSWG (57.3 MSWG),

developed left knee pain shortly after standard decompression. A tentative diagnosis of decompression sickness was made and recompression therapy was initiated with alleviation of pain occurring at 60 fSWG (18.3 MSWG). A US Navy Treatment Table 5 (oxygen breathing) regimen was then selected and complemented uneventfully. The subject had been undergoing biomedical evaluation for several days prior to diving; thus a clinically diagnosed case of dysbarism with subsequent treatment was available for study. This individual was then monitored for a 10-d period. The acute phase of decompression sickness was characterized by a marked shortening of clotting time and a thrombocytopenia with accompanying increased platelet aggregates. The recovery phase was categorized by a variety of hematological and biochemical changes. Hemodilution an elevated megathrombocyte index, and a tendency toward eosinopenia were evident for most of the 10-d observation period. Other persistent alterations detected during this period included a relative hyperglycemia, depressed urine Na⁺/K⁺, and increased ketosteroid excretion. These observations indicate that abatement of pain after treatment of dysbarism can be followed by the onset of a variety of biochemical and hematological changes. Moreover, complete recovery may require upwards of 10 d.

33. **Associations between Psychological factors and Pulmonary toxicity during intermittent oxygen breathing at 2 ATA.** ROBERT J. BIERSNER, DAVID A HALL and PAUL G. LENAWEAVER. *Aviation Space and Environmental Medicine*, Vol. 47, Feb. 1976, P. 173-176, Refs. 7.

Associations between the psychological and pulmonary effects of breathing intermittent oxygen at 2 ATA were examined among four experienced divers. A fifth diver, who served as a control, breathed only normoxic nitrogen. Psychological tests included digit span, short-term memory for easy and difficult word associations, simple and complex psychomotor performance, and reported moods. The criterion of oxygen toxicity was the total hours of intermittent oxygen tolerated before developing a 10% reduction in vital capacity. Short-term memory for difficult word associations and self-reported moods of Activity, Depression, Fatigue, and Happiness were found to be significantly correlated with this criterion of oxygen toxicity. Part of the impairment found on these measures,

however, was probably related to the absence of adequate sleep and rest as evidenced by the worsened performance of the control diver over the 15-h testing period. The results replicated the findings of earlier research on the psychological effects of continuous oxygen breathing under hyperbaric conditions and at 1 ATA, and may indicate that oxygen intensifies the effects of other stressors such as fatigue. In addition, the results showed that reported moods may be important indicators of impending pulmonary toxicity during intermittent oxygen exposure.

X AVIATION OTOLARYNGOLOGY

34. **Sinus Barotrauma in Divers.** BART MCKENZIE, CARL EDMONS. *The Annals of Otolaryngology and Laryngology*, Vol. 85, Jan-Feb. 1976, P. 61-64, 6 Refs.

Sinus barotrauma is a common occupational disease of divers, with the incidence of descent barotrauma approximately double that of ascent. Pain chronologically associated with the change of pressure is the most dominant symptom and is seen in 92% of the cases presented for treatment. The majority complain of a frontal distribution of pain, with ethmoidal and maxillary being much less significant. Epistaxis is the second commonest symptom, and may be the sole symptom in some ascent cases. A history of recent or past sinus barotrauma or upper respiratory tract pathology is very common. Clinical examination supports the evidence of upper respiratory tract pathology in many cases. The radiological signs of abnormality were present in over three quarters of the cases examined. Of these the maxillary sinus was affected in most cases, the frontal in approximately one quarter and the ethmoidal in less than a fifth. The pathology was more commonly that of mucosal thickening, but in 12% of cases there was a fluid level. It is noted that although symptoms were predominantly frontal, x-ray changes were most often present in the maxillary sinuses.

35. **Evaluating the ability of aircrew personnel to Hear Speech in their operational environments.** CE WILLIAMS, JD MOSKO and JW GREENE. *Aviation Space and Environmental Medicine*, Vol. 47, P. 154-158, 5 Refs.

High-quality tape recordings were constructed of single, double and triple word test items from the six monosyllabic word list of the Modified

Rhyme Test (MRT) a multiple-choice intelligibility test. The test words were incorporated in a carrier phrase somewhat analogous to typical aircraft radio messages. The recorded lists were mixed with shaped noise and played back to a group of listeners at three speech-to-noise ratios. The regular closed-response format of the MRT was utilized for all three types of test items. There was little difference in overall listener performance for the single, double, and triple word test items. Because of their more representative message length and decreased testing time, the tripple word test item will be utilized in subsequent data-gathering studies directed toward the development of an efficient reliable test for assessing the ability of aircrew personnel to hear speech in their operational environments.

36. **Pressure-dependent variation in volume of mucosal lining of the middle ear.** L. ANDREASON, S. INGELSTEDT, A. IVARSON B. JONSON and O. TJERNSTROM. *Acta Oto-Laryngologica* Vol. 81, May-June 1976, P. 442-449, 6 Refs.

A method is described for studying pressure-dependent variation in the volume of the mucosa of the middle ear. Studies were performed at different pressures in the middle ear as well as at different ambient pressures. It was found that the pressure dependent volumetric changes of the mucosa were the same whether the pressure in the middle ear was changed directly by altering the intratympanic or indirectly by altering the ambient pressure. With the method described it is also possible to determine the middle ear volume without artefacts due to the middle ear mucosa. The volume-pressure relationship of the middle ear mucosa varied from 0.6 to 1.7 cm H₂O and linearly with the volume of the middle ear. Comparisons between determinations of the middle ear volume with and without consideration of the mucosal compliance showed differences, especially in small middle ears. The effect on the volume of the mucosa caused by variation of posture was also studied. The physiological middle ear pressure depends on the functional state of the Eustachian tube, the middle ear volume, the tympanic membrane and the middle ear mucosa. Thus, knowledge of the mucosa compliance is important for calculating middle ear pressure as well as for determining the volume of the air-filled middle ear space. The method might also prove a useful tool in the elucidation of the vascular bed both in

health and in disease as well as the reaction of the mucosal vessels to drugs.

XI. VESTIBULAR PHYSIOLOGY

37. **Perceptual Illusion of rotation of three-dimensional objects.** ROGER N. SHEPARD, SHERRYL A. JUDD. *Science*, Vol. 191; March 1976 P. 952-954; 6 Refs.

Perspective views of the same three-dimensional object in two orientations when presented in alternation, produce an illusion of rigid rotation. The minimum cycle duration required for the illusion increased linearly with the angular difference between the orientations and at the same slope for rotations in depth and in the picture plane.

38. **Postural behaviour & Motion sickness.** T. FUKUDA. *Acta Oto-Laryngologica*, Vol. 81, Mar-Apr. 1976, P. 237-241, 2 Refs.

One of the acting techniques used in Kyogen, a classical Japanese stage comedy, prompted two questions; why is it that one may suffer from motion sickness as a car passenger, but as a driver, escapes its effects? And how can one learn postural adjustment against motion sickness by repeatedly travelling in vehicles?

39. **Vestibular Habituation in Flightcrew.** P. PIALOUX, P. FONTELLE, PH. COURTIN, A. GIBERT, P. ROBERT, P. BLANC and E. LAFONTAINE., *Aviation Space and Environmental Medicine*, Vol. 47, March, 1976, P. 302-307, 41 Refs.

Vestibular habituation is a general reaction to any repetitive sensory stimulation. It can be characterized by four main features: acquisition, retention, loss or dishabituation, and transfer. This study concerns three groups of subjects: The first group consists of a) 27 pilots at present serving in the French Air Force, b) 12 pilots at present serving in the major civil airlines, c) 8 navigators, radio-navigators, and crew mechanics, some of whom are flying club pilots, and d) 3 professional pilots trained in flying clubs. All of these subjects had more than 2000 hrs flying time. They were from 27 to 50 years old. The second group consists of airline stewards. The third group consists of trainee pilots still in flying school.

various factors. It relates them to the operation of aircrews "round the clock" and on transmeridian routes and discusses some possibilities of an appropriate scheduling.

10. **Effects of Time zone changes on performance and physiology of airline personnel.** F. S. PRESTON, S. C. BATEMAN, F. W. MELCHEN, R. WILKINSON, and R. V. SHORT. *Aviation Space & Environmental Medicine*, Vol. 47, July 1976, P. 763-769, 5 Refs.

This study is the second of a series of experiments describing the effects of time zone changes on the performance and menstrual cycle changes in a group of 16 female airline personnel. Four groups of four subjects each spent 4 d in the isolation unit of the University of Manchester. One group acted as control; the other three groups were subjected to two 8-h retardations in time, representing Westerly flight. All groups were required to complete an identical battery of workload tasks. In addition, the effects of a therapeutic preparation (mepiprazole hydrochloride) were studied in a double-blind experiment. The results of the study confirmed previous experiments in that there was impaired performance in individuals subjected to time zone changes when work was carried out in local time, but the results very difficult to compare with those obtained in Easterly shifts. The therapeutic agent appeared to have little influence on the effect of time zone changes upon subjects, although they reported favourably on its use.

11. **Man in transit: Biochemical and Physiological changes during intercontinental flights.** MALCOLM CARRUTHERS *The Lancet*, Vol. 1, May, 1976, P. 977-980, 11 Refs.

Fifteen members of the passengers and crew of a plane flying from Buenos Aires to London have been studied, before, during, and after the 20-hour flight. Even allowing for circadian variation, there were clear rises in the urinary excretion of noradrenaline in the first part of the flight, and of both noradrenaline and adrenaline in the 2 days afterwards. Plasmacortisol levels were normal during the flight, but decreased on the 1st day afterwards, and returned towards normal levels on the 2nd day. Though there were increases in plasma triglyceride and glucose during the flight, cholesterol and free fatty acid levels were unchanged. The subjects

passed small volumes of highly concentrated urine during the flight, though urine volume and osmolarity returned to normal on the 2 post flight days. This suggests rehydration following the very low humidity of the flight and the change from a summer heat-wave in Argentina to the cold and damp of an English winter. Electrocardiographic recordings obtained from the three pilots during the flight showed the expected heart-rate peaks during landing and takeoff at the various airports along the route, with mean rates of about 90 beats per min throughout their periods at the controls. Their high level of adrenaline excretion was also reflected in the ST-T changes seen in these traces but absent at rest. Electroencephalographic recordings also obtained on five members of the flight-deck crew showed occasional tendency to mass synchronisation and microsleep pattern indicative of fatigue and drowsiness. Though the crew had all been off duty for at least 24 hours before the flight, these biochemical and physiological changes indicate that climatic conditions can prestress an aircrew before a flight, and lead to impaired adaptation to the additional strains of exacting work in rapidly changing surroundings of temperatures, humidity, and time. Methods of minimising these changes are considered in relation to "time-lock" hotels and Concorde.

III. ENVIRONMENTAL PHYSIOLOGY

12. **Sustained venoconstriction in man supplemented with CO₂ at high altitude.** JULIO C. CRUZ, ROBERT F. GROVER, JOHN T. REEVES, JOHN T. MAHER, ALLEN CYMERMAN and JOSEPH G. DENNISTON, *Journal of Applied Physiology*, Vol. 40, Jan 1976, P. 96.00, 29 Refs.

Venoconstriction occurs at high altitude. This study sought to determine whether hypoxia or hypocapnia is the cause of the venoconstriction. Five male subjects were exposed to 4,000-4,400 m (P_B 449-465 mmHg) with supplemental 3.77 ± 0.02% CO₂ in a hypobaric chamber for 4 days. Similar alveolar O₂ tensions were obtained in four control subjects exposed to 3,500-4,100m (P_B 445-492 mmHg) without CO₂. A water-filled plethysmograph was used to determine forearm flow and venous compliance. Systemic blood pressure was measured with the cuff procedure. Catecholamines were measured in 24-h urine collections. Venous compliance fell at high altitude in both groups and was less (P 0.01) than control values. Forearm flow and resistance were unaltered at altitude in the

All of these subjects were examined for their suitability, in particular undergoing a damped swing test. The first oscillation was in an anti-clockwise direction and the damping extended over 20 periods. The following parameter was measured: the ratio of total left nystagmus frequency to total right nystagmus frequency. In "normal" control subjects the ratio is greater than 1. The results were: The first group: In 41 out of 50 subjects, the ratio of left tremors frequency to right tremors frequency was less than or approximately equal to 1. In the second group: The results showed no significant differences in comparison with a control group of subjects. In the third group: Zero flying time—the results were identical with those of control

subjects: 40 h flying time—the ratio approached 1; 100 h flying time—the ratio was less than 1. Vestibular habituation, that is inversion of the preponderance of the total number of left tremors over the total number of right tremors, was observed in the technical flight crew. The appearance of this inversion during the pilots' training was studied and its retention tested. This test for showing vestibular habituation may be of use for monitoring the function of equilibrium and the development of habituation during flight training.

In this report, we shall first review the definition and characteristics of vestibular habituation, and the main body of recent work on this phenomenon in flight crew. Our own findings will be then presented.

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