Abstracts of Current Aviation Medicine Literature

I. ACCELERATION AND SPACE PHYSIOLOGY

1. Modification of cardiac function by synchronised oscillating acceleration.

A. BHATTACHARYA, C. F. KNAPP, E. P. McCUTCHEON, & J. M. EVANS. *J. Appl. Physiol. : Respirat. Environ. Exercise Physiol.* 47: 612-620, 1979.

The sensitivity of selected cardiovascular (CV) responses to the physical stressor of External whole-body oscillating Acceleration Synchronised with the Electrocardiogram (EASE) was analyzed in 8 chronically instrumented tranquilized dogs. A sinusoidal acceleration wave form was imposed on the supine animals along the spinal ($\pm G_z$) axis at a constant amplitude of ± 0.75 G, and a frequency equal to the paced-heart frequency (2 3 Hz). When the peak force was positive in early systole, and a negative in early diastole, changes in myocardial oxygen consumption (MVo_2, +8%), mean coronary flow (MCF, +8%), stroke volume (SV, +15%), cardiac work (CW, +19%) and the time derivative of left ventricular pressure (dp/dt, +18%) were minimal in comparison to nonoscillatory control values When the peak force was positive in early diastole and negative in late diastole and early systole, changes in MVo_2 (41%), MCF (+33%), SV (+33%), CW (+50%), and dp/dt (+31%) were maximal. Thus the capability of EASE to produce a range of desired sustained CV responses provides a basis for its potential diagnostic/therapeutic applications.

2. Simulated weightlessness : effects on bioenergetic balance.

J. P. JORDAN, H. A. SYKES, J. C. CROWNOVER, C. L. CHATTE, J. B. SIMMONS II, & D. P. JORDAN. *Aviation Space Environ. Med.* 51 : 132-136, 1980.

As a prelude to a flight experiment, an attempt was made to separate energy requirements associated with gravity from all other metabolic needs. The biological effects of weightlessness were simulated by suspending animals in a harness so that antigravity muscles were not supporting the body. Twelve pairs of rats were allowed to adapt to wearing a harness for 5 d. Experimental animals were then suspended in harness for 7 d, followed by recovery for 7 d. Control animals were harnessed but never suspended. VO_2, VCO_2 and rate of CO_2 expiration from radio-labeled glucose were monitored on selected days. Food intake and body mass were recorded daily. Metabolic rate decreased in experimenta animals during 7 d. of suspension and returned to normal during recovery. Although some of the metabolic changes may have related to variation in food intake simulated weightlessness appears to directly affect bioenergetic balance.

3. Radiographic comparison of human lung shape during normal gravity and weightlessness.

D. B. MICHELS, P . J. FRIEDMAN, & J. B. WEST. *J. Appl. Physiol. : Respirat. Environ. Exercise Physiol.* 47 : 851-857, 1979.

Human lung shape was measured during zero gravity (OG) to decide whether the normal vertical regional differences in ventilation are due directly to distortion of the elastic lung by its own weight, or instead, due indirectly to the effect of gravity on the shape of the rib cage and diaphragm. This was important because we previously established that weightlessness virtually abolishes the normal topographical inequality of ventilation (J. Appl. Physiol. : Respirat. Environ. Exercise Physiol. 45 : 987-998, 1978). Chest radiographs were made after 10s of a weightless flight trajectory aboard a NASA-Ames Research Center Learjet in both posterior-anterior and left lateral projections on five seated volunteers at residual volume, functional residual capacity, and total lung capacity. Lung shape was assessed by measuring lung heights and widths in upper, middle, and lower lung regions. We found no significant differences between any of the normal gravity (1 G) and O G measurements, although there was a slight tendency for the lung to become shorter and wider

at O G (mean changes generally less than 3% or about 0.5 cm). By contrast, Grassino et al (J.Appl. Physiol. 39:997-1003, 1975) found no change in the vertical distribution of ventilation by moving the abdomen in or out. We conclude that gravity produces the topographical distribution of ventilation in the upright human lung by distorting the elastic lung tissue within the chest rather than by altering the shape of the rib cage and diaphragm

II. BIO-MEDICAL ENGINEERING

4. An ultrasonic plethysmograph for space flight applications.

P. K. BHAGAT, J. F. LAFFERTY, D. BOWMAN, & M. P. KADABA *Aviat. Space Environ. Med.* 51 : 185-188, 1980.

The study and evaluation of cardiovascular deconditioning during space flight impose unique requirements on the limb volume measuring system (LVMS). The LVMS must operate in both earth and zero gravity environments, be simple to calibrate, respond to both small and large changes in limb volume, and be largely insensitive to humidity, ambient temperature, and pressure variations. This study reports the development of an ultrasonic plethysmograph based on the transit time measurement principle which meets the space-imposed requirements. It consists of a pulse generator, a pulse receiver amplifier, a voltage comparator, synchronous pulse generator, an elapsed time counter, and the transmit and receive piezoelectric crystals resonant at 2 MHz and of 3 mm diameter. The transit time for an ultrasonic pulse to propagate across a limb cross section is computed in a digital fashion using a 32 MHz clock. This system was compared with a Whitney strain gauge for dynamic system response using a 50 torr venous occlusion. The ultrasonic plethysmographic results were comparable both in accuracy and sensitivity to that of the Whitney strain gauge. The developed ultrasonic system using a pair of crystals placed on opposite side of a limb does not restrict or confine the limb movement in any manner. This system is expected to provide a more accurate assessment of limb volume changes under space conditions.

5. Estimation of the hydromotive source pressure from ejecting beats of the left ventricle.

K. SUNAGAWA, A. YAMADA, Y. SENDA, Y. KIKUCHI & M. NAKAMURA. *IEEE Trans. Bio-Med. Engg. BME*-27 :299-305, 1980.

The relationship between peak isovolumic developed pressure (P_{max}) and end diastolic volume can indicate ventricular contractility. Therefore, we propose a practical method to estimate (P_{max}) from the pressure curve of an ejecting contraction of left ventricle. For the estimation, we first considered the left ventricle a linear time varying hydromotive pressure source (HMP (t)) coupled in series with an internal impedance. To formulate the HMP (t) we Fourier analyzed isovolumic pressure curve obtained under various conditions in six dogs. Since the higher order harmonics were found to be very small, HMP (t) could be described simply as

$$HMP(t) = + \tfrac{1}{2} P_{max} \cdot (1 - \cos wt) + Pd$$

where Pd = end diastolic pressure and $w = 2/T$ in which T is duration of contraction. Finally HMP (t) for ejecting contraction was estimated by fitting the equation to the isovolumic portions of the pressure curve of ejecting contractions. The estimated P_{max} values correlated well with observed P_{max} values ($r = 0.951$, $N = 24$). We conclude that the proposed technique can be used to estimate P_{max} from a single ejecting beat.

6. Indirect measurement of instantaneous arterial blood pressure in the human finger by the vascular unloading technique.

K. YAMAKOSHI, H. SHIMAZU, & T. TOGAWA. *IEEE Trans. Biomed. Engg. BME*-27 : 150-155, 1980.

For the indirect measurement of beat-to-beat systolic and diastolic pressure in the human finger, a new hydraulic servocontrol system was designed to maintain the vascular volume in the unloaded state. The servocontrol system consists of a compression chamber equipped with an occluding cuff and a photoelectric plethysmograph, and electromagnetic shaker, and a volume servo circuit. The shaker connected to a diaphragm actuator is used for controlling the cuff pressure. The vascular volume change in the finger is detected by the photoelectric plethysmograph. The plethysmographic signal is fed into the servo circuit to control the cuff pressure, which is clamped at a proper value corresponding to the unloaded vascular volume. At this state the controlled cuff pressure follows the intraarterial pressure. The accuracy of this method

was evaluated using an in vitro vascular model of the finger. Comparisons with direct measurement were carried out successfully in four normotensive and six hypertensive subjects.

7. Non-invasive measurement of hematocrit by electrical admittance plethysmography technique.

K. YAMAKOSHI, H. SHIMAZU, T. TOGAWA & M. FUKUOKA. *IEEE Trans. Biomed. Engg.* BME-27 : 156-161, 1980.

A new method for the noninvasive measurement of hematocrit by means of electrical admittance plethysmography was developed. The principle of this method is based on the evidence that the electrical admittance variation in a finger segment immersed in an electrolyte solution disappears when the resistivity of the solution is equal to that of the blood flowing into the segment. Thus, the blood resistivity and, therefore, the hematocrit can be noninvasively determined from the electrolyte resistivity. The hematocrit values determined by this method (Hct_y) were compared with those by the capillary method (Hct_c) in 16 subjects ; the linear regression equation was $Hct_y = 1.02\ Hct_c - 0.35$ with a correlation coefficient $r=0.981$.

8. Spectrophotometric monitoring of arterial oxygen saturation in the fingertip.

I. YOSHIYA, Y. SHIMADA & K. TANAKA. *Med. Biol. Eng. Comput.* 18 : 27-32, 1980.

A noninvasive oximeter that analyses the oxygen saturation of arterial blood in the fingertip is described. The light, after attenuating the infrared portion to avoid thermal injury, is applied to the fingertip through an optical transmitter made of glass fibres. The transmitted light is transferred to an optical reception system where a spectrophotometric determination of oxygen saturation is performed. The determination is performed by considering only the change in the attenuation of light caused by the inflow of arterial blood into the fingertip. The correlation between the oxygen saturation measured with the present instrument (y) and that with the blood gas method (x), was $y=0.907x+8.592$ with a standard deviation and a correlation coefficient of 0.135% and 0.983, respectively. The reproducibility was assessed in a healthy subject by measuring the oxygen saturation repeatedly 60 times. The mean saturation was 95.82 $\pm$0.675% (mean + standard deviation). The instrument has been useful in monitoring arterial oxygenation in patients with respiratory failure in our intensive-care unit. One of the disadvantages of the instrument is that the measurement is interrupted when the fingertip changes its position against the light beam.

III. CLINICAL AVIATION MEDICINE

9. Verapamil in chronic stable Angina : A controlled study with computerised multistage treadmill exercise.

V. BALASUBRAMANIAN, A. LAHIRI, R. PARAMASIVAN & E. B. RAFTERY. *Lancet* i : 841-848, 1980.

The efficacy of verapamil (360 mg daily) in the treatmennt of patients with chronic stable angina pectoris was compared with placebo. 28 patients were studied in a placebo-controlled double blind crossover trial of 2 weeks each and afterwards on long-term verapamil. Exercise tests were performed at the end of the placebo period, and after 2 weeks and 4 weeks on verapamil. On placebo, angina developed in all 28 patients during treadmill tests; the mean exercise time was 6.6 min (SEM $\pm$ 0.5 min). The mean exercise time increased to 9.2 ($\pm$ 0.8) min at 2 weeks, and 11.2 ($\pm$8) min at 4 weeks on verapamil. In 15 and 20 patients out of the 28 angina did not develop during treadmill exercise at 2 and 4 weeks respectively. Trinitrin consumption also decreased. There was a significant improvement in ST-segment changes. Constipation (in 7 patients) and reversible PR-interval prolongation (in 2 patients) were the only side effects. No patient had clinical sign of heart-failure. Thus verapamil (360 mg daily) may be useful in the management of chronic stable angina.

10. Glucose intolerance and aging : Evidence for tissue insensitivity to insulin.

R. A. DEFRONZO. *Diabetes* 28 : 1095-1101, 1979.

The relative contribution of impaired insulin secretion and of tissue sensitivity to insulin to the glucose intolerance of aging were examined in 84 healthy volunteers, ranging in age from 21 to 84 yr, employing the hyperglycemic and euglycemic insulin clamp techniques, respectively.

Hyperglycemic Clamp: The blood glucose concentration was acutely raised and was maintained at 125 mg/dl above basal levels for 2 h. Since the glucose concentration was held constant, the glucose infusion rate was an index of glucose metabolism (M). In young subjects, M averaged 9.48 ± 0.40 mg/kg min compared with 6.48 ± 0.28 in old subjects ($P < 0.001$). When all subjects were considered together, a progressive age-related decline in M was observed ($r = -0.665$, $P < 0.001$). The plasma insulin response (I) was biphasic, with an early burst within the first 6 min, followed by a phase of gradually increasing insulin concentration. No difference in either the early or late phases of insulin secretion was observed between young and old subjects. Consequently the M/I (X100) ratio, an index of tissue sensitivity to endogenous insulin, decreased from 14.90 ± 1.101 to 10.98 ± 0.81 mg/kg min per μU/ml ($P < 0.005$).

Euglycemic Insulin Clamp: The plasma insulin concentration was acutely raised and was maintained at about 100 μU/ml above basal levels by a primed continuous infusion of insulin. The blood glucose concentration was held constant at the basal level by a variable glucose infusion. (M/IX 100), again, was a measure of tissue sensitivity to insulin (exogenous) and was decreased in old (4.95 ± 0.31 mg/kg min per μU/ml) versus young (6.95 ± 0.45) subjects ($P < 0.001$). Hepatic glucose production was measured with tritiated glucose during the euglycemic clamp study; it declined similarly in young (to 0.13 ± 0.005 mg/kg min) and old (to 0.09 ± 0.03 mg/kg min) subjects.

In conclusion, under the present experimental conditions, employing intravenous glucose and/or insulin, impaired tissue sensitivity to insulin is the primary factor responsible for the decrease in glucose tolerance observed with advancing age. Since hepatic glucose production is normally suppressed by insulin in old subjects, the site of insulin resistance must reside in peripheral tissues. Beta cell response to glucose, as determined by the hyperglycemic clamp technique, cannot account for the age-related decline in M.

11. Alcoholic heart disease. Editorial.

Lancet, i: 961–962, 1980.

Alcohol can cause fatty infiltration, fatty degeneration, chronic interstitial myocarditis, hypertrophy and dilatation of the heart. Alcoholic heart disease may present as arrhythmia, congestive heart failure or rarely with beri beri heart disease. A stage before heart failure can be detected because systolic time intervals become abnormal, LVEDP increases abnormally with high stress. Sudden death in such patients is relatively common. The mechanism involved is possibly cardiac muscle damage because of enzymatic interference and protein synthesis inhibition. It probably takes 10 years of high alcohol intake to produce serious damage.

12. Control of blood pressure by carotid sinus baroreceptors in human beings.

G. MANCIA, A. FERRARI, L. GREGORINI, G. PARATI, G. POMIDOSSI, & A. ZANCHETTI. *Am. J. Cardiol.* 44: 895–902, 1979.

Most techniques available for studying arterial baroreflexes in man are unsuitable for analysis of the primary function of these reflexes, that is, arterial pressure control. Such control can be evaluated during increases and decreases in carotid baroreceptor activity obtained with a variable pressure neck chamber. This study reviews some technical aspects of the technique and describes the influence the carotid baroreceptors exert on arterial pressure in normotensive subjects and in those with essential hypertension. Major differences can be found in the two populations. In normotensive subjects the change in blood pressure is greater with a decrease than with an increase in baroreceptor activity. The former response becomes progressively less and the latter progressively greater with increasingly high blood pressure, so that in severe hypertension the reflex shows an asymmetry opposite to that in normotensive subjects, the change in blood pressure being greater with an increase than with a decrease in baroreceptor activity. These results imply that in human hypertension the carotid baro reflex mechanism controlling blood pressure undergoes a very marked resetting but shows no major reduction in sensitivity. In hypertensive subjects cardiac output and peripheral resistance were also measured. It was found that the depressor response to an increase in carotid baroreceptor activity depends on both a reduction in cardiac output and a systemic vasodilatation. However, peripheral vasoconstriction is the only factor accounting for the pressor response to reduced baroreceptor activity.

13. Effects of a postexercise sauna bath on ECG pattern and other physiologic variables.

A. M. PAOLONE, W. T. LANIGAN, R. R. LEWIS & M. J. GOLDSTEIN. *Aviat. Space Environ. Med.* 51 : 224-229, 1980.

In an attempt to determine the risk of sauna bathing after heavy exercise, the responses of 10 clinically normal adult males (mean age 44 years) were observed and recorded for 25 min. during recovery from a standard, heavy exercise task on two separate days. On one of the 2d, recovery was interrupted by a 10-min. (min 6-16) exposure to intense, dry heat (70-74°C, 3-6% R H.). The higher heart rate and rectal temperature during the treatment (min 6-16) and post treatment (min 16-26) phases on the experimental day were indicative of the expected response to the heat stress. Systolic blood pressure did not differ on experimental and control days during either phase of recovery, while diastolic blood pressure decreased during the heat exposure. Double product was higher during treatment and post-treatment phases on the experimental day indicating an increased myocardial O_2 need in response to the heat. ECG(CM_5) changes were limited to increased J-point displacement during the treatment phase on the experimental day, with S-T segment flattening (0.08 s) in one case, and prolongation of the Q-T interval (corrected for rate) with reduction in T-wave amplitude. The prolongation of electrical systole and T-wave flattening were not observed during exercise at comparable and higher heart rates and may be associated with reduced subendocardial perfusion. We concluded that sauna bathing of short duration after exercise represents a tenable risk for clinically normal males.

14. A physiological body-cooling unit for treatment of heat stroke.

J. S. WEINER & M. KHOGATI. *Lancet* i : 507-509, 1980.

A cooling bed is devised to attain a high rate of evaporative cooling by spraying patients with atomised water spray at 15°C and warm air which reached the body surface at 30°-35°C at a flow rate of 0.5 m sec^{-1}. With this, the skin temperature was maintained at 32-33°C. The time taken by this method to bring core temperature down from 39.5°C to 37.5°C was 6.5 minutes as compared to about 20 mins by cold air spray or water bath at 15°C. The mean cooling rate was 200 K cals in 6.5 mins.

IV. ENVIRONMENTAL, AVIATION AND EXERCISE PHYSIOLOGY

15. Dynamics of ventilation, heart rate, and gas exchange : sinusoidal and impulse work loads in man.

H. K. BAKKER, R. S. STRUIKENKAMP, & G. A. De VRIES. *J. Appl. Physiol : Respirat. Environ. Exercise Physiol.* 48 : 289-301, 1980.

Dynamic characteristics of ventilation, heart rate, and gas exchange in response to sinusoidally varying work loads were analysed in four male subjects, exercising in the upright position on a bicycle ergometer. Mean work-load and sinusoidal amplitude were about 1.5 and 0.9 W/kg. fat-free mass, respectively. Seven different frequencies were used, the periods ranging from 12 to 0.75 min. To further investigate the linearity of the variables under study, 10-s impulse loads were also applied to three of the four subjects. Harmonic analysis of the sine-wave data and comparison of the sine-wave fundamentae responses with the impulse frequency responses showed that only O_2 uptake behaves in a linear fashion. Ventilation and CO_2 production showed quasi to non-linear behaviours, whereas the responses of heart rate and alveolar partial pressures were clearly dependent on the type of forcing used. By means of mathematical parameter identification techniques, it was found that the individual frequency responses of O_2 uptake could be almost completely described by a four parameter transfer function with parameter values showing second-order underdamped to critically damped dynamics.

16. Plasma volume changes during rest and exercise in different postures in a hot humid environment.

F. Z. DIAZ, D. R. BRANSFORD, K. KOBYASHI, S. M. HORVATH, & R. G. McMURRY. *J. Appl. Physiol. : Respirat. Environ Exercise Physiol.* 47 : 798-803, 1979.

Plasma volume shifts were investigated in five male subjects who rested and exercised in the upright low-sit, and supine postures in a hot humid environment (49.5°C, 28.9 Torr). The resting and exercise periods were each 45 min in duration. Weight losses during rest were 0.3% with an additional weight loss of 1.1% during exercise. During exercise subjects worked at either 360 or 540 kpm. min^{-1} in each of

three postures. Each experiment was preceded by a 30-min control period in the supine posture at an ambient temperature of 22°C. At rest plasma volume was reduced 17.3% in the upright, 9.0% in the low-sit, and 2.2% in the supine postures (using the end of the supine rest as the zero reference point). Supine exercise resulted in a plasma volume decrease of 11%, the low-sit 7.1%, and the upright 2.7%. The total reduction in plasma volume during the rest and exercise period was 20% in the upright, 16.1% in the low-sit, and 13.3% in the supine. No significant differences in plasma volume shifts were observed between the high and low work loads. The results indicate that the plasma volume shifts observed during rest and exercise in the heat are qualitatively similar to those observed in a cool environment.

17. Circadian performance differences between morning and evening 'types'.

J. A. HORNE, C. G. BRASS & A. N. PETTITT. *Ergonomics* 23 : 29–36, 1980.

Two groups of subjects identified as either morning (M) or evening (E) types, determined by a self-assessment questionaires, were measured for performance efficiency at a simulated production-line inspection task given for 15 sessions at different times of the waking day. Systematic fatigue and practice effects were minimised by a random presentation of these sessions over a series of days. Although there were no significant within-or between-group changes with circadian trends for items erroneously rejected, significant differences were apparent with the number of items correctly rejected. M types' correct rejection levels were significantly better than E types' in the morning, whereas they were worse during the evening. Whilst E types showed a steady improvement throughout the day, M types showed a general decline. A post-lunch dip in performance was quite evident for M types, but not for E types. In addition, the circadian trends in correct rejection levels and body temperature were highly positively correlated for E types, but a significant negative relationship between these parameters was found for M types. These findings are discussed.

18. Reflex control of the heart.

P. SLEIGHT. *Amer. J. Cardiol.* 44 : 889–894, 1979.

The control of heart rate by the arterial baroreceptors and the evidence that these reflexes are impaired in pepole with raised arterial pressure are reviewed. The results with the Oxford phenylephrine test are compared with those using neck cuff methods as the stimulus. It is concluded that the neck cuff method gives useful information about heart rate changes but is less reliable when blood pressure is used as the response, because the relatively slow changes in arterial smooth muscle tone are probably the result of the differing information sensed by the carotid and aortic receptors. Contrary to the diminution in baroreflex gain seen with the phenylephrine methods, M a n c i a and his collegues in Milan (using a neck cuff) report increased response of blood pressure in patients with hypertension. The evidence for the existence of neurogenic "deafferentation" hypertension is reviewed ; it is concluded that denervation hypertension does exist, despite the experiments of Cowley and Guyton. It is possible that some cases of human essential hypertension may be the result of arterial baroreceptor partial denervation caused by stiffening of the baroreceptor areas by arteriosclerosis.

19. Effect of high haematocrit on alertness.

J. R. WILLISON, D. J. THOMAS, G H. du BOULAY, J. MARSHALL, E. A. PAUL, T. C. PEARSON, R. W. ROSS RUSSELL, L. SYMON, & G. WETHERLEY-MEIN. *Lancet i* : 845–848, 1980.

Patients with high-normal or above-normal haematocrit were found to have impaired alertness when compared with a control group matched for age and occupation. On retesting the controls had improved alertness scores attributable to a practice effect ; but the patients, when retested after reduction of haematocrit by venesection, had improved significantly more than the controls. Improvement in alertness correlated very well with the increase in cerebral blood flow which followed venesection. Levels of venous haematocrit that are generally accepted as normal may not necessarily be optimum.

20. Heat stress exposure of aerial spray pilots.

B. E. D. GRIBETZ, M. K. RICHTER & M. GORDON. *Aviat. Space Environ. Med.* 51 : 56-60, 1980.

Heat stress (WBGT index) in the cockpits of agricultural spray pilots, and its physiological and

subjective effects, were measured for 9 pilots flying in hot weather for a large Israeli aerial spray company. There was concern that heat exposure may be one of the factors involved in a recent increase in the fatal and non-fatal crash rate among Israeli spray pilots. WBGT index calculations were based on sequential cockpit wet bulb, dry bulb, and globe temperatures read when aircraft landed. The WBGT was always above 25°C and exceeded 26.7°C in 70% of observations. In pilots, a daily weight loss of 0.6-1.2% of total body weight was usual, as were rectal temperature increases of 0.5°C. Daily water intakes ranged from less than 100 ml to 2000 ml per workshift. Questionnaires indicated that 42 of 45 pilots said they would drink more fluids if they were provided between flights by ground crews. An unresolved problem was whether conventional threshold standards for heat exposure were set at levels that may produce insidious impairments in pilot psychomotor performance. Cockpit air cooling is suggested as a measure for preventing heat stress in hot climates. However, appropriate filter technologies would be needed to prevent pesticide exposures during flight. Engineering and other measures to prevent heat stress and dehydration should rank high as part of a comprehensive program to protect the health and performance levels of agricultural spray pilots.

V. HIGH ALTITUDE PHYSIOLOGY

21. Quantification of bubbles formed in animals and man during decompression.

E. O. BELCHER. *IEEE Trans. Bio-Med. Engg.* BME-27 : 330-338, 1980.

Bubbles that form in the tissues and bloodstreams of animals and humans undergoing a compression/decompression sequence are considered precursors to symptoms of decompression sickness. A prevalent method used to monitor these bubbles is to ensonify the pulmonary artery or inferior vena cava with ultrasound and listen for Doppler shifted signals in the reflected and scattered sound.

We have developed a system that automates the detection and quantification of bubble signals present in the Doppler flow noise. The system contains a sensitive and accurate algorithm that is adaptive to the highly varying noise background. The system is easy to use and self-documenting.

22. Blockade of the different enzymatic steps in the synthesis of brain amines and memory (CAR) in hypobaric rats treated and untreated with L. Dopa.

F. BOISMARE, M. Le PONCIN-LAFITTE & J. R. RAPIN. *Aviat. Space Environ. Med.* 51 : 126-128, 1980.

L. Dopa associated with an extracerebral inhibitor of dopa-decarboxylase is able to protect the rats against the deleterious effects of hypobaric hypoxia on a conditioned avoidance response. L. Dopa loses its protective effect against hypoxia if tyrosine hydroxylase, dopadecarboxylase, or dopamine beta hydroxylase is previously blocked. L. Dopa's protective effect must therefore be due to an indirect action on the endogenous catecholamine metabolism.

23. Investigation of flow rates of oxygen systems used in general aviation.

J. W. BRANTIGAN. *Aviat. Space Environ. Med.* 51 : 293, 1980.

Flow rates of two general aviation constant flow oxygen systems were tested at altitude using a Ted Nelson flow meter and using timed flow into a volume bag. Contrary to the manufacturer's claim, the Rajay SK-10 system was not altitude compensated and provided a flow rate of about 2.2 l/min independent of altitude. The Scott system provided the stated 2.5 l/min with the standard connector and 8 l/min with the "green" connector, the significance of the color code being not widely understood. The conclusion of the 1975 report on oxygen mask performance should be revised according to these flow data. The Ted Nelson flow meter performed within its stated accuracy.

24. Body fluid compartments in human during acute high-altitude exposure.

S. C. JAIN, J. BARDHAN, Y. Y. SWAMY, B. KRISHNA, & H. S. NAYAR. *Aviat. Space Environ. Med.* 51 : 234-236, 1980.

Body fluid compartments were studied in a group of sea level residents at sea level and during 12d of acute exposure to an altitude of 3,500M. Measurements of total body water and extra cellular water were done on the third and 12th days of exposure, while plasma volume was measured on 12th day only.

The intracellular water, blood volume, and red cell mass were computed from the above parameters. Total body water and extracellular water decreased progressively, the decrease being 4.7% ($p < 0.001$) and 6.0% ($p < 0.05$) respectively, on the 12th day. Plasma volume and blood volume decreased significantly with a slight increase in red cell mass. Intracellular water, computed from total body water and extracellular water, decreased by 4.3% on 12th day. This study suggested hypohydration on acute altitude exposures.

25. Intravascular hemolysis in actue mountain sickness.

R. E. LOVLIN, S. ROWLANDS, G. R. KINNEAR, & E. RAST. *Aviat. Space Environ. Med.* 51 : 271-272, 1980.

A case of acute mountain sickness (AMS) is described of a fit young man while on a climbing expedition in Mexico. The subject exhibited intravascular hemolysis in addition to normal AMS symptoms. This case is reported in the hope that others will look for and report the presence or absence of intravascular hemolysis on climbing expeditions.

26. Permeability changes in cerebral, iridic, and retinal vessels during experimental decompression sickness in the rat.

T. TERVO, J. LEHTOSALO, V. P. LEHTO, M. HEINO, I. KANTOLA & L. A. LAITENEN. *Aviat. Space Environ. Med.* 51 : 137-141, 1980.

An investigation has been made of the effect of acute decompression sickness upon the permeability of the cerebral, iridic and retinal vessels of the rat, with sodium-fluorescein as intravenous tracer. No permeability changes were observable during the first 15 min subsequent to decompression, following exposure to 5.1 bar for 50 min. Focal leaky areas were found in the brain parenchyma after exposures to 5.1 bar for 120 min. Although sodium-fluorescein partially permeated the pial vessels in controls, the treatment in a hyperbaric chamber seemed to increase the diffusion of the tracer from the pia into the cerebral cortex. Nevertheless, both the iridic and retinal vessels remained "tight". The factors which increase the permeability of microvasculature in brain and possible reasons for the negative results obtained with the iris and retina in decompression sickness are discussed.

27. Chronic propranolol treatment blunts right ventricular hypertrophy in rats at high altitude.

N. F. VOELKEL, I. F. McMURTRY, & J. T. REEVES. *J. Appl. Physiol. : Respirat. Environ. Exercise Physiol.* 48 : 473-478, 1980.

Chronic β-receptor blockade has been reported to inhibit right ventricular hypertrophy in rats at high altitude. If so, we wanted to determine whether β-receptor blockade or some other drug action were involved and whether the heart, the lung vessels, or blood alterations were affected. In rats, chronic treatment with DL-propranolol (2mg/kg ip once daily) reduced right ventricular hypertrophy and polycythemia of chronic high altitude. D-Propranolol and metoprolol did not reduce hypoxia-induced right ventricular hypertrophy or polycythemia. In isolated lungs from low-altitude rats treated chronically with DL-propranolol or with D-propranolol blunted the acute hypoxia pressor response and angiotensin II induced vasoconstriction in lungs from high altitude rats. Two effects of DL-propranolol treatment were seen: 1) blockade of β_2-adrenergic receptors, which reduced the right ventricular hypertrophy of high altitude through reduction of hematocrit; and 2) a non-β-effect which reduced vascular responsiveness to acute hypoxia in the isolated lung preparation.

VI. HYPERBARIC MEDICINE

28. Hemodynamics in awake rabbits during hyperbaric helium-oxygen exposure.

L. E. BOERBOOM & N. BOELKINS. *J. Appl. Physiol. : Respirat. Environ. Exercise Physiol.* 48 : 282-288, 1980.

Although man is being exposed to hyperbaric environments more frequently, the effects of these environments and the inert gases used are not clearly defined. We therefore designed an experiment to examine both the effects of helium and elevated pressure on the cardiovascular system in conscious rabbits exposed to normoxic levels of a helium-oxygen ($He-O_2$) gas mixture at 1 and 11 atmospheres absolute (ATA) for 2 h. Variables studied included heart rate, blood pressure, cardiac output, systemic

vascular resistance, organ blood flow, and resistance to flow. The only change observed was a decrease in heart rate from a control of 284 ± 7 (mean ± SE) to 246 ± 12 beats/min after 2 h of breathing He–O_2 at 1 A T A. We therefore conclude that the cardiovascular system is not adversely affected by helium or elevated pressure as used in this experiment.

29. Endotoxin protection against oxygen-induced acute and chronic lung injury.

F. LEE & R. J. ROBERTS.
J. Appl. Physiol. : Respirat. Environ. Exercise Physiol. 47 : 577-581, 1979.

Small dosages of endotoxin (100-500ng/kg) provide significant protection against the acute manifestations of pulmonary O_2 toxity and lethality. Ninety-seven percent of endotoxin-treated adult rats survived a 27-h exposure to ≥ 95% O_2 with minimal lung changes, compared to 32% of control animals ($P < 0.02$). Exposure to ≥ 95%O_2 for 7 days resulted in a 20% survival rate in untreated control rats vs 98% survival in endotoxin-treated rats ($P < 0.01$). Histological evaluation of lung from survivors revealed substantially less collagen and reticular fiber deposition in the endotoxin-treated animal lungs. Endotoxin treatment was associated with increased activity of the protectant antioxidant enzyme systems of the lung in an apparent dose-response manner. Endotoxin's protective activity against O_2 toxicity does not appear to depend on an initial toxic insult to the lung like with α - naphthylthiourea, oleic acid, or alloxan treatment. The data support a protective role for endotoxin against the acute and the more chronic manifestations of O_2-induced pulmonary injury.

VII. PSYCHOLOGY & NEUROPSYCHIATRY

30. Development of performance evaluation tests for environmental research (PETER) : Complex counting test.

R. S. KENNEDY & A. C. BITTNER, Jr.
Aviat. Space Environ. Med. 51 : 142-144, 1980.

This study is the first in a program to develop a battery of Performance Evaluation Tests for Environmental Research (PETER). Nineteen volunteer subjects were tested daily for 3 weeks on a complex task requiring the operator to keep simultaneous track of several things with changing states. Average daily performances are reported as well as reliabilities of three main types : 1) internal consistency of the test ; 2) sensitivity-the ability to defferentiate subjects, and 3) stability-consistency of measurement over repeated sessions. The results showed that, on this task, learning was accomplished quickly and performance stayed level for 3 weeks. The cross-trial reliability for this test was found relatively stable after 3 d of practice, with a decline of only r = .94 to r = .79 over 11 d. This task is further noted as having several characteristics which make it particularly suitable for use in environmental research. It is concluded that the complex counting test can be recommended for use in environmental and other time-course research.

31. Comparison of two techniques for the development and maintenance of tracking behaviour in monkeys.

D. F. McCOY, S. R. SESCHLEMAN, G. B. NALLAN, & G. M. PACE. *Aviat. Space Environ. Med.* 51 : 121-125, 1980.

The present study compared two methods by which animal subjects can be taught to perform a pursuit tracking task. Rhesus monkeys were trained to track in order to avoid shock (Method 1) or to obtain food (Method 2). One animal received training under both procedures. Both techniques were effective ; however, the method utilizing shock produced faster learning and more efficient performance. The possible reasons for these differences are discussed along with generality of the results. These methods should have implications for tracking research in which animal models are required.

VIII. AVIATION OTOLARYNGOLOGY & VESTIBULAR PHYSIOLOGY

32. Neuroanatomical correlates of vestibular function.

R. R. GACEK, *Ann. Otol.* 89 : 2-5, 1980.

Neuroanatomical data revealed by new neuroanatomical techniques over the past decade, have clarified the central connections of the peripheral vestibular sense organs. A knowledge of this information is important in the clinical evaluation of vestibular disorders. The reflex connections of the

semicircular canals serve vestibulo-cerebellar, vestibulo-ocular, commissural and vestibulospinal pathways. The central connections of the utricular macula are primarily in a descending direction to the motor neurons of the entire length of the spinal cord. These form the basis for vestibulospinal reflexes which are characteristically associated with utricular function. Additional connections provide the basis for vestibulo-ocular responses to utricular activity. Finally, the saccule has reflex connections, both to the upper spinal cord to a minor degree and to extraocular nuclei that serve vertical and oblique eye movements. The minor vestibular group Y nucleus provides a commissural reflex connection for the saccule.

33. Oxygenation and ambient air pressure influence on alcohol-induced nystagmus in rabbits.

L. M. ODKVIST & W. J. OOSTERVELD. *Aviat. Space Environ. Med.* 51: 129-131, 1980.

The effect of ambient pressure with various inspiratory partial pressures of oxygen on the duration of positional alcohol nystagmus (PAN) was investigated in rabbits. In five groups of rabbits, different combinations of ambient pressures with different partial pressures of oxygen were applied. Alcohol was administered intravenously in a dosage of 2.85 g/kg body weight. PAN was recorded by electronystagmography. Neither a change of ambient pressure, nor a variation of the inspired oxygen partial pressure had any influence on the duration of PAN. The blood alcohol concentration did not differ significantly between the groups. The theoretical discussion is completed with the practical message that oxygen therapy does not help sobering up. In 6 out of 46 rabbits followed, there occurred a positional alcohol nystagmus type II, i.e. with reversed beat direction.

34. Evaluation of the relationship between motion sickness symptomatology and blood pressure, heart rate, and body temperature.

A. GRAYBIEL, & J. R. LACKNER. *Aviat. Space Environ. Med.* 51: 211-214, 1980.

This study investigated the relationship between the development of symptoms of motion sickness and changes in blood pressure, heart rate, and body temperature. Twelve subjects were each evaluated four times using the vestibular-visual interation test. The results were analyzed both within and across individual subjects. Neither a systematic group nor consistent individual relationship was found between the physiological parameters and the appearance of symptoms of motion sickness. These findings suggested that bio-feedback control of the physiological variables studied is not likely to prevent the expression of motion sickness symptomatology.

35. Motion sickness in the squirrel monkey.

J. M. ORDY & K. R. BRIZZEE. *Aviat. Space Environ. Med.* 51: 215-223, 1980.

Because it is of the same taxonomic order as man, the squirrel monkey has been introduced as a nonhuman primate model for the study of such aspects of motion and space sickness as susceptibility, prevention, treatment, and neural mechanisms. In this study on susceptibility, the specific aims were to examine the effects of combined vertical rotation and horizontal acceleration, phenotype, sex, visual cues, morning and afternoon testing, and repeated test exposures on incidence, frequency, and latency of emetic responses. The highest emetic incidence of 89%, with an emetic frequency 2.0 during 60 min, and a latency of 19 min from onset of testing, occurred at 25 rpm and 0.5 Hz linear acceleration. Susceptibility—defined by incidence, frequency, and/or latency of emesis—was significantly higher in Bolivian than Colombian phenotypes, in the presence of visual cues, in males, but not at different periods of the day or with two successive test exposures. Since the emetic responses were quite similar to man in the eliciting motion stimuli, it was concluded that the squirrel monkey represents a very suitable primate model for studies of motion and space sickness.

IX. HUMAN ENGINEERING & ESCAPE FROM AIRCRAFT

36. Bioman—An improved occupant-crew station compliance modelling system.

G. D. FRISCH & L. A. D'AULERIO. *Aviat. Space Environ. Med.* 51: 160-167, 1980.

The need to visualize and interpret human body movement data from experiments and simulations has led to the development of a computerized, three-dimensional representation of the human body and crew station. While conventional charts and graphs can be used to follow movements of individual body

parts, it has been our experience that only by observing the entire movement of the various body segments can experimental results be integrated with simulation studies. Such a process requires that program output be used to animate a realistically formed and jointed human body model incorporated within an existing or projected crew station. Animations are essential whenever the volume of data collected or generated is too great to assimilate piecemeal, or when the complexity of the motion under study leads to visualization difficulties in a two-dimensional graph. Dissatisfaction with existing body models and stick figure displays led to the development of a new human and crew station model for the computer with distinct advantages in display realism, movement definition, collision or interaction detection, and cost-effectiveness in a real-time animation play-back environment. Development of this program was meant to provide an improved method for evaluating the physical compatibility of crew members under all types of G environments.

37. Studies of limb-dislodging forces acting on an ejection seat occupant.

D. J. SCHNECK. *Aviat. Space Environ. Med.* 51 : 256–264, 1980.

A mathematical theory is being developed in order to calculate the aerodynamic loading to which a pilot is exposed during high-speed ejections. Neglecting the initial effects of flow separation, results thus far indicate that a pilot's musculo-skeletal system is not likely to withstand the tendency for limb-flailing if he is ejecting at Mach numbers in excess of about 0.7. This tendency depends very strongly upon the angle at which the pilot's limbs intercept a high-speed flow; the forces that cause limb dislodgement increase dramatically with speed of ejection. Examining the time-course of limb-dislodging forces after the initial onset of windblast, the theory further predicts the generation of a double vortex street pattern on the down-stream side of the limbs of an ejection seat occupant. This results in the corresponding appearance of oscillating forces tending to cause lateral motion (vibration) of the limbs. The amplitude and frequency of these oscillating forces are also very dependent on the Mach number of ejection and the angle at which the pilot's limbs intercept the flow. However, even at moderate Mach numbers, the frequency can be as high as 100 cycles per second, and the amplitude rapidly exceeds a pilot's musculoskeletal resistive powers for Mach numbers above 0.7.