

Abstracts of Current Aviation Medicine Literature

I ACCELERATION PHYSIOLOGY

1 Cardiovascular responses of man exposed to +Gz accelerations in a centrifuge.

Cardiovascular investigations were conducted in male volunteer subjects exposed to +Gz acceleration. Some of them did not have any previous experience of the centrifuge. Electrocardiogram, blood pressure, heart rate, stroke volume and cardiac output were recorded. Accelerations ranging from +1.5 Gz to +6 Gz were applied during periods of from 30 sec to 20 min. Acceleration was achieved in 10-90 sec. Heart rate markedly increased as a function of acceleration intensity, reaching 160 beats/min. Decreases in cardiac output (30-40%) and stroke volume were also observed. Protection by an anti-G suit reduces tachycardia. Accelerations induce various electrocardiographic disorders lasting several minutes after the stress has been stopped. These are sometimes the first symptoms of functional cardiovascular failure. The centrifuge turns out to be an excellent screening tool. However, when, used for testing various aircrew equipment, strict monitoring of the subject is required.

[Vettes, B, Viellepond, H and Auffret, R. *Aviat Space Environ Med.* 51 (4) : 375, 1980.]

2. Development, test, and evaluation of an advanced anti-G valve for the F-15.

The USAF School of Aerospace Medicine (USAFSAM) Crew Technology Division has developed an advanced anti-G valve for pressurizing the anti-G suit during exposures to acceleration. The anti-G valve now in fighter aircraft has been found to operate too slowly to counteract the rapid onset of G, possibly causing pilots of high performance aircraft to

black out, loose consciousness, and/or become fatigued. The time relationship to G-suit pressurization using the conventional anti-G valve was found to be sigmoidal, having two relatively slow pressurization phases - one early, and the other late - in the suit-inflation schedule. These two slow phases were eliminated by preinflating the anti-G suit to 0.2 lbs/in² (psi) prior to an increase in G (called "Ready Pressure") and by increasing the air flow through the anti-G valve (called "Hi-Flow"). The Hi Flow Ready Pressure (HFRP) anti-G valve developed by USAFSAM increased the rate of G-suit pressurization threefold. This valve was tested on eight F-15 pilots, using the centrifuge at the Naval Air Development Center, Warminster Pa. When this experimental valve was compared with the conventional anti-G valve now operational in the F-15 aircraft, the HFRP valve received a high degree of pilot acceptance because it had better valve response, reduced valve error scores, and allowed the pilots to tolerate high-G exposures with less effort. Subsequent flight tests of 18 HFRP anti-G valves on F-15 aircraft confirmed the valves to be reliable, have high acceptance, and provide an extra 1 G in tolerance.

[Burton, RR, Sheffstall, RM and Jaggars, JL. *Aviat Space Environ Med.* 51 (5) : 504, 1980.]

3. Human tolerance to aerial combat maneuvers

An acceleration profile was developed on the USAF School of Aerospace Medicine's 6.1 m radius centrifuge to measure human tolerance to the Aerial Combat Maneuver (ACM). The ACM profile is a continuous respective, 4.5 G for 15 s to 7 G for 15 s, cyclic G exposure which is terminated by the subject

at his fatigue endpoint. ACM tolerances using this type of G profile were determined for seven subjects at four different seatback angles: i.e., 13°, 30°, 55° and 65° from the vertical. Group (mean ± S.E.) tolerances for the ACM were 170 ± 17 s at 13° and 541 ± 48 s at 65°. These tolerances were not usually correlated with relaxed gradual onset G tolerances. The subjective fatigue endpoint was physically verified using heart rate, heart rhythm, and performance criteria at the four seatback angles. The potential value of the ACM profile is considered as a measure of the effectiveness of anti-G equipment and methods in the aerial combat environment.

[Burton, RR and Sheffstall, RM. *Aviat Space Environ Med.* 51(7): 641, 1980.]

4. Frank orthogonal vectorcardiograms in humans during and after exposure to 1 Gz acceleration stress.

Frank orthogonal vectorcardiograms (VCGs) were recorded from 10 subjects prior to, during and for 15 min after exposures to +3 Gz, -5 Gz, and +7 Gz. The order of acceleration exposure was randomized, with the individual exposures separated by at least 1 week. Standard USAF anti-G suits were worn by all subjects. Detailed analysis of the scalar lead electrocardiograms revealed no abnormalities. There were no consistent signs of conduction disturbances or ischemic ST-T segment changes. The QRS axis of the VCG demonstrated posterior rotation in the sagittal plane and counterclockwise rotation in the transverse plane during +G stress. The changes in the VCGs recorded during +Gz stress appeared to be related to rotational changes of the heart due to mechanical stress and/or motion within the thorax. There were no ECG or VCG changes indicative of myocardial ischemia and/or damage during or after +Gz stress.

[Laughlin, MH, Shinnery, JE, Strom, JA, Cosgrove, DJ, Fitzpatrick, EL, Keiser, HN and Whittaker, RN. *Aviat Space Environ Med.* 51 (7) : 653, 1980.]

5. Acceleration forces on the human subject.

An overall view of the methodology of acceleration research i.e. G-tolerance measuring devices and the peculiarities of each, general information on G tolerance and types of G stress, the methods of

determining G tolerance, and the methods of modifying one's G tolerance, is presented. Some human factors aspects of G tolerance, as well as some physiologic changes under G, i.e. ECG changes, cardiac problems, and various other biochemical and hematological alterations, are discussed. Special emphasis is placed on the proven G-associated cardiac pathology found in various animal models, and its possible application to the human subject.

[Voge, VM. *Aviat Space Environ Med.* 51 (9) : 970, 1980.]

6. Human responses to repeated high G simulated aerial combat maneuvers.

Five subjects wearing standard USAF anti-G suits and seated at a 65° back angle were exposed to a simulated aerial combat maneuver (SACM) which was repeated 5 times with 4-min 1-G rests between each SACM exposure. The SACM was 122 s in duration with 10 s acceleration peaks of 10, 8 and 6 G; between these peaks, the subject was at 4 G for 15 s. This series of repeated SACM exposure fatigued four of the five subjects. Heart rate and rhythm, arterial oxygen saturation, expired gases, lactate, pyruvate, glucose, CPK enzymes and isoenzymes, blood volume, subjective fatigue measurements and subject performance were examined relative to the development of fatigue, the energy cost of the M-1 and tolerance to the SACM. All physiologic-metabolic parameters were significantly affected by the repeated SACMs, however, only heart rate changes appeared to be correlated with developing fatigue. A significant amount of energy is required to perform the M-1. Subjects whose energy metabolic and cardiovascular states are least disturbed by high G exposure are those persons who will perform best and become least fatigued during repeated aerial combat maneuvers.

[Burton, RR. *Aviat Space Environ Med.* 51 (11) : 1185, 1980.]

II AIRCRAFT ACCIDENT INVESTIGATION

7. Hypoxia induced fatal aircraft accident revealed by voice analysis.

The voice communication was the only clue of the fatal F-104J accident encountered during high altitude intercept procedures, and it was analysed to

prove the presence of hypoxia as a causal factor. A simulated low-pressure chamber flight was undertaken, and the subject's voice, saying the same words as the pilot, was analyzed in the same way. Comparison of these two voices revealed a similarity in characteristic changes of the sound spectrum and time course. The blurred formation of formant, fundamental, and harmonic frequencies, as well as the obscured gap in pre-vocal cord opening time (VOT) of the sound spectrogram, were thought to be the effects of hypoxia. Lowered fundamental frequency of the pilot's voice, even at the stressful period of attack, has strongly suggested decreased vigilance due to hypoxia. Through these findings, it was concluded that the cause of the accident was probably hypoxia in the pilot.

[Saito, I, Fujiwara, O, Utsuki, N, Muzumoto, C and Arimori, T. *Aviat Space Environ Med.* 51 (4) : 402, 1980.]

8. Investigation of life change as a contributing factor in aircraft accidents: a prospectus.

The author presents a personal perspective on attempts to reduce aircraft accidents resulting from human failure in the cockpit. The premise is that accidents result from an imbalance between performance ability and performance demand. Advances in decreasing pilot-induced accidents must come from methods that will prevent the stresses that diminish performance ability. It is suggested that the investigation of life change as a contributing factor in aircraft accidents will be fruitful because of the tremendous amount of research that has already been done in this field. A review of previous work leads to three recommendations; the Recent Life Change Questionnaire (RLCQ) should be developed as a tool for management of individual aircrew; a character assurance program should be adopted; and a technique to remove accident-prone individuals should be developed.

[Haakonson, NH. *Aviat Space Environ Med.* 51 (9) : 981, 1980.]

9. 3W approach to the investigation, analysis, and prevention of human-error aircraft accidents.

Human error is the largest cause of U.S. Army aircraft accidents. An approach to this problem is presented which is based on a model of the human error accident. This 3W approach identifies what

task error (TE) caused or contributed to the accident, what inadequacy (I) in the aviation system caused or allowed the TE to occur, and what remedial measure (R) is required to correct the I. There were 82 human-error accidents analyzed to identify TEIR information. Statistically important Is were identified which could be remedied based on accident costs. Then, potentially cost effective remedial actions were ranked on a cost-benefit totempole. The totempole was given to the aviation system manager as a management tool to assist in determining priorities for corrective actions.

[Rickatson, DS. *Aviat Space Environ Med.* 51 (9) : 1038, 1980.]

10. The value of postmortem examination of passengers in fatal aviation accidents.

Annex 13 to the Convention on International Civil Aviation recommends that the state conducting the inquiry into a fatal aviation accident should encourage internal autopsy by an aviation pathologist on those killed. Many countries recognise the value of such examinations on operating crew, but require the examination of passengers merely as aids to identification and to the investigation of the cause of death. This paper attempts to correct this misconception and to demonstrate the importance of examining passengers as completely as possible. The reasons for doing this can be divided into three broad groups. The first concerns accident reconstruction and involves a careful analysis of the injury patterns sustained by the passengers. The second is concerned with the evaluation of the safety equipment provided for passengers' use. The third deals with the multitude of medico-legal problems, both civil and criminal, that inevitably arise after a fatal accident.

[Cullen, SA and Turk, EP. *Aviat Space Environ Med.* 51 (9):1071, 1980.]

11. Interpretation of coronary artery disease in fatal aircraft accidents.

The author describes three cases which illustrate the difficulties in interpreting the significance of coronary atherosclerosis. When presented with a case where a pilot with severe coronary artery disease, but without thrombosis, has been killed in an unexplained accident, even after carefully

assessing all the circumstantial and pathological findings, one may be unable to reach a firm conclusion as to whether the coronary artery disease is an incidental finding, a possible or probable cause or a highly probable cause of the accident.

[Underwood Ground, KE. *Journal of the Royal Society of Medicine*. 72(5): 377, 1979.]

III AVIATION OTOLARYNGOLOGY

12. Identification of the minimum noise level capable of producing an asymptomatic temporary threshold shift.

The present study was designed to identify the minimum noise level capable of producing an asymptomatic temporary threshold shift (ATTS). It was estimated that at some level below 85 dBA, probably 70-80 dBA, there existed an exposure level at which no ATTS would occur. It is assumed that if a long-duration noise does not produce temporary changes in hearing levels, then it would not produce permanent changes either. This level would then define an exposure condition below which personnel could be exposed for indefinite periods of time without adverse auditory effects. Subjects were exposed to continuous pink noise for 24 h at levels of 65, 70, 75, 80, and 84 dBA. TTS growth and recovery was measured at specific intervals throughout each condition. Results demonstrate that at the most sensitive frequency (400Hz), at ATTS threshold level would be predicted in the region of 75-80 dBA.

[Stephenson, MR, Nixon, CW and Johnson, DD. *Aviat Space Environ Med*. 51(4):391, 1980.]

IV BIORHYTHM

13. Effect of an altered rest-activity or feeding schedule on the shift of motor activity rhythm of mice.

Preflight acclimatization to the rhythm of destination and postflight daytime activity are assumed to be effective counter-measures against the jet lag syndrome. Regarding this idea, resynchronization of motor activity rhythm was investigated in mice subjected to daytime exercises on a driven belt before or after the reversal of lighting regimen. In addition, the effect of prior daytime feeding was studied. No evidence was manifested that the forced exercises or

feeding schedule would hasten synchronization. This result indicates that the central control system of motor activity rhythm could not be manipulated favourably by such method in mice. On the basis of the result obtained, the applicability of countermeasures to human beings was discussed.

[Murakami, H and Murakami, Y. *Aviat Space Environ Med*. 51(4): 371, 1980.]

14. An attempted validation: study of the birthdate-based biorhythm (BBB) hypothesis.

The birthdate based biorhythm (BBB) hypothesis was examined for utility as a predictor of human performance. Data from quizzes of 26 students taken periodically throughout a semester, and measures over 1 month of landing performances by seven pilots were analysed by multiple regression/correlation methods. Regression equations were developed to test the correspondence between performance and cycle phases. A second analysis used a nonorthogonal least-square spectrum method to determine if the data contained any systematic rhythms in the infradian range. No significant results were obtained which would support the BBB hypothesis as a predictor of human performance. Also, no evidence was found to substantiate the existence of the three proposed BBB cycles.

[Englund, CE and Naitoh, P. *Aviat Space Environ Med*. 51(6): 583, 1980.]

V CLINICAL AVIATION MEDICINE

15. Treatment of air or oxygen/nitrogen mixture decompression illness in the Royal Navy.

Fifty cases of air divers with definite decompression illness have been analysed. The new R.N. Tables 63 and 73 appear to be equally satisfactory for the treatment of uncomplicated arterial gas embolism. The use of steroids in treating arterial gas embolism has become accepted practice whereas their use in decompression sickness is only justifiable for serious cases. Plasma expanders are of proven use in decompression sickness. Those cases receiving further hyperbaric oxygen therapy after an initial therapy did uniformly show a variety of sustained and/or nonsustained improvement associated with the therapy. The role of maintaining cases under pressure

for long periods in a saturation mode on oxygen/nitrogen mixtures needs evaluation.

[Pearson, RR and Leitch, DR. *Journal of the Royal Naval Medical Service*. LXV (2) : 53, 1979.]

16. Coronary artery disease in aviation; routine examination of aircrew.

In the last 16 years, there have been only seven fatal accidents affecting commercial aircraft from all countries of the International Civil Aviation Organization that can with reasonable certainty be ascribed to coronary disease in a pilot. There have been other instances of death or lesser incapacitation of the pilot either in the air, or shortly before take-off or just after landing. ECG testing and exercise ECG testing, routinely carried out, are lacking of sensitivity. In a great number of cases of apparently quite abnormal T waves, there is no detectable cardiac disease as judged by coronary arteriography, left ventricular angiography and echocardiography. Absence of significant coronary artery disease can be established only by coronary arteriography, though there is evidence that it underestimates the extent of disease. Routine use of exercise ECG testing would create far more problems than it would solve in a supposedly healthy, asymptomatic, generally, young to middle-aged population. The author concludes that presymptomatic diagnosis of coronary artery disease is a very imperfect art. It is probable that, no matter what we do, the total elimination of unexpected coronary attacks will prove impossible. It is of paramount importance that cockpit design and flight procedures should be such that any threat to flight safety following incapacitation should be minimal or non-existent.

[Kelly, HB. *Journal of the Royal Society of Medicine*. 72 (5) : 374, 1979.]

17. Radiology of the vertebral column in the medical examination of Air Force pilots.

The authors propose specific standards for important segments of the vertebral column in relation to the different jobs of the Air Force personnel, especially fighter pilots and helicopter pilots. For transport aircraft pilots the vertebral column standards should be less rigorous; there are no specific requirements

as long as the candidate is fit for military service. The critical part of the vertebral column for fighter pilots is the dorsolumbar region and for helicopter pilots the sacrolumbar region. The various causes for disqualification are examined. (In French)

[Delahaye, RF, Auffret, R, Melges, PJ, Kleitz, C. *International Review of the Army, Navy and Air Force Medical Services*. 53 (2) : 119, 1980.]

18. Comparison of reactive hyperemia in warm and cool human forearms over a range of ischemic periods.

The characteristics of reactive hyperemia in the warm human forearm are well documented but comparable data at lower temperature are sparse. The present study was designed to examine reactive hyperemia in the forearms of 8 subjects using a range of ischemic periods of 0.5, 1, 2, 4 and 8 min at plathy-smograph temperatures of 34 and 14°C. The peak flow rates and hyperemic volumes following all of the durations of ischemia were significantly lower at 14°C. There was a proportional relationship between the hyperemic volume and the duration of ischemia at both temperatures. The differences noted is explained by a reduction in the rate of metabolism in the forearm at the lower temperature, but reduced vascular distensibility cannot be excluded.

[Shakir, I, Gooden, BA and Mac Donald IC. *Aviat Space Environ Med*. 51 (5) : 470, 1980.]

19. Prevalence of coronary heart disease risk factors in a young military population.

This study was undertaken to determine the extent to which coronary heart disease risk factors are manifest in a young (17-35 years old) male military population. Approximately 360 individuals underwent medical and physical determination of body composition, blood cholesterol analysis, blood pressure measurement, history of smoking, and a maximal exercise stress test to assess maximal oxygen uptake (V_{O_2max}) and the incidence of electrocardiographic abnormalities. Obesity (20% body fat), elevated blood cholesterol (200 mg/dl), and cigarette smoking (10 cigarettes/d) were the most predominant risk factors with incidences of 29, 32, and 36% respectively. Only 2.4% of the sample had a

positive stress test as indicated by an ST-segment depression of 1 mm or greater. An inverse relationship between $\dot{V}O_2$ max and present body fat was the only significant finding between level of aerobic power and risk factor prevalence. These data provide information on the prevalence of cardiovascular disease risk factors in an age group for which there has been only limited information.

[Patton, JF and Vogel, JA. *Aviat Space Environ Med.* 51 (5): 510, 1980.]

20. Coronary heart disease: an expensive Air Force problem.

Death or disability from CHD is a major public health problem that costs the Air Force about 50 million dollars annually. Statistically, 20% of 30,000 pilots in the Air Force could have significant degree of coronary atherosclerosis. In a flight incapacitation due to "heart attack" is a real possibility. Fortunately, aircraft accidents related to coronary events have been very uncommon. The basic mechanisms leading to the development of CHD, a multifactorial condition, are not fully understood. The significance of various risk factors associated with an increased incidence of CHD are discussed. It is hoped that preventive programs designed to identify, educate, and treat those at high risk will reduce the incidence of premature death and disability due to CHD. Two such programs (HEW's MRFIT and USAF's HEART) are briefly described. The costs, benefits, risk, sensitivity, and predictive value of tests available to detect CHD in asymptomatic individuals are outlined.

[Dehart, RM *Aviat Space Environ Med.* 51 (9): 1057, 1980.]

21. Effects of whole body vibration on spinal reflexes in man.

Recent studies have described sensory-motor function alterations resulting from vibrations applied to various parts of the body. The present work describes the effect produced at the myotatic loop level by long term vibration. Hoffmann and tendon reflexes as well as tendon vibration response were substantially depressed by 18 Hz, \pm 0.25 G vibration applied to the whole body or to the legs of seated human subjects. The reflex inhibition lasted throughout the 15 min vibration period and persisted minutes after

stimulus cessation. In contrast, vibration limited to the S's head and trunk showed much weaker effects. This suggests that the vibration acts mainly upon extero and proprioceptive receptors rather than upon the vestibular organs. The results are discussed in relation to findings derived from experiments involving locally applied short duration vibration.

[Roll, JP, Martin, B, Gauthier, GM and Mussa-Ivaldi, F. *Aviat Space Environ Med.* 51 (11): 1227, 1980.]

VI ENVIRONMENTAL PHYSIOLOGY

22. Effort tolerance of subjects at different age under high temperature conditions.

The experiments were carried out in 23 healthy men aged 21 - 45 years in a thermobaric chamber at temperatures of 30, 40 and 45°C, recording the physiological parameters of the circulatory system, respiratory system and temperatures. It was found that the reactions were most stable under these conditions in the age group 40-45 years. A factor limiting the ability to work at high ambient temperature seems to be reduced adaptation capacity of the circulatory system.

[Golec, L and Sokolowski, E. *Lekarz Wojskowy.* 55 (9-10): 484, 1979.]

23. Effects of induced cyclic changes of deep body temperature on performance in a flight simulator.

Previous studies have shown that performance of a simple, motor task may be degraded by heating the skin when the body temperature is above a critical level of 37.6°C. The experiment reported here confirms these findings for performance in a simple flight simulator. The significance of the results is discussed with reference to flight in high-performance aircraft.

[Gibson, TM, Allan, JR, Lawson, JG and Green, RG. *Aviat Space Environ Med.* 51 (4): 358, 1980.]

24. Thresholds for detection of constant rotary acceleration during vibratory rotary acceleration

The effects of vibratory angular acceleration αR on detection thresholds for constant αR in a dynamic flight simulator are reported in three experiments. Detection thresholds were determined for 10 pilots

and four nonpilots using a random, double-staircase procedure while the subject sat erect in a device which rotated about an earth-vertical axis. Constant aRs were presented for 0.5 and 1.0 s with concurrent vibratory aR at 1 and 5 Hz, and thresholds with no vibratory aR were established. The thresholds were obtained while the subjects observed a visual reference in the enclosed cockpit in two experiments and in total darkness in a third. The results confirmed earlier experiments showing an inverse relationship between the duration of constant aR and detection threshold and showed that the detection thresholds in darkness were higher than with a visual reference present. Two analyses of variance revealed no significant differences in thresholds across the three vibration conditions. These results indicate that vibratory aRs of fairly high levels can be present in a dynamic flight simulator without masking the pilot's ability to detect either maneuver or disturbance motions.

[Clark A, Stewart JD and Philips, NH. *Aviat Space Environ Med.* 51(6):603, 1980.]

25. Psychomotor deterioration during exposure to heat.

The effect of different heat loads on vigilance and complex cognitive tasks involved in a mission of different intensities were examined. Nine healthy volunteers were randomly exposed for 2 h to three climatic conditions; comfort (21°C ET), moderate heat load (30°C ET) and severe heat load (35°C ET). The subjects were assigned to missions of shooting at targets of three different sizes. Physiological parameters (HR, T_{re} , and sweat rate) and psychomotor ability were monitored. Exposure to 35°C ET gave rise to elevated HR, T_{re} and dehydration of 2.5%, while exposure to 21°C ET and 30°C ET caused no physiological burden. Speed of performance was significantly higher when the subjects were exposed to moderate heat load than to either comfort or severe heat load. Percentage of errors, however, rose gradually with the rise in heat load. The results indicate: a) The effect of the intensity of the task and heat load on deteriorating performance are synergistic; b) psychomotor performance deteriorates even before physiological parameters are impaired, possibly because of feelings of discomfort; c) even highly motivated subjects are affected by heat load, especially when assigned to

complex missions which require a high state of vigilance, cooperation, and coordination.

[Epstein, Y, Karan, G, Moisselev, J, Gasko, O and Yachin, S. *Aviat Space Environ Med.* 51(6):607, 1980.]

26. The effect of alcohol on body heat loss.

The effect of the ingestion of alcohol on cooling in seminude human subjects was examined at 25 and 30°C in air; in heavily clothed individuals at -23°C in air; and nude subjects in a water calorimeter at 25°C. It was observed that consumption of the equivalent of five bar whiskey drinks did not affect the cooling rate of subjects as measured by infrared techniques or by thermistors. Total heat loss, measured in the calorimeter, was also not affected by drinking alcohol. It is concluded that the ingestion of alcohol does not cause an increase in cooling rate in humans.

[Livingstone, SD, Kuehn, LA, Limmer, RE and Weatherston, B. *Aviat space Environ Med.* 51 (9) : 961, 1980.]

27. Orthostatic responses in heat tolerant and intolerant subjects compared by three different methods.

The orthostatic responses of 10 heat tolerant and five intolerant subjects were evaluated by three different test methods — standing, head-up tilt (HUT), and head-up tilt after prolonged exercise (HUTPE) — in a hot environment of 40°C, 40% RH. No difference was found within the normal group between responses in the standing and HUT test. In the HUTPE test orthostatic responses were inadequate and 5 of 10 subjects fainted. The heat intolerant subjects reacted to all three tests similarly to the normal group, though their heart rate was higher and 3 out of 5 fainted at an earlier phase in the HUTPE test.

[Karan, G, Epstein, Y, Ohri, A and Magazanik, A. *Aviat Space Environ Med.* 51 (11):1205, 1980.]

VII EXERCISE PHYSIOLOGY

28. Physiological effects of cold air inhalation during exercise.

Selected physiological responses of six normal subjects were observed, during rest and exercise, while they breathed (a) ambient and (b) cold (-35°C) air. All experiments were 10 min in duration and the

exercise experiments consisted of pedalling a bicycle ergometer at loads requiring approximately 60% and 75% of each subject's VO_2 max. Heart rates and minute ventilations during the most strenuous exercise averaged approximately 170 bpm and 70, respectively. Diastolic blood pressure was significantly lower, during cold air inhalation. Oxygen uptake, respiration rate and rectal temperature were not affected by cold air breathing; and no subject complaints were attributable to cold air inhalation. Recent studies in the literature suggest that cold air is not fully warmed in the upper respiratory passages; however, the present study observed only slight changes in measured physiological responses to rest and exercise with cold air breathing.

[Hartung, GH, Myhre, LG and Nunneley, SA. *Aviat Space Environ Med.* 61(6): 591, 1980.]

VIII HIGH ALTITUDE AND SPACE PHYSIOLOGY

29. Retinal studies at 446 Torr in a hypobaric chamber.

This study was designed to see if retinal haemorrhage occurred after 24 h of decompression to a pressure of 446 torr. Four subjects were studied after 24 h of decompression and had retinal photography and fluorescein angiography performed at rest and following maximum exercise. No haemorrhages or fluorescein leakage was noted, even though the subjects experienced typical symptoms of acute mountain sickness and showed an increase in lung density-consistent with subclinical pulmonary edema. We conclude that 24 h exposure to 446 torr with a period of maximal exercise is an inadequate stress, either in time and/or degree, of hypoxia to produce retinal haemorrhage or leakage, as measured by fluorescein.

[Sutton, JR, Coates, G, Gray, GW, Mansell, AL, Powles, ACP and Zehorok, R. *Aviat Space Environ Med.* 51(4): 407, 1980.]

30. Combined effect of hypoxia and cold on the phospholipid composition of lung surfactant in rats.

The phospholipid composition of lung tissue and lung lavage in rats exposed to acute hypoxia, chronic hypoxia, and acute and chronic hypoxia associated with cold has been estimated and compared with controls. Different fractions of phospholipids were separated by thin layer chromatography. Results

showed that acute hypoxia lowered phospholipids in lung lavage but superimposition of cold lowered phospholipids both in lung tissue and lavage. In chronic hypoxia, phospholipid contents of lung tissue and lavage decreased while the addition of cold showed no further reduction in lung tissue phospholipids; on the contrary phosphatidyl choline fraction of lung lavage increased. It is concluded that the effect of hypoxia alone in lowering surfactant is related to the duration of exposure. Cold with hypoxia lowers phospholipids in the acute stage; in the chronic stage it does not further reduce phospholipids.

[Kumar, R, Hegde, KS, Krishna, B and Sharma, HS. *Aviat Space Environ Med.* 51(6): 459, 1980.]

31. Relation of breathing oxygen-argon gas mixtures to altitude decompression sickness.

A 95% oxygen-5% argon breathing mixture produced by a molecular sieve generator was shown to be similar to a 95% oxygen 5% Nitrogen mixture for breathing during 1-h exposures at 7,620 m (25,000 ft) or 10,792 m (35,000 ft), as determined by the detection of proportionate numbers of intravascular bubbles in the pulmonary artery of dogs. Comparable results were obtained with 95% oxygen - 5% Helium or 100% oxygen. The partial pressures of a 5% mixture at 7,620 and 10,792 m were 14.1 and 8.6 torr, respectively, and were apparently low enough so that the non-metabolizable gases did not result in differences in the incidence of intravascular bubble formation or decompression sickness. Argon at the 10% level showed a non-significant trend to produce more bubbles. Individual susceptibility or resistance to form bubbles was observed with the different gases. Denitrogenation with either 5 or 10% mixture of the inert gases was quite effective, as shown by a reduction in the number of intra-vascular bubbles detected.

[Cooke, JP, Ikels, KG, Adams, JO and Miller, RL. *Aviat Space Environ Med.* 51(6): 537, 1980.]

32. On the use of oxygen to facilitate decompression.

Oxygen is widely used at elevated partial pressures to facilitate decompression, yet the optimum dosage and the magnitude of the beneficial effects are poorly known. This is because oxygen enhancements, expressed as increases in the allowed pressure

reductions, are small and easily masked by individual variation. Furthermore, oxygen can also produce detrimental results, and the range from a therapeutic to a toxic dose is narrow. Berghage and McCracken recently reported two massive investigations involving 1185 rats and 60 experimental conditions. These authors suggest that the conventional concept of an "equivalent air depth" (EAD) is untenable and that oxygen must be considered in calculating the total tissue gas tension. We find instead that the observations of Berghage and McCracken are compatible with a model in which the tensions of oxygen and carbon dioxide dissolved in tissue are taken into account, and that this model, in turn, agrees with EAD predictions of oxygen enhancements for sub-toxic oxygen pressures.

[Young, DE and Lally, DA. *Aviat Space Environ Med.* 51 (8): 644, 1980.]

33. Red blood cell count (RCC) and volume (MCV) of three subjects in a hypobaric chamber.

Measurements of red blood cell count (RCC) and mean corpuscular volume (MCV) were made on three subjects during a 42-h continuous exposure to low barometric pressure. RCC varied insignificantly in two subjects but increased steadily with time in the third. MCV decreased appreciably (12-14%) in all three subjects 5 h after exposure to the low pressure but returned close to baseline values after 40 h. It is concluded that 1) short exposures to low barometric pressures result in a reduction in red cell size; 2) increased red cell production in response to low oxygen levels shows individual variations.

[Sewchand, LS, Lovlin, RE, Kinnear, G and Rowlands, S. *Aviat Space Environ Med.* 51 (6): 577, 1980.]

34. Venous gas bubbles while flying with cabin altitudes of airliners or general aviation aircraft 3 hours after diving.

Decompression venous gas bubbles were detected with the precordial Doppler ultrasound technique in humans at simulated altitudes of 1,000-3,000 m 3 h after no-stage decompression dives to 15 or 39m. Bubbles were detected at 3,000 m in a total of 80% of the subjects; in 90% after the 100-min shallow dives to 15 m with some bubbles present in the first

minutes (mean onset 12 min), and in only 30% after the 10 min deeper dives to 39 m with later appearances of bubbles (mean onset 28 min). At both 2,000 and 1,000 m bubbles could also be detected, sometimes in the first minutes. The risk of decompression sickness must be considered high with the amount of gas bubbles found, even though only uncertain symptoms appeared in this study. Thus, a safe interval between ordinary SCUBA diving and flying in airliners of general aviation aircraft seems to be more than 3h.

[Balldin, UI. *Aviat Space Environ. Med.* 51 (7) : 649, 1980.]

35. Molecular sieve generation of aviators' oxygen: performance of a prototype system under simulated flight conditions.

The molecular sieve method of generating an enriched-oxygen breathing gas is one of several candidate onboard oxygen generation (OBOG) systems under joint Army-Navy-Air Force development for application in tactical aircraft. The performance of a nominal two-man-capacity molecular sieve oxygen generation system was characterized under simulated flight conditions. Data are given on the composition of the molecular sieve-generated breathing gas (oxygen, nitrogen, carbon-dioxide, and argon) as a function of inlet air pressure, altitude, breathing gas flow rate, and ambient temperature. The maximum oxygen concentration observed was 95% with the balance argon. At low demand flow rates and certain conditions of pressure and altitude, the argon enrichment factor exceeded that of oxygen giving a maximum argon concentration of 6.6% with the balance oxygen. The structural integrity of the unit was verified by vibration and centrifuge testing. The performance of the molecular sieve unit is discussed in the context of aircraft operating envelopes using both diluter demand and 100% delivery subsystems.

[Miller, RL, Ikels, KG, Lamb, MJ, Boscola, EJ and Ferguson, RH. *Aviat Space Environ Med.* 51 (7) : 665, 1980.]

36. Physiological factors of stress in space-flight-present concepts on human adaptation to space flight.

The biomedical results collected in Apollo, Skylab and Soyuz space missions are reviewed and

considered in the frame of the new Shuttle-Space Lab missions. Some mechanisms related to human adaptation to the space environment and needing further research are described. The following problems are studied: motion sickness, redistribution of body fluids and cardiovascular deconditioning, fluid and electrolyte changes, bone decalcification and muscle atrophy, reduction in the circulating red blood cell mass, sensory systems, modification in the reflexes-G-forces during launch and reentry, spacecraft atmosphere and extra-vehicular activity, noise problems, sleep and work-rest cycles, radiation safety and some problems of physiological stress predictable in a very long duration stay in space station. (In French).

[Evrard, E. *International Review of the Army, Navy and Air Force Medical Services*, 54 (1) : II, 1981.]

IX. HUMAN ENGINEERING

37. Active muscle torques about long bone axes of major human joints.

Incorporation of the active muscle torques into the multi segmented total-human-body models can be considered the next major improvement of these models. The first step toward achievement of this goal is to obtain active muscle torque data about long-bone axes of major human joints. This paper presents results of research conducted to collect such data at the shoulder, hip, elbow, knee, and ankle joints. Active muscle torques were determined about the long-bone axes of the upper arm, upper leg, lower arm, and lower leg, which are the body segments associated with the major joints mentioned. Numerical results are presented for three male subjects for a specific number body segment orientation with respect to the joints. It was concluded that, although there are intra- and inter-subject variations for the maximum values of the active muscle torques about long-bone axes, there are some trends one can establish for the behaviour of the magnitude of these torques.

[Engin, AE and Kaleps, I. *Aviat Space Environ Med*, 51 (6) : 551, 1980.]

38. Device for measuring the precision of eye-hand coordination while tracking changing size.

Psychophysical evidence supports the idea that the human visual pathway computes an object's rate of change of angular size rather independently of the object's trajectory and rather independently of other visual parameters, including contrast and intensity. This independence could provide a basis for accurately judging the component of an object's velocity along a line through the eye in the working visual environment where many visual parameters vary simultaneously. We describe a procedure for quantifying a subject's ability to track changing size, and illustrate the procedure with preliminary experimental data. The subject's RMS tracking errors are displayed in three frequency bands. Our device also measures perturbing effect of sideways motion upon the subject's ability to track changing size. Such data may go some way to predict a subject's performance in tasks of eye-limb coordination, especially where visual information is largely restricted to the changing size channel.

[Regan, D and Beverley KI. *Aviat Space Environ Med*, 51(7): 688; 1980.]

X HYPERBARIC MEDICINE

39. Is the weight loss of hyperbaric habitation a disorder of osmoregulation?

To examine the weight loss of hyperbaric helium oxygen habitation, we measured the exchange of liquids and calories in six men who lived in this atmosphere for 32d. The maximum pressure was 49.5 ATA. The men lost 3.7-10.1 Kg. in spite of warm ambient (31-32°C) temperatures and adequate calories (2,737 kcal/d) provided for the sedentary ways of chamber living. Weight loss and a calculated fluid deficit were accompanied by significant hemoconcentration, shown by increase in serum proteins. These changes were followed by a rise in urinary aldosterone and vasopressin, but not thirst. Weight loss in hyperbaric atmospheres is probably multifactorial, but our data suggests an uncoupling of normal osmoregulation may have occurred in the present set of subjects. This may have been due to altered lung mechanics, increased catecholamines, or effects of high pressure on cellular responses to vasopressin.

[Raymond, LW, Raymond, WS, Frattali, VP, Soda, J, Leach, CS and Spaur, WH. *Aviat Space Environ Med*, 51(4): 397, 1980.]

40. Medical hyperbaric oxygen therapy : 22 cases.

Between 1976 and 1979, 22 patients had hyperbaric oxygen therapy at Wright-Patterson Air Force Base Medical Center. Seventeen patients benefited and five did not—one of two carbon monoxide poisoning patients, both gas gangrene patients, and four of five osteomyelitis victims were greatly helped while 10 of 13 soft tissue wounds were healed with the hyperbaric oxygen treatment. This local series exemplified the range and limitations of the medical application of hyperbaric oxygen.

[Welsh, F, Maros, L and de Treville, RTP. *Aviat Space Environ Med.* 51(6): 611, 1980.]

XI SURVIVAL

41. The thermal properties of a survival bag incorporating metallised plastic sheeting.

Five male subjects were exposed to a cooling environment equivalent to 1082 W/M². The subjects wore a clothing assembly with insulation properties of 1.55 clo. A casualty bag incorporating metallised plastic sheeting was provided for additional insulation. Deep body temperature fell 1.2°C and mean skin temperature 2.6°C, over the 2-h period. Metallised plastic sheeting did not prevent heat loss throughout the clothing assembly, as indicated by the fall in body and skin temperature and an increase in metabolic heat production. From measurements made during the exposure, the calculated insulation value of the complete assembly of 2.93 clo was close to the predicted value of 2.80 clo calculated from the thermal resistance of the assembly layers. It is concluded that the metallised plastic sheeting in this casualty bag did not provide significant additional thermal insulation.

[Light, IM. *Aviat Space Environ Med.* 51(4):367, 1980.]

XII. WORK PHYSIOLOGY

42. Performance effects of alcohol intoxication and hangover at ground level and at simulated altitude.

Eight private pilots, four men and four women, were trained to perform on a two-dimensional track-

ing task (joystick control of a localizer/glideslope instrument) and to respond as quickly as possible to the onset of a red pinlight, appended to the tracking instrument, by depressing a button on the joystick. Tracking and reaction time scores were obtained under both static (stationary) and dynamic conditions (during angular acceleration), at ground level and at simulated altitude of 3658 m (12,000 ft). Subjects were tested in pairs one night per week for three consecutive weeks (alcohol, placebo, and sleep control sessions). Sessions began at about 1700 hours and continuing through midnight to about 1100 hours the next day. Subjects performed in the evening after a monitored dinner, drank prepared beverages from 2100 to midnight, and were tested again. Subjects slept 4-5 h, were awakened around 0645 were fed, and performed the tasks again, beginning about 0730. Ground-level test sessions always preceded ascent in the altitude chamber and sessions included completion of several questionnaires and rating forms by the subjects. At midnight following alcohol ingestion (3.25 ml of 100-proof alcohol/kg body weight), peak breath alcohol levels averaged 91 mg%. Impairment in tracking performance and in visual reaction time occurred during midnight sessions following alcohol ingestion. While ratings of hangover and other questionnaire data indicate awareness of hangover symptoms, no hangover-related performance impairment was recorded during morning sessions. In addition, no significant altitude-alcohol interactions on performance were obtained during either acute intoxication or hangover periods. These results thus offer no evidence contrary to the "8-hour rule".

[Collins, WE. *Aviat Space Environ Med.* 51 (4) : 327, 1980.]

43. Absolute and relative work capacity in women at 758, 586 and 523 Torr barometric pressure.

Six young women performed an incremental bicycle work test at sea level barometric pressure (P_a = 758 torr) and during acute exposure (1 h) to simulated altitudes of P_a 586 and 523 torr. Submaximal oxygen uptake (VO₂) for a given workload was independent of altitude but maximal oxygen uptake (VO₂ max) decreased 10 and 13%, respectively, at higher altitudes. Although heart rate (fc) was consistently higher at altitude for a given VQ₂, the slope of fc vs. VO₂ was

independent of altitude and VO_2 max. Exercise f_c appeared to be a function of the relative work load i.e. VO_2 as a percentage of VO_2 max measured at each P_B . Carbon dioxide (CO_2) elimination increased with altitude for a given VO_2 but also was a function of the relative workload. Pulmonary ventilation (BTPS), however, was consistently 10-15% higher at altitude when expressed as a percent of VO_2 max primarily due to an increase in respiratory rate. Compared to published studies on males, this increased

ventilation may impart a slight advantage to women in maintaining arterial oxygenation, but ventilatory reserve may be decreased and limited at higher altitudes. At altitudes down to P_B 523 torr, the control of f_c responses and decrements in maximal oxygen uptake in women were similar to males, but ventilatory control mechanisms differed.

[Miles, D.S. Wagner, J.A. Horvath, S.M. and Reyburn, J.A. *Aviat Space Environ Med.* 51 (5): 439, 1980.]