Abstracts of Current Aviation Medicine Literature

I ENVIRONMENTAL PHYSIOLOGY

1 Heart Rate and Spontaneous Work-Rest Cycles During Exposure to Heat

Ten young men and women performed different workloads (25-50% of O_2 max) on a bicycle in ambient temperatures of 25,35 and 45°C. Air velocity (V_a) and water vapour pressure (P_a) were kept constant ($V_a = 0.25$ ms^{-1}, $P_a = 2.3kPa$). The subjects determined themselves the time and duration of the successive work and rest phases but had to perform at least 60 min of cycling during the 180 min of exposure. The whole working duration was spontaneously split up into one to six working phases whose durations ranged from 9 to 146 min. Whatever the number of working phases, the duration of the last phase was about 50% of the first one, and the duration decrease occuring with exposure time was nearly proportional to the order number of the working periods. For a given pattern of work-rest cycles, work finally stops at a constant critical heart rate level. This level depends on experimental conditions and on subjects.

[J J Vogt, J P Libert, V Candas, F Dauli and Ph Mairieux]

2 Inherent Variability in Heat-Stress Decision Rules

There currently exist many decision rules which help define hot working environments through the use of heat threshold values, or onset points for increasing risk of heat strain. A degree of variability is introduced into these decision rules due to the inherent need to estimate metabolic workload and to measure fluctuating thermal variables. This study evaluated the extent of this variability, and compares heat stress decision rules based on comprehensive and abbreviated methodologies.

The approach consisted of pairing Wet-Bulb Globe Temperature (WBGT) values with fhe corresponding values of human heat exchange calculated from the generally accepted equations developed as the Heat-Stress Index (HSI). Several levels of metabolic workload, clothing radiant heat, wetbulb temperature, air temperature and air velocity were used as input to a computer model for generating the corresponding HSI and WBGT. This iterative procedure provided the ability to look at the specific

work, clothing and environmental components that yield a limiting heat load of HSI—75, and then to identify the corresponcing WBGT for that set of components. This procedure served as a basis for validating abbreviated guideline rules and for conducting the sensitivity analysis of thermal components.

Results suggested that the sensitivity level of the measurement and estimation process greatly reduces the overall precision and confidece in any set of heat-stress decision rules. Simplified/abbreviated rules, when combined with appropriate administrative and work practice, should yield protection to the worker that is comparable to the seemingly more precise methods.

[J D Ramsey and C P Chai, Ergonomics, 1983, Vol. 26, No. 5 495-504.]

3 Head and/or Torso Cooling During Simulated Cockpit Heat Stress

Liquid-conditioned garments (LCG's) may be useful in alleviating heat stress on aircrew members. This study evaluated the effects of a liquid-cooled vest and/or cap on subjects exposed to a thermal environment which simulated the stress of low-level flight in hot weather. The chamber was set at dry bulb temperature 35°C, wet bulb temperature 26°C and black globe temperature 43°C. Subjects were eight men, aged 23-45 years. Each subject was studied in one 100 min exposure: uncooled control (XX); head cooling only (HX); torso cooling only (XT); and combined head and torso cooling (HT). Cooling effects were evaluated by using rectal temperature (Tre); heart rate (HR); sweat rate (SRF and SRT for forehead and total body, respectively); and subjective comfort. Uncooled runs (XX) produced final values: Tre—37.8°C, HR—94 beats/min, SRT—25 g/m². h and SRF—45 g/m². h. Combined head and torso cooling maintained the subjects at nearly their initial (baseline) state. Cap effects per se were assessed by comparing HX to XX, and HT to XT. Head cooling proved 2-3 times as efficient as torso cooling, although limited by the small surface area involved. We conclude that the specific effects of head cooling in improving comfort and-diminishing forehead sweating, as well as the efficient systemic cooling observed, justify further work on cockpit applications.

Nunneley SA and RJ Maldonado, Aviat. Space Environ. Med. 54(6): 496-499, 1983.

4 The Acquisition and Validation of the Surface Electromyogram signal fr Evaluation Muscle Fatigue

The advent of new USAF aircraft control concepts necessitated the investigation of muscle fatigue in complex dynamic environments. The Acceleration Effects Branch of the Aerospace Medical Research Laboratory of Wright-Patternson Air Force Base has undertaken such a study for evaluation of fatigue in lateral G environments. Investigation of the literature indicates that the Fast Fourier Transform (FFT) of the electromyogram (EMG) single samples could be used to determine fatigue by analysis of the center frequencies and amplitudes of the sample power spectra. Reproducibility of data, especially in a dynamic environment, proved to be a challenge. However, acquisition and processing of the EMG signal have been optimized to give consistently reproducible and useable data. The method of sampling data and its processing are discussed.

[Luciani RJ, DA Ratino, DR McGrew and RI Suizu, Aviat Space Environ Med 54(8) . 744-760, 1983.

5 Results of our 15-Year Study into the biological Effects of Microwave Exposure

The results obtained during 15 years of clinical and experimental examinations of biological microwave exposure effects are briefly surveyed. Some important results are reported. Based on their experience, the authors present their attitudes concerning harmful microwave effects on living matter. They consider that microwave effects, either direct or indirect, are the results of hyperthermia. Exposure of the living body to irradiation intensities not causing thermal effects do not induce important pathological alterations in the irradiated organisms. Also it has been pointed out that the term "injury" is more suitable than the term "microwave sickness" when harmful effects of microwaves to the living organism are concerned. According to the authors the term "microwave sickness" is not acceptable as a synonym for professional diseases of persons working with sources of microwave energy, since it refers to the complex of insufficiently defined symptoms of uncertain etiology.

[Djordjevic Z, A Kolak, V Djokovic, P Ristic and Z Kolcevic, Aviat Space Environ Med 54(6) 539-542, 1983.]

6 Effects of Noise on Signal Detection

Twelve subjects were tested twice in visual vigilance tasks which lasted 40 min. Employing a two-category confidence rating scale they detected increments in light level from displays of five lights. The display was flashed on simultaneously for 0.5s every 3.5s. The subjects performed the task on different days under two conditions of continuous white noise: 'quiet' (70dB) and 'noise' (100dB). Half of the subjects had the noise treatment in the order of quiet-noise and half in the reverse order. No effects of noise either upon the overall performance or upon the vigilance decrement were observed. For the risky criterion results showed mainly that during a run under the two conditions the percentage of correct and false responses decreased. d' remained unchanged and B partly increased as a function of time. For the cautious criterion only B increased during a run under the two conditions. The results were interpreted in terms of arousal theory.

[Stanisa Milosevic, Ergonomics, 1983, Vol 126 No 10 939-946.]

7 Diurnal Rhythmicity and Air Force Flight Accidents Due to Pilot Error

In order to evaluate the possible role of an endogenous rhythmic factor in Air Force flight accidents a retrospective study was carried out. The study included all Air Force (aircraft) flying accidents which have been attributed to pilot's error and which occurred, in peace time missions, over a period of 12 years (1968-1980). The frequency of hourly accidents was computed separately, for each month, for each day of the week, and for each year, for each month, for each day of the week, and for each calendar day. Identical computations were carried out for the frequency of hourly flights. When the hourly ratios of these two parameters were computed, by dividing the value of one parameter to the other at each hour, a rhythmic (rather than constant) diurnal pattern was obtained. The pattern was defined as the "Hourly Accident Coefficent (HAC)". The HAC values ranged from 1.58 to 0.68 (pooled data for all surveyed aircrafts) and from 4.12 to 0.74 (data for fighter planes). The pattern, which exhibited a diurnal rhythm, was independent of the frequency of flights and appeared to be related to the sleep-wake cycle of the pilots, especially to the time of waking from the night sleep. The results are used as a directive for a progressive study aimed at evaluating the practical implications of the presented observations.

[Ribak J, IE Ashekenazi, A Klepfish, D Avgar, J Tal, B Kalmor and Y Noyman. Aviat. Space Environ Med. 54(12), 1096-1098, 1983.]

8 Cognitive effects of Passive Smoking

The cognitive performance of 32 non-smoking subjects was tested on two separate occasions. In one condition subjects performed on a modified Wilkinson auditory detection task and attempted a modified Raven's progressive matrices test whilst sitting in a room with a confedrate who was smoking cigarettes. In the second, nonsmoky, condition the subjects undertook parallel forms of the two tests but were in a clean environment with the same confederate who did not smoke. The results indicated a significant reduction in performance on both tests in the smoky over the non-smoky condition. Furthermore, the data from the detection task indicated that the confederate has a significant influence on the level of this reduction. Implications of these results are discussed, particularly, with respect to the roles of carbon monoxide and of social variables in mediating the performance reduction.

[By D J. Oborne, Ergonomics, 1983, Vol. 26, No. 12, 1163-1171.]

9 Interactions of Alcohol and Caffeine on Human Reaction Time

Eight subjects (4 females) took part in an experiment to investigate the direction of the interactive effects of alcohol and caffeine on reaction time. Subjects were tested under each of four conditions on separate occassions: no alcohol + no caffeine; no alcohol + caffeine: alcohol to no caffeine; and alcohol + caffeine. Alcohol was given in the form of 65.5 degrees proof vodka in the quantity of 2.2 ml/kg body weight; caffeine was given in the form of crushed 150-mg tablets in decaffeinated coffee.

Under these conditions the experiment demonstrated that caffeine has a synergistic interaction with alcohol. Furthermore, using Sternberg's (37) additive-factor method, it was shown that the effects of both alcohol and alcohol + caffeine occur mainly on the peripheral stages of information processing

(i.e. at the stimulus input and response output) rather than centrally.

[Osborne MJ and Y Rogers, Aviat. Space Environ. Med. 54(6). 528-534. 1983.]

II HUMAN ENIGNEERING

10. Human factors of flight-deck automation: Report on a NASA-Industry workshop

With the advent of microprocessor technology, it has become possible to automate many of the functions on the flight deck of commercial aircraft that were previously performed manually. However, it is not clear whether these functions should be automated, taking into consideration various human factors issues. A NASA-industry workshop was held to identify the human factors issues related to flight-deck automation which would require research for resolution. The scope of automation, the benefits of automation and automation-induced problems were discussed, and a list of potential research topics was generated by the participants. This report summarizes the workshop discussions and presents the questions developed at that time. While the workshop was specifically directed towards flight-deck automation, the issues raised and the research questions generated are more generally applicable to most complex interactive systems.

[Deborah A Boehm-Davis, Renwick E Curry, Earl L Wiener, R Leon Harrison Ergonomics, 1983, Vol 126, No 10, 953-961.]

11 A method for measuring the load imposed on the back of a sitting person

A method for calculating the biomechanical load on the spine (at L3) and certain muscles in the back is described. It utilizes a small computer on-line to a force platform and the results are obtainable within a few seconds.

The method, which has been devised to evaluate aspects of industrial seating, deals with vertical forces arising from support of the hands and arms, weight lifting and vertical acceleration as well as trunk movements. It does not deal with horizontally imposed forces. It is shown to be quicker and more accurate than calculations using manual measurements of displacements and can be applied in both the field and the laboratory.

[JAE Eklund, EN Corlett and F Johnson, Ergonomics, 1983, Vol 26, No 11, 1063-1076.]

12 Industrial workplace layout design an application of engineering anthropometry

Workplace layout design parameters or dimen sions were determined mathematically by using th existing anthropometric data, for performing indus trial tasks in sitting, standing and a combination o sitting and standing positions for the general mal female and a combination of male and femal operators and the individual male and femal operators for the 5th, 50th and 95th percentile The data were duly adjusted to account for th clothing, shoe and posture allowances. The reac dimensions were based on the most commonly use industrial operations which require a grasping mov ment. Appropriate allowances were provided t adjust the reach dimensions for other types o operations. The horizontal and vertical clearanc dimensions and reference points for the horizont and vertical clearances were established. For th determination of the normal working area in th horizontal plane, Squires' concept was recommend ed in preference to Farley's concept.

[Biman Das and Robert M. Grady, Ergonomics, 1983, Vol. 3 No. 5, 433-447.]

13 Spinal loading in static and dynamic postures: EMG and intra-abdominal pressur study

The difference in physiological stress betwee static posture loading and dynamic lift is poor understood. Therefore, the quantitative pattern o gradual increase and decrease of stress as measu ed by EMG of erectores spinae at T_{12} and L_3 an intra-abdominal pressure (IAP) due to steady pro gressive loading and unloading in static stoopin posture was studied and compared with that o stoop lifting of the same weight. For dynamic load ing and unloading a steady flow of 25 kg of wate into or out of a plastic tub held in the hand whil maintaining a stooping posture was used. Th subjects also performed stoop lifting weights o 15 and 25 kg. In static posture loading the mea EMG at T_{12} was approximately 50% of the L_3 leve During unloading in that posture it was reduced t 33%. The level of electromyographic activity a T_{12} for loading was not significantly different fro unloading. At L_3, however, the magnitude increase significantly for unloading. The EMG and intrab

dominal pressure responses of static posture were between 33 and 50% of the corresponding phases during stoop lifting of the same weight. An insignificant difference in IAP and heart rate between static posture loading and stoop lifting indicates a less critical role of IAP and no difference in cardiac stress in less stressful tasks.

[S Kumar and PR Davis, Ergonomics 1983, Vol 26, No 9 913-922.]

14 Neck muscle loading and fatigue: Systematic variation of headgear weight and center-of-gravity

An extensive series of experiments has been conducted to quantify the fatigue of neck muscles as measured by isometric endurance time. The neck muscles were dynamically and statically loaded by systematic variation of 15 headgear configurations consisting of 5 different centers-of-gravity (forward-low, center-low, center-high, right-lateral-low and aftward-low) and 3 different weights (3.21b, 5.01b, 9.01b, 1.45, 2.27, 4.09 Kg). Each of six subjects would rotate his head laterally (from side-to-side) for 30 min in each of the 15 headgear loading combinations. Immediately thereafter, the subject would position his head in an isometic head dynamometer and exert a sustained right lateral neck contraction at 70% of his maximum strength (MVC), during which endurance time (to fatigue) was recorded. The results indicate that there were no significant differences ($P>0.05$) in endurance time between the 3.21b/forward-low, 3.21b/lateral right-low, and 9.01b/aftward-low compard to controls (endurance time for at 70% MVC isometric neck contraction in which there was prior head loading). All other head loading configurations (weight and center-of-gravity combinations did result in a significant reduction ($P>0.05$) in endurance times (compared to controls).

These results are significant since they provide useful insights into the optimal trade-off between various centers-of-gravity and helmet weight combination of neck muscle endurance.

[Phillips CA and JS Petrofsky. Aviat. Space Environ. Med. 54 (10) 901-905, 1983.]

15 A Dynamic Analysis of Spinal Compression with Different Lifting Techniques

Although it is commonly assumed that lifting with flexed knees and the trunk erect will lead to reduced compressive force on the low back, the benefits are only realized when the load can be lifted between the knees, i.e. close to the body. Moreover, the assumption has often been based solely on an analysis of the initial lifting posture, ignoring the inertial forces due to accelerations of the body and the load.

For this study a biomechanical sagittal plane model was developed to take full account of dynamic factors, based on direct recordings of body movements, acceleration of the load and forces at the feet.

Twenty subjects lifted a 15 kg box from a 10cm high shelf to knuckle height with four lifting techniques: leg lift, back lift, load kinetic lift, and trunk kinetic lift. In the 'kinetic' lifts the subjects tried to use the kinetic energy of the horizontally moving load or the vertically moving body, respectively, in order to reduce the spinal load.

When the peak compressisns were considered the leg lift produced least stress. The compression — time integral over the accelerative phase of the lift, relating the total stress of a lift, was smallest in the back lift.

The results of the load kinetic lift did not differ markedly from the 'non-kinetic' lifts, but the trunk kinetic lift was clearly the most stressful of the techniques studied.

[T.P.J. Leskinen, H.R. Stalhammar I.A.A., Kuorinka and J.C.G. Troup Ergonomics, 1983, Vol. 26, No. 6, 505-604]

16 The Peculiar Problems of Equipment Design

The equipment designer is faced by problems created by our irrational attitudes to the use of tools and equipment in our domestic and working lives. These attitudes are expressed in the siting and layout of housing and in the misuse of equipment in hospitals. If equipment is to play its full role, it must be plentiful, available where needed and with sufficient space for its use. It must not carry hidden costs arising from architectural inadequacies and human conservatism. Finally the use of equipment must be

included in the training and philosophy of staff and the rehabilitation of patients.

[Kenneth Agnew, Ergonomics, 1983, Vol. 26, No. 8, 781-704]

17 Some Comparisons of On-Display and Off-Display touch Input Devices for Interaction with Computer Generated Displays

The relative merits of non-display and off-display touch input devices are discussed, together with the additional features of computer-generated feedback and the means of confirming a selection subjects' performances with on-display and off-display devices are compared in three experiments with increasing target resolution requirements-menu selection, tabular display, and target acquisition. Performance, and subjective reactions, appear to be no worse for the off-display input, although both devices are worse than rolling ball (tracker ball) for high resolution targets. Characteristic types of error with these devices are demonstrated, and to beneficial effects of enhanced computer-generated feedback are shown. It is concluded that off-display continuous touch input carries no performance penalty over the on-display counterpart, and that its use is justified where its other advantages are apposite.

[D. Whitfield, R.G. Ball, J.M. Bird, Ergonomics, 1983, Vol. 26, No. 11, 1033-1063.]

III SPACE MEDICINE

18 Spacelab Mission 4—The First Dedicated Life Sciences Mission

Spacelab is a large, versatile laboratory carried in the bay of the Shuttle Orbiter. The first Spacelab mission dedicated entirely to life sciences is Spacelab-4. It is scheduled for launch in late 1985 and will remain aloft for 7d. All of the investigations are currently classified as "tentatively selected", with "final selection" and confirmation planned for late 1983. The 24 tentatively selected investigations have been combined into a comprehensive, integrated exploration of the effects of acute weightlessness on living systems. An emphasis is placed on studying physiological changes previously observed in manned space flight. This payload has complementary designs in both human and animal investigations in order to validate animal models of human physiology in weightlessness. The experimental subjects include humans, squirrel, monkeys, laboratory rats, two species of plants, and frog eggs. The primary scientific vascular adaptation to weightlessness (including postflight reductions in orthostatic tolerance and exercise capacity) and changes in vestibular function (including space motion sickness) associated with weightlessness. Secondary scientific objectives include the study of red cell mass reduction, negative nitrogen balance, altered calcium metabolism, supressed in vitro lymphocyte reactivity, gravitropism and phototropism in plants, and fertilization and early development in frog eggs. The rationale behind this payload, the selection process, and details of the individual investigations are presented in this paper.

[Perry TW and DH Reid Aviat Space Environ Med 54(12) 1123-1128. 1983.]

19 Cardiovascular Examinations and observations of Deconditioning during the Space Shuttle Orbital Flight Test Program.

During the first four flights of the space shuttle, cardiovascular data were obtained on each crewmember as part of the operational medicine requirements for crew health and safety. From monitoring blood pressure and electrocardiographic data, it was possible to estimate the degree of deconditioning imposed by exposure to the microgravity environment. For this purpose, a quantitative cardiovascular index of deconditioning (CID) was derived to aid the clinician in his assessment. Isotonic saline was then investigated as a countermeasure against orthostatic intolerance and found to be effective in partially reversing the hemodynamic consequences. It was observed that the space flight environment of re-entry might potentially be arrhythmogenic in atleast one individual.

[Bungo, MW and PC Johnson Jr Aviat Space Environ Med 54(11): 1001-1004.1983.]

20 Etiological factors in space motion sickness

We compared susceptibility to motion sickness during exposure to sudden-stop stimulation as a function of gravitoinertial force level. Our findings show that susceptibility is greatly enhanced, both

with eyes-closed and eyes-open, for zero-g and 2g conditions in parabolic flight compared with 1g test conditions. The change in susceptibility is likely related to three factors; alterations in vestibulo-ocular function which result from variations in gravitoinertial force level (28, 29); the altered pattern of otolithic activity resulting during variations in gravitoinertial force level; and the altered canal-otolith response synergies that result during exposure to gravitoinertial force levels greater or less than terrestrial levels. These factors are shown to be related to the etiology of space motion sickness and to the alterations in performance and vestibular function that are experienced by astronauts during re-entry. An explanation is also proposed for the decrease in susceptibility to motion sickness exhibited by the Skylab astronauts inflight and for some period postflight during exposure to cross-coupled angular accelerations (20).

[Lackner JR and A Graybiel. Aviat Space Environ Med 54(8) 675–681, 1983.]

IV HYPERBARIC OXYGEN THERAPY

21 Pharmacokinetics of pentobarbital under hyperbaric and hyperbaric hyperoxic conditions in the dog

High hydrostatic pressure has been shown to reverse the anesthetic effects of barbiturates. However, attempts to distinguish between two possible causes of this reversal, changes in drug disposition or changes in drug-receptor interaction, have not been reported. This study examined the possible effects of hyperbaria and hyperbaric hyperoxia on the distribution and clearance of pentobarbital in the dog. The drug was administered to six mixed-breed dogs as a 30mg/kg i.v. bolus at 1 ATA breathing air 6 ATA breathing air, and 2.8 ATA breathing 100% oxygen, with serial blood sampling for 12 h. Pharmacokinetic and statistical analyses showed no significant effects of hyperbaria or hyperbaric hyperoxia on the total plasma clearance, volume of distribution or elimination half-life. If pressure reversal of barbiturate anesthesia occurs of these pressures, changes in the disposition of the drug are not the causative factors.

[Kramer, WG, DW Welch, WP Fife, BN Chaikin, C Melock and DR Gross Aviat Space Environ Med 54(11); 1005-1008, 1983.]

22 A Five-year survey of hypobaric chamber physiological incidents in the Canadian Forces

Hypobaric chamber training forms an integral part of the Canadian Forces (CF) Aeromedical Training Programme (AMTP). There are four standard types of runs (Type I, II, III, IV) in which personnel are exposed to the reduced atmospheric pressures, ranging from ground level (GL) to 43,000 ft (13,106m) (0.16 ATA). Physiological incidents involving trapped gases in the hollow body organs resulting from exposure to these reduced atmospheric pressures are considered "normal" during chamber runs and are managed by well established procedures. Altitude decompression sickness (DCS) on the other hand is a potentially life-threatening disorder and must be managed accordingly. This report is a summary of all physiological incidents occurring in CF hypobaric chambers during the period 01 Jan 1977-31 Dec. 1981, and emphasizes significant trends in the incidence of altitude DCS at these chambers.

[Crowell, LB Aviat Space Environ Med 54(11), 1034-1036, 1983.]

23 Protection against Oxygen Toxicity by Intravenous Injection of Liposomes Containing Catalase and SOD

Survival of rats exposed to 100% oxygen was increased from 69.5 ± 1.5 to 118.4 ± 8.9h (X ± SEM) by intravenous injection of liposomes containing catalase and SOD. Rat lung catalase and SOD activities were increased 3.1 and 1.7 fold, respectively, 2h after intravenous injection of liposomes containing catalase and SOD. The increase in survival time was associated with a significant decrease in the effusion of fluid into the pleural cavity. Injection of liposomes containing catalase and superoxide dismutase (SOD) also significantly increased the average lung wet weight of rats exposed to 100% oxygen from 3.2 ± 0.2 to 4.8 ± 0.4g. Intravenous injection of liposomes containing buffer plus free catalase and SOD decreased the mean volume of pleural effusion 89% and had no significant effect on survival time. Free catalase and SOD injected in the absence of liposomes did not increase survival time or decrease pleural effusion volume of rats exposed to 100%

oxygen. Liposome-augmented lung catalase activity had a half life of 1.9h. These results suggest that pulmonary oxygen toxicity is directly related with an enhanced rate of production of reduced oxygen species. Liposomes containing antioxidant enzymes may also be used for modification of other pathologic states where oxygen radical formation is involved.

[Fed Proc 42(7): 1894, 1983. HBO Review, Vol. 4, No 3.]

24 Operational Safety in Clinical Hyperbaric Chambers

Clinical hyperbaric chambers have achieved a very fine safety record over the past several years. Hyperbaric medicine can be both safe and effective. However, the following considerations must be kept in mind.

1. Clinical hyperbaric chamber installation, operation and safety is highly complex and expensive undertaking and requires careful planning.

2. Use of shortcuts to operate a hyperbaric chamber with sub-standard, low-cost materials or without adequate system safety designs is dangerous and should not be permitted.

3. Attempts to operate a hyperbaric chamber without a well-trained and experienced crew invite disaster and should never be made.

4. Safe chamber operations—a physical plant that is designed, built and maintained in accordance with accepted principles. Operating and emergency prodedures that are understood and adhered to by all personnel. A trained and experienced crew that understands all aspects of proper patient selection, decompression procedures and chamber safety.

[Stephen D Reimbers, PE HBO Review, Vol 4, No 2 : 113, 1983.]

V AVIATION OPHTHALMOLOGY

25 A Concept on Optic Vestibular Coordination

The optic vestibular coordinations, in observations of optokinetic nystagmus elicited by combined applications of optokinetic and subminimal labyrinthine stimulations, were discussed from viewpoints of power spectrums. It was observed, optokinetic nystagmus closely resemble the 1/f fluctuation pattern and may be modified by the simultaneous presence of labyrinthine stimulation in the manner of the whitening of power spectrum in frequencies higher than 0.03 Herz. It may be suggested that in frequencies lower than 0.03 Herz the oculo-motor reflex is dominant and in frequencies higher than that the vestibulo-oculomotor reflex takes over and plays an important role in developing optokinetic nystagmus and stabilizing the retinal image.

[Tadahiko Watanabe, Acta Otolaryngol, Suppl. 393 : 72-7, 1983.]

26 The Incidence of Refractive Anomalies in the USAF Rated Population

A field survey was conducted to determine the percentage of US Air Force pilot and navigators required to wear corrective lenses. A random sample survey stratified by major air commands (MAJCOMS) was designed to retrieve the data. Data requested included initial (entry) visual acuity and refractive error and current visual acuity and prescription of glasses were required. Of, 2383 forms sent, 2183 were returned completed. Analysis indicated that almost 20% of pilots and 50 navigators are required to wear corrective lenses while flying. The percentages are consistent among MAJCOMS. Aircrew members who enter undergraduate pilot training with minus or plano refractive values are much more susceptible to develop myopia during their flying careers than those with plus refractive values.

[Provines, WF, WM Woessner, AJ Rahe and TJ Tradici, Aviat Space Environ, Med.54(7):622-627, 1983.]

VI AVIATION ENT

27 Aural Barotrauma and Surfactant

The concept is introduced that surfactant may be present in the Eustachian tubes as a release agent which would be absorbed to tissuse surfaces to facilitate their separation in maintaining aeration of the middle ear.

[Hills, BA, Aviat. Space Environ, Med. 54(11):1039, 1983]

VII EXERCISE PHYSIOLOGY

28 Cardiorespiratory response to exercise in men repeatedly exposed to extreme altitude

The ventilatory and heart rate responses to exercise were studied in four experienced high-altitude

climbers at sea level and during a 6-wk period above 4500m to discover whether their responses to hypoxia were similar to those of high-altitude natives. Comparison was made with results from four scientists who lacked their frequent exposure to extreme altitude. The climbers had greater VO2 max at sea level and altitude but similar ventilatory responses to increasing exercise. On acute hypoxia at sea level their ventilatory response was less than that of scientists. Their heart rate response did not differ from that of scientists at sea level, but with acclimatization the reduction in response was significantly greater. Alveolar gas concentrations were similar after acclimatization, but climbers achieved these changes more rapidly. The increase in hematocrit was similar in the two groups. It is concluded that these climbers, unlike high-altitude residents, have cardiorespiratory responses to exercise similar to those of other lowlanders except that their ventilatory response was lower and the reduction in their heart rate response was greater.

[Milledge JS, MP Ward, ES Williams and CR A Clarke. J. Appl. Physiol. Respirato. Environ. Exercise Physiol. 55(5): 1379-1385, 1983.]

29 Effects of Strength Training on 'G' Tolerance

The G tolerance of pilots flying modern, high performance fighter aircraft is crucial. Therefore, methods to increase 'G' tolerance are of vital importance. In this study, G tolerance was studied in a human centrifuge using simulated aerial combat maneouvers (ACM)—consisting of 15s periods of 4.5 and 7G until exhaustion—before and after 11 weeks of muscle strength training. The ACM-time in 11 fighter pilots was increased after this training by 39%. Gains were observed in knee extensor muscle strength during slow contractions by 17% and in anaerobic power by 14%. Aerobic performance and various muscle histochemical indices, as assessed from muscle biopsy samples obtained from m. vastus lateralis, were unchanged. Neuromuscular adaptation seems to be responsible for the increased muscle strength, as well as for the improved performance of the M-1 straining maneuver. This might explain the enhanced G tolerance.

[Tesch PA, Hjort and Ul Balldin. Aviat. Space Environ. Med. 54(8): 691-695, 1983.]

30 Maximal exercise at extreme altitudes on Mount Everest

Maximal exercise at extreme altitudes was studied during the course of the American Medical Research Expedition to Everest. Measurements were carried out at sea level (inspired O_2 partial pressure (PO_2) 147 Torr), 6300m during air breathing (inspired PO_2 49 Torr). The last PO_2 is equivalent to that on the summit of Mt. Everest. All the 6300m studies were carried out in a warm well-equiped laboratory on well-acclimatized subjects. Maximal O_2 uptake fell dramatically as the inspired PO_2 was reduced to very low levels. However, two subjects were able to reach an O_2 uptake of 1 L/min at the lowest inspired PO_2. Arterial O_2 saturations fell markedly and alveolar-arterial PO_2 differences increased as the work rate was raised at high altitude, indicating diffusion limitation of O_2 transfer. Maximal exercise ventilations exceeded 200 L/min at 6300m during air breathing but fell considerably at the lowest values of inspired PO_2. Alveolar CO_2 partial pressure was reduced to 7-9 Torr in one subject at the lowest inspired PO_2, and same value was obtained from alveolar gas samples taken by him at rest on the summit. The results help to explain how man can reach the highest point on earth while breathing ambient air.

[West JB; SJ Boyer, DJ Graber, PH Hackett, KM Maret, JS Milledge, RM Peters Jr, CJ Pizo, M Samaja, FH Sarnquist, RB Schoene and RM Winslow. J Appl Physiol Resplrat Environ Exercise Physiol 55(3) : 688-698, 1983.]

31 Power output and fatigue of human muscle In maximal Cycling exercise

We studied maximal torque-velocity, relationships and fatigue during short-term maximal exercise on a constant velocity cycle ergometer in 13 healthy male subjects. Maximum torque showed an inverse linear relationship to crank velocity between 60 and 160rpm, and a direct relationship to thigh muscle volume measured, by computerized tomography. Peak torque per liter thigh muscle volume (PT, N $m1^{-1}$) was related to crank velocity (CV, rpm) in the following equation : PT = 61.7 — 0.234 CV (r = 0.99). Peak power output was a parabolic function of crank velocity in individual subjects, but maximal power output was achieved at varying crank velocities in different subjects.

Fiber type distribution was measured in the two subjects showing the greatest differences and demonstrated that a high crank velocity for maximal power output. The decline in average power during 30s of maximal effort was least at 60 rpm (23.7 ± 4.6% of initial maximal power) and greatest at 140 rpm (58.7 ± 6.5%). At 60 rpm the decline in power over 30s was inversely related to maximal oxygen uptake (ml. min^{-1}) ($r = 0.69$). Total work performed and plasma lactate concentration 3 min after completion of 30s max. effort were similar for each crank velocity.

[McCartney, Neil, Goerge JF Heigenhauser and Normal L. Jones. J Appl Physiol Respirat Environ Exercise Physiol 55(1): 218-224, 1983.]

32 Alteration of Ischemic Cardiac Function in Normal Heart by Daily Exercise

Myocardial function, tissue blood flow, and heart rate measurements were studied during control and a 2-min occlusion of the left circumflex coronary artery in conscious dogs. These measurements were made in the same dogs before exercise in the untrained state (UT) and after a 4-wk treadmill exercise program in the partially trained condition (PT). Ultrasonic segment length gauges were used to measure myocardial function in the ischemic zone, defined by staining the myocardial tissue. Microspheres (15um), labelled with different isotopes, were used to measure the myocardial tissue flow in the normal and ischemic zones. Myocardial function in the ischemic zone of 20 dogs was reduced 71 ± 6% in the UT condition; however, after PT, the percent reduction in segment length function was only 33 ± 4% during occlusion. During occlusion, an increase in heart rate of 46 ± 7% in the UT condition was observed; yet after PT heart rate increased only 19 ± 5%. In 5 UT dogs with heart rate held constant (150 beats/min), the decrease from control in tissue blood flow to the ischemic zone in the subendocardium during occlusion was 60 ± 7%. After PT, the decrease from control in tissue blood flow in the same dogs was 34 ± 6%. These data indicate that the improved myocardial function during ischemia was a result of the improved coronary collateral blood flow into the ischemic zone after PT.

[Delvin R Knight and H Lowell Stone J Appl Physiol 35(1): 62-60, 1983.]

33 Dynamics of Cardiac output and Systolic Time Intervals in Supine and upright exercise

Transient and steady-state responses of stroke volume (SV), heart rate (HR), cardiac output (Q), left ventricular ejection time (LVET), pre-ejection period (PEP) and the ratio of LVET to PEP during bicycle exercises of 50 and 100W were studied in four healthy male subjects in supine and upright postures. A computer-based system in which impedance cardiography was incorporated served to determine the above parameters on a 10s interval basis. SV remained almost unchanged in response to exercise in a supine posture, whereas it increased significantly in an upright posture, although the individual differences among subjects were found to be large. The half-response times of variables to a step work load were determined. An approximate accordance was observed among the response times for HR, Q and LVET/PEP. There was an inverse relationship between LVET and HR, the slope of which was found to be steeper in the supine posture than in the upright posture, reflecting the difference between the SV responses in both postures. LVET fell shortly after the cessation of exercise despite the decreasing HR. In as much as the paradoxical reduction of LVET was also found in the case when SV remained unchanged in response to exercise, no changes in SV can be the cause thereof. Thus, a transient increase in ejection rate, which is due to either the increased myocardial contractility or decreased peripheral vascular resistance may be responsible for the phenomenon.

[Miyamoto Y, J Higuchi, Y Abe, T Hiura, Y Nakazono and T Mikami. J Appl Physiol Respirat Environ Exercise Physiol 55(6): 1674-1681, 1983

VIII CLINICAL AVIATION MEDICINE

34 Coronary bypass Surgery: Military Aviation Medicine Perspective

Close examination of medical and surgical literature shows that significant proportions of patients undergoing coronary artery bypass surgey do not achieve an angina-free state; of those who do, a large proportion will relapse over the ensuing 4-6 years. It is apparent from the literature that coronary bypass surgery does not reverse the underlying processes of atherosclerosis. Therefore, aviators who

have undergone this surgery are at increased risk for angina and other unpredictable coronary events should not be favourably considered for continued military flying duties.

[Wehrly, DJ Aviat Space Environ Med 54(11) : 1043-1046, 1983.]

35 Return to Flying after Head Injuries : A Review

The pathology of head injury is discussed in relation to severity and to the change of recovery. Return to flying status, then, depends mainly on the the hazard of subsequent post-traumatic epilepsy (PTEP). Assessment of the threat of PTEP is based on the incidence of onset of PTEP within 1 year (75%) and 2 years (85%) of head injury in those who will develop the complication. Clear risk markers which increase the chances of later PTEP include past history of febrile convulsions, family history of epilepsy, "early" PTEP, intracranial haematoma, and depressed skull fracture. The persisting risk in depressed skull fracture is itself adversely affected by early epilepsy, dural laceration, focal neurological signs, and post-traumatic amnesia longer than 24 hours. Permanent prohibition on grounds of inititial severity can rarely be warranted. A cautious open-minded assessment of each individual by AMEs with specialist referral where indicated is recommended.

[Firth JL Aviat Space Environ Med 54(7) : 603-606, 1983.]

36 Age Related changes in Lung Functions In Indian Servicemen.

A cross-sectional study of active Indian servicemen of various age groups (20-25, 26-30, 31-35, 36-40, 41-46, 46-50, 51-55, 56-60 and 61-70year) was conducted to assess the age related changes in lung functions and also to compare such changes with that of other populations. Comparison in terms of percentage changes as well as in absolute units to a standardised height was made between groups and with reported data on other populations. The results showed gradual and steady decline in most of the lung volumes and capacities (FVC, FEV, ERV, IC and MVV) as age advanced, but this was significant from 40 year onwards. In general, lung volumes and capacities were smaller in Indian service men of all age groups, but the age related changes were of the same magnitude as compared to that of other populations.

[Lazar Mathew, J Sengupta, SC Lakhera and CV Raman, Indian J. Med. Res. 79, Apr 1984, pp-529-537.]

37 Minimal Coronary Artery Disease and continuation of Flying Status

Prior to 1976, any degree of coronary artery disease, including intimal roughening, was disqualifying for flying status in the United States Air Force. A consideration to continue flying duties for aviators with minimal coronary disease must recognize that the disease is progressive, with known lesions worsening and new lesions forming in areas previously free of disease. However the five year mortality for subjects with equal to or less than 30% lesions (2% mortality) is less than the mortality for apparently healthy males of similar age who have not had their coronary anatomy defined by angiography. However, the mortality rate for 30% lesions is three times greater than that for individuals with known normal coronary arteriograms.

The USAF School of Aerospace Medicine (USAFSAM) instituted a minimal coronary artery disease study group in 1976. This study group returned aviators to flying status, if no single lesion was greater than 30% and the aggregate (sum) of lesions was not greater than 50%. Subjects with symptoms of ischemia, ECG and/or angiographic evidence of myocardial damage, serious arrhythmias, left ventricular dysfunction, or any degree of left main coronary disease were all excluded from this study group. A total of 12 aviators have now been returned to flying status with minimal disease. Of the 12, 5 have been recatheterized at a mean interval of 30 months, and 2 have been disqualified due to disease progression. The other 3 subjects have shown no progression. No cardiac events have occurred in any of the 13 subjects.

A separate natural history study of 15 asymptomatic USAF subjects with 30 to 50% lesions has been accomplished. These 15 subjects have been found to be free of events of a mean follow-up of 55 $\pm$ 26 months. An additional USAFSAM review has ascertained the natural history of lesions less

than 30% in individuals drawn from the USAFSAM catheterization file from prior years. Of 31 patients with lesions less than 30%, 25 have been followed up for a mean period 62 ± 23 months. One subject in this group suffered a myocardial infarction at 77 months after the diagnosis.

We conclude that aviators with no lesions greater than 30% and no aggregate of lesions greater than 50% can be safely returned to flying status, provided that repeat cardiac catheterizations are performed at one to three year intervals, depending upon the results of annual evaluations which include a thorough risk factor analysis, treadmill testing, complete non-invasive evaluation and nuclear imaging studies.

[McGranahan, GM, Jr, JR Hickman, Jr GS UHL, MA Montgomery and JH Triebwasser Aviat Space Environ Med 54(6): 548-550, 1983.]