Abstracts of Scientific Papers to be Presented at Association's 1956 Meeting in Chicago

General Studies

Emergency Survival in the Arctic. KAARE RODAHL, M.D. Arctic Aeromedical Laboratory, Ladd Air Force Base, Alaska.

On the basis of recent developments, the role of the Arctic regions in future air operations is reviewed, with a description of the north polar basin as a new field of interest. Emphasis is placed on human factors in operations, survival, escape and evasion. A systematic analysis is presented of the survival situation in the Polar Sea, with a discussion of the environment in terms of macroclimate, microclimate, time distribution of temperature, wind chill factors, precipitation and snow cover, terrain and surface characteristics. On this basis, an analysis is made of the requirement for environmental protection, and the availability of water and natural food sources. Problems related to clothing, shelter, rations, techniques, and physical and mental fitness are discussed. Finally, an outline is given of the Arctic Aeromedical Laboratory's approach to these problems, with a discussion of some recent results.

Problems Involving the Pilot and His Tasks; the Changing Emphasis in Aviation Medicine. CAPTAIN ASHTON GRAYBIEL, (MC) USN. USN School of Aviation Medicine, Pensacola, Fla.

No other specialty has undergone the radical changes in emphasis which have characterized aviation medicine during its brief existence. Since the selection and care of the pilot was placed in the hands of physicians they have had a heavy responsibility in a contest wherein the flyer has continually battled plane and environment, and, sometimes, the enemy. The history of this contest discloses that with each important advance in aviation a human element usually appeared as a factor limiting the full exploitation of the technological advance. Thus far we have been concerned mainly with the health of the flyer and his microenvironment. But today we find that the pilot has reached the limits of his ability to carry out certain assignments even under favorable environmental conditions. The limiting factor is no longer comprised of such things as visual acuity, hypoxia, and disease. The limiting factors are to be found in the basic ability of the flyer to carry out an exacting task. Insofar as we have reached this point, the crucial problems are no longer medical in the usual meaning of this word. The question must now be put, how much responsibility does the flight surgeon have beyond the point of ensuring a healthy flyer operating in an acceptable environment?

The Development of an Aviation Medicine Residency Program. BRIG. GEN. M. S. WHITE, USAF (MC). Hq. Tactical Air Command, Langley AFB, Virginia.

A description is given of how a residency program has been established in aviation

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medicine at a military installation. The program furnishes a broad background for the further progress and practice of a physician in this specialty. A similar type of program can be instituted at any military or civil facility concerned with the problems of flying.

The Aeromedical Aspects of Turbo Prop Commercial Aircraft (Viscount) in the United States. LUDWIG G. LEDERER, M.D. Capital Airlines, Washington, D. C.

A study is presented on various aeromedical aspects of the turbo prop-type aircraft. The data presented was obtained from personal observation of the author on test flights, training flights, and ferry flights. Passenger comfort data were obtained by cabin attendants during regular commercial flights. Work areas, vision, vibration, noise levels, heating and ventilation, and pressurization are discussed as each affects cockpit areas, cabin areas, and ground maintenance. Wherever possible these topics are compared to conventional piston combustion gasoline-type aircraft now in general use in the United States.

Space Medicine

Gravi-Receptors. HUBERTUS STRUGHOLD, M.D. USAF School of Aviation Medicine, Randolph Air Force Base, Texas.

In studies on orientation in space, the centrally located otolith apparatus is widely discussed in the literature. Little attention is given to the peripherally distributed mechano-receptors such as specific nerve endings in skin, muscle and connective tissue. The receptors in question are the Meissner corpuscles in the skin, the muscle spindles, and the Pacinian corpuscles. After an anatomical description of their histology and numerical distribution in the human body, the part that their exteroceptive and proprioceptive function play under the conditions of zero-gravity is discussed.

Life at the Boiling Point of Tissue at Room Temperature. D. E. BEISCHER, PH.D. and SUE BORN, M.S. USN School of Aviation Medicine, Pensacola, Fla.

Animals known not to be very sensitive to anoxia (frogs, cockroaches, worms) were studied in an arrangement corresponding to the Torricelli tube. The animals live in the tube without oxygen in a water vapor atmosphere practically at the boiling point of their tissue at room temperature. Frogs survive under these conditions for one hour, cockroaches for two hours, and worms for five hours. Death is finally caused by anoxia.

In a second series of experiments the ambient pressure was lowered by a mechanical pump to values below the water vapor pressure at the prevailing temperature. The animals die under these conditions from dry-out in time intervals which depend on the ambient pressure. Physically, the effects of very low pressure on the animals correspond to exposure to a strong draft which removes all water from the body surface (forced surface evaporation.)

Ambient pressures corresponding to or lower than the water vapor pressure at body temperature are not functional limits for living tissue, *per se.* If means could be devised to avoid anoxia and freeze-drying, living matter may be expected to endure at very low pressure.

Temperature of a Space Satellite and Human Heat and Water Balance in It. K. BUETTNER, Departments of Meteorology and Physiology, University of Washington, Seattle, Wash.

Temperatures of high flying missiles and of space ships are controlled, initially, by air temperature and frictional heat; higher up the temperatures are controlled by solar and terrestrial radiation. At high altitudes the radiation temperature depends entirely on absorptivity of the surface coating and the geometrical pattern. The strong abrasive forces of high speed in air, extreme transient temperatures, and meteoric impacts make the choice of a suitable white paint quite difficult. Survival of a man or animal in a small and primitive container calls for use of all our knowledge on heat and mass exchange, clothing, etc. These

heat and mass exchanges vary strongly from high to zero gravity. Conditions in the container will enforce the use of human heat regulation and human heat capacity. In this respect the following physiological facts should be considered: (1) man can endure active overheating better than passive one; (2) the differences of individuals are important; (3) the water loss by nose breathing is much smaller than previously described; (4) water diffusion through human skin flows in both directions, (depending on direction of gradient); (5) no diffusion water passes if air having the same temperature as the skin and 80-85 rel. humidity (covers the skin of normal man); and (6) prolonged enclosure of feet in airtight rubber boots does not produce accumulated sweat water.

Sensomotor Performance during Weightlessness: Eye-Hand Co-ordination. SIEGFRIED J. GERATHEWOHL, PH.D., HUBERTUS STRUGHOLD, M.D., and HERBERT D. STALLINGS, Major, USAF. USAF School of Aviation Medicine, Randolph Air Force Base, Texas.

During dives and parabolic flights, von Beckh (1954) casually observed an adaptation of psychomotor behavior to the weightless condition. The object of the experiment reported here was to study systematically how well humans adjust their eye-hand coordination to conditions of increased and decreased gravity. Six test subjects performed a simple aiming test in a Lockheed T-33 aircraft. Each subject had to aim a pencil at the center of a test chart, and to hit it under 1 *g*, zero *g*, and 3 *g* conditions. Mode and rate of adaptation to the three gravitational states were determined by a quantitative evaluation of the hits with regard to their accuracy and position.

The hits made during straight-and-level flight were randomly distributed around the target. In the weightless state, however, the subjects tended to hit too high and less accurately especially during the first trials. The greatest deviations from the normal performance occurred during increased weight, yielding hits predominantly below the target. Compensation through learning was better for decreased than for increased weight, depending upon (1) number of repetitions, and (2) amount of *g* encountered. The results so far obtained also seem to indicate that this type of psychomotor adjustment to weightlessness is permanent, if a perfect level of adaptation was previously obtained.

Improved Techniques for Exposing Animals to Primary Cosmic Ray Particles. DAVID G. SIMONS, Major, USAF (MC) and DRUEY P. PARKS, 1st Lt., USAF. USAF Aero Medical Field Laboratory, Holloman Air Force Base, N. M.

The 1955 series of northern balloon flights conducted by the Aero Medical Field Laboratory were launched from geomagnetic 58° N at International Falls, Minn. The flights reached altitudes up to 126,000 feet ranging in duration between 8 and 26 hours. The experiments were designed for maximum exposure to low energy heavy primary particles such as iron nuclei. The marked improvement in altitude performance compared to previous flights was obtained by using larger balloons and flying nearly as many specimens in a capsule weighing a total of 65 pounds rather than 165 pounds.

Optimum Altitudes for Biological Experimentation with the Primary Cosmic Radiation. H. J. SCHAEFER, PH.D. USN School of Aviation Medicine, Pensacola, Fla.

The past two years have brought about great progress in the balloon technique. The altitude region about 5 $g/cm.^2$ pressure (120,000 feet) is now accessible for prolonged exposures of test animals. The question arises how closely these conditions verify the theoretical optimum of exposure to the heavy component of the primary radiation.

The relationships governing the attenuation of the heavy nuclei beam in the air ocean differ basically from those governing the distribution of thin-down hits in a limited target body of higher density (test animal). Isodose charts shown for the latter case demonstrate that beyond certain minimum altitudes focal centers of maximal hit frequencies develop in the exposed object. The focal dosage and location of these centers within the target depend in a complex way on the type of heavy nucleus, the size of target, and the altitude of exposure. The pertinent relationships are presented.

Whereas for small specimens (tissue cultures, seeds, skin of small rodents) the above mentioned ceiling altitude is optimal, considerably improved performance data are needed for maximal hit frequencies of the heaviest group (Ca and Fe nuclei) within the body of small or medium sized mammals.

Tracks of Heavy Primary Cosmic Ray Nuclei in Emulsion and Biological Tissue. HERMAN YAGODA. National Institutes of Health, Bethesda, Md.

Methods for the estimation of the charge of slow heavy primaries from their maximum delta-ray density are described. The resultant charge and energy distribution secured from emulsions flown at 94,000 feet is discussed from the viewpoint of the frequency of thindown hits in tissue. In small blocks of emulsion (7.6 x 7.6 x 1 cm.) the frequency diminishes roughly exponentially with increasing atmospheric depth. Under 16 g cm.$^{-2}$ of air 5.9 ± 0.5 heavy nuclein of $Z \geqq 6$ are observed to come to rest by ionization per cc. of emulsion per day of exposure. For this flight at geomagnetic latitude 55° N, the ratio of M-to-H-type nuclei producing thindowns is 4.45 ± 1. Two successful recoveries of emulsions flown to 130,000 feet are now in the process of study. Preliminary results on the external members of a (7.6 x 7.6 x 5.4 cm.) block (Ophelia) indicate 17 ± 2 thindown hits per cc. per day. In a second exposure at about the same elevation a (7.6 x 7.6 x 0.9) slab of emulsion was embedded horizontally, at eye-level, in a phantom of a human skull (Yorick). This experiment should provide an accurate measure of the heavy primary terminal hit frequency in brain and eye tissue free from the uncertainties in the evaluation of collision cross-sections in complex biological materials.

Tissue Cultures Exposed to High Altitudes. WALTHER HILD, M.D. Tissue Culture Laboratory, Univ. of Texas Medical Branch, Galveston, Texas.

Cultures of L-strain cells mounted in Rose chambers of 2 ml. capacity were sent aloft in pressurized, temperature controlled gondolas to altitudes of 120,000 to 130,000 feet. Exposure times varied between 8 and 36 hours. Cultures were examined immediately after descent and compared with controls. No differences including the number of dead cells were found. Tetraphenyltetrazolium chloride (TTC) was accumulated by fatty droplets in cells of both experimental and control cultures to the same degree, suggesting that there was no immediate detectable damage due to high altitude exposure. After subculturing both series there was an obvious difference in the mode of outgrowth. The control grew in typical sheets of one cell thickness whereas the descendants of the exposed cells formed starlike clusters which were maintained for several weeks. Such clusters are occasionally obtained from the L-strain but ordinarily to a lesser degree. Moreover, after repeated subcultures the typical pattern was re-established. There seemed to be no evidence of transitory or permanent damage to the exposed cells by cosmic rays as revealed by morphological studies.

Aviation Physiology

Effects of Various Pilots Tasks on Metabolic Rates. PERRY TILLER, B.S., HERBERT R. GREIDER, B.S., and EDNA GRABIAK, B.A. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

The use of an impermeable full pressure suit imposes a heat load above that normally encountered by aviation personnel. To determine the effects of wearing this suit, base line metabolic rates were established for flying personnel while wearing summer flying clothes and while exposed to various simulated flight conditions. Five such simulated flight situations were established for experimental purposes in the F9F-5 simulator. The situations were: take-off, combat, emergency, straight and level flight and descent and landing. Rest was also included as a condition. Metabolic rates were measured during these conditions. The results indicate that the combat situation produced the highest metabolic rates. The simulated

combat condition raised the heat production of the subjects an average of 50 per cent. Statistical analysis revealed that there are significant differences between all conditions. The probable cumulative effects of wearing the full pressure suit coupled with the added heat production resulting from the stress of combat are discussed in this report. Future plans for further research in this area are also mentioned.

Emission Spectroscopy in Analysis of Respiratory Gases. II. Carbon dioxide Analysis Using the Carbon Dioxide Doublets Near 2883 and 2896. A. CLAYTON S. WHITE, M.D., LOREN C. WATKINS, JR., B.S. and EDWARD E. FLETCHER. The Lovelace Foundation, Albuquerque, N. M.

Several small volume gas discharge tubes energized with rf and dc have been developed and employed as light sources for investigating the emission spectra of "dry" carbon dioxide alone and in the presence of various concentrations of oxygen and nitrogen. Under appropriate and standardized conditions, using the rf technique, the well-known and relatively strong carbon dioxide doublets near 2882 and 2884 Å and 2895 and 2898 Å have been recorded photographically and photoelectrically. Emission attributable to oxygen did not occur in either the 2883 Å or the 2896 Å spectral regions, but weak nitrogen activity existed under the operating conditions employed. The influence of the latter proved minimal, however, and calibration data indicated that emission intensity was a consistent and linear function of carbon dioxide concentration, although there were slight differences in the curves for carbon dioxide in air and carbon dioxide in oxygen.

Unconscious Incidents While Flying. Wing Comdr., T. J. POWELL, RCAF. Institute of Aviation Medicine, Toronto, Canada.

Seven pilots have been investigated for unconscious episodes while flying F-86 (1), T-6 (1), and T-33 (5) type aircraft. Their flying experience varied from 200 to 3,000 hours. Two of the incidents occurred in air-to-air firing exercises but the others were during straight and level flying. The altitude was considered significant in only one case. The periods of unconsciousness varied from a few seconds to six minutes. Three pilots were flying solo and, of these, two recovered consciousness to find themselves diving dangerously near the ground. One episode was probably due to hypoxia and one to the after effect of heavy drinking. The remaining five cases showed similarities in that the incidents occurred three to five hours after a light meal; disorientation immediately preceded the unconsciousness, and disorientation and nausea followed. Before the incidents the pilots were either apprehensive or annoyed. Hyperventilation was probably present. In two cases the prolonged, increased g of the firing exercise was a factor; they were unprotected by g suits. The EEGs showed no true epileptic patterns but three were borderline. One trainee pilot was removed from flying training because of a diagnosis of possible abdominal epilepsy; the remainder were allowed to continue flying without restrictions. No repetitions of the episodes have occurred in these individuals.

Hyperventilation and Simulated Altitude. F. A. SUNAHARA, PH.D., F. GIRLING, PH.D., R. A. SNYDER, PH.D. and E. D. L. TOPLIFF, B.A. Defence Research Medical Laboratories, Toronto, Canada.

Severe symptoms of acapnia have occurred below 30,000 feet both in aircraft and in decompression chambers (RCAF data). An attempt was made to reproduce the symptoms and measure the alveolar pCO_2 at which they occurred.

Voluntary, unassisted hyperventilation was attempted at ground level and at a simulated altitude of 25,000 feet. Respiratory rate and tidal volume were independently varied so that the ventilation volume increased two to four fold. The subjects breathed 100 per cent oxygen at ground level and at simulated altitude. There was no significant difference in the alveolar pCO_2 readings at altitude and ground level. All the subjects found that the higher ventilation rates were difficult to sustain. Mild symptoms of lightheadedness and tingling of the extremities were experienced. There was no carpopedal spasm or other visible evidence of acapnia, although the electromyograph

showed slight spontaneous muscular activity in some subjects.

On the basis of the present report it does not seem likely that hyperventilation can be achieved more easily at altitude than at ground level, providing that oxygen supply is adequate and there are no complicating conditions.

Emission Spectroscopy in Analysis of Respiratory Gases. III. Oxygen Analysis Using the Oxygen Triplet Located Near 7772. Å CLAYTON S. WHITE, M.D., LOREN C. WATKINS, JR., B.S. and EDWARD E. FLETCHER. The Lovelace Foundation, Albuquerque, N. M.

Small volume rf and dc activated discharge tubes have proven suitable as light sources for producing emission activity attributable to oxygen. Oxygen spectra appeared as a triplet near 7772, 7774 and 7775 Å and as a singlet near 8446 Å. Photographic spectographs obtained with the quantograph, a camera-equipped instrument using a 15,000 line/in grating for light dispersion, indicated that nitrogen activity occurred near the triplet and singlet when the dc light source was employed. Also, with the dc discharge tube operated at relatively low pressures, strong oxygen activity was apparent when carbon dioxide was the test gas, indicating that oxygen was being produced from carbon dioxide in the discharge tube. When the rf light source was operated at relatively high pressures, strong oxygen emission was noted, but nitrogen activity was decreased and no indication of oxygen production from carbon dioxide was apparent. The utility of the emission technique in quantitatively analyzing gases for oxygen content, using a prism instrument, was investigated and satisfactory calibration data were obtained.

The Catalytic Effect of Mitochrome on the Electron Transfer Mechanism of the Respiratory Enzyme Citochrome-C. HERMAN W. SHMUKLER, M.S., B. DAVID POLIS, Ph.D., and JOHN WYETH, M.S. USN Aviation Medical Acceleration Laboratory, Johnsville, Pa.

A new heme-protein, mitochrome, that was implicated in the high energy phosphate transferring mechanism of mitochondria, has been isolated in this laboratory. Further studies on this protein have demonstrated a catalytic effect on the electron transferring mechanism of the respiratory enzyme chain utilizing oxygen, and oxidizing reduced coenzyme-I. The site of action of the new heme-protein was localized at the cytochrome-C oxidation and reduction step. Electrophoretic studies show an interaction between the two proteins. The result of spectrophotometric and enzymatic studies suggest the formation of a cytochrome-C mitochrome complex that can be reduced with coenzyme-I, although both proteins are inactive alone. This demonstration of functional activity of mitochrome in the electron transferring mechanism, as well as in the phosphate transferring mechanism of cellular metabolism, helps to define the utilization and regulation of energy available to the cell as a result of its respiration.

Transthoracic Pressure in Man During Rapid Decompression. ULRICH C. LUFT, M.D., and RICHARD W. BANCROFT, Ph.D. USAF School of Aviation Medicine, Randolph Air Force Base, Texas, and The Lovelace Foundation, Albuquerque, N. M.

Dynamics of rapid decompression as reflected in the pressure across the chest wall were studied in a rigid model and in man. Peak pressures encountered in the dry model containing air were directly proportional to the absolute differential of decompression in the cabin regardless of the initial cabin pressure. In the human chest transthoracic pressure increased with the fractional differential as well as with the absolute differential of decompression (fractional differential is the ratio pressure change: initial pressure). The discrepancy between the model and the human lung is ascribed to water vapor generated in the lungs during decompression. The time characteristic for the lungs and airways of a subject decompressed in the end-expiratory phase of normal breathing was found to be 0.55 seconds. This is equivalent to the rate of decompression in a cabin of 200 m^3 volume with an opening of one square meter. Knowledge of the human decompression equivalent permits an estimate of safe or marginal conditions for decompression in terms of cabin volume and orifice.

Transthoracic pressure transients during decompression in a cabin with a time characteristic of 0.1 second at various simulated cabin and flight altitudes are described. Flow resistance in the respiratory tract appears to be much higher during rapid decompression than in quiet spontaneous breathing.

Brief Instantaneous Anoxia in Man. ULRICH C. LUFT, M.D., and WERNER K. NOELL, M.D. USAF School of Aviation Medicine, Randolph Air Force Base, Texas, and The Lovelace Foundation, Albuquerque, N. M.

Sudden anoxia was induced by decompression from 300 mm. Hg. (23,500 ft.) to 69 mm. Hg. (55,000 ft.) in 0.2 seconds, breathing oxygen at cabin pressure. Three phases of cerebral failure are observed in rapid sequence. First, a state of automatism, 13 to 15 seconds after decompression. Second, a phase of "arrest" with fixation of the eyes, loss of comprehension and cessation of spontaneous movements including respiration (onset 17 to 19 seconds). Third, progressive failure of postural tone interrupted by brisk muscular contractions. In the first two phases behavior is similar to that observed in psychomotor and "petit mal" seizures. The EEG changes are of the non-paroxysmal type. EEG activity may disappear entirely during the third phase. Duration of the exposure shown in this film was 12 seconds. Recovery becomes apparent 10 to 12 seconds after recompression to 300 mm. Hg.

Gaseous Cavity Formation in Explosively Decompressed Animals. LOUIS J. SANTAMARIA, B.S., and HERBERT R. GREIDER, B.S. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

An exploratory study was undertaken to determine the location and comparative sizes of gaseous cavities formed in explosively decompressed rats. Animals were maintained at sea level in a small, plastic covered chamber. This chamber was placed in a larger chamber which was evacuated to the desired simulated altitude. To effect decompression, the plastic lid of the animal chamber was perforated by a dart actuated by a pneumatic mechanism on the outside of the altitude chamber. The animal chamber was then rotated 180°, thereby dumping the animal into an ethyl alcohol and dry ice bath at approximately -100°C. Time was allowed for the animals to freeze completely after which the apparatus was recompressed to sea level conditions. Approximately one-half inch transverse sections were made through the head and torso at different levels. Color photographs were made of these frozen sections. The gross sections showed gaseous cavities in the thorax, abdomen, subcutaneous areas and in certain organs. Abdominal cavities were large with the gut occupying only a small portion of the whole transverse section. In other areas such as the head, neck and thorax, cavities were smaller.

The Estimation of Lean Body Weight (LBW) from Anthropometric Measurements. CAPTAIN ALBERT R. BEHNKE (MC) USN. USN Radiological Defense Laboratory, San Francisco, Calif.

Techniques developed during the past 20 years for the determination of whole-body specific gravity and total body water have made possible the estimation of LBW and hence of body fat in healthy men. These techniques, however, are too complicated for easy application. Recourse was made, therefore, to anthropometric skeletal measurements ($\overline{M}$ D) and it was found that $(\overline{M}\ D)^2 \times H \times k = LBW$, where H represents stature and k is derived from measurements on more than 4,000 individuals. From these data individuals may be classified on the basis of LBW and it can be shown that the adult mammalian lean body mass lends itself to definition in terms of a remarkably simple geometrical model.

Observations on Animals Exposed to Altitudes of 50,000 and 60,000 Feet. ALFRED F. FASOLA, Ph.D., JOHN KEMPH, M.D., and FRED HITCHCOCK, Ph.D. Laboratory of Aviation Physiology, Ohio State University, Columbus, Ohio.

Dogs fitted with a bladder partial pressure suit and plastic mask connected in such a way as to provide a pressure in the bladder suit equal to that supplied to the mask were exposed to simulated altitudes of 55,000 feet (69 mm. Hg.) and 60,000 feet (54 mm. Hg.). Pressures provided in the mask and suit were respectively 75 and 100 mm. Hg.

Observations were made on survival time, hematocrit, blood pH, blood gases and cardiac output. At 55,000 feet survival was usually for the duration of the experiment (several hours) but at 60,000 feet the animals usually survived for only a few minutes although one animal survived for more than four hours and one an hour and a half. The administration of ACTH (40 units per day for six days) markedly increased survival time. After exposure to altitude for one and one-half hours the following changes in blood were observed: (1) pH rose to about 7.50; (2) O_2 capacity increased, hematocrit increased; and (3) O_2 content, CO_2 content and percent saturation decreased. After exposure to 55,000 feet for one hour cardiac output, as determined by the dye dilution technique with Evans Blue, was decreased 60 per cent. The short survival time at 60,000 feet made cardiac output determination at this altitude impossible.

Preliminary Investigation of Bone Change Associated with Decompression Sickness. LT. KENNETH R. COBURN, (MSC) USN. Naval Air Station, Corpus Christi, Texas.

The etiology of decompression sickness is reviewed and the probable mechanisms of bubble formation are pointed out. The literature dealing with the incidence of asymptomatic aseptic bone necrosis in caisson workers is examined because of the similarity of conditions in caisson work and in low pressure chamber work. A Navy-wide survey was conducted in which long bone studies were made on all available low pressure chamber workers. The incidence of bone change is noted and discussed in relation to yellow marrow content of the bones and the adequacy of circulation in the long bones, particularly in the femoral heads.

Aviation Medical First Aid. W. R. FRANKS, M.D. RCAF Institute of Aviation Medicine, Toronto, Canada.

First aid has been defined as the "emergency treatment given before medical care can be obtained in cases of accident, injury or illness." It is becoming obvious that immediate treatment of aviation medical disabilities in the air has these dimensions. Professional assistance is removed, and treatment has to be administered by non-medical personnel, even self-applied. Delegation of aeromedical treatment to aircrew members presents certain problems and opportunities. The nature of the disabilities is liable to be peculiar to the air situation, entailing such factors as hypoxia, changed acceleration resulting in vascular alterations, trauma or disorientation with possible vertigo, aeroembolism, hyperventilation, aero syncope, visual failure at altitude in cloud or at night, fatigue, binaural disorientation, problem association with excessive heat, or conversely cold. Aeromedical first aid presents further peculiar problems, including (1) dangers from delegation of medical knowledge and self treatment to operating personnel; and (2) the content of the treatment. For instance, the manual application of suitable pressure in the *g* suit can often be an effective measure in conditions of reduced blood supply to brain, and similarly, 100 per cent oxygen has its place. The situation warrants reappraisal.

A Radioisotope Method of Determining Cardiac Output. ROBERT E. ZIPF, M.D., JOE M. WEBBER, M.D., G. RICHARD GROVE, Ph.D., and CAPTAIN TERRENCE F. MCGUIRE, USAF (MC). Research Department, Miami Valley Hospital, Dayton, Ohio, and USAF Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

A simple basic method for determination of cardiac output using albumen-bound radioactive iodine (RISA) is described. Several variations, suited to different purposes, are discussed, along with the derivations of the formulae involved.

The method was developed and extensively tested on a large series of subjects comprised of both the healthy and those afflicted with cardiovascular disorders.

The advantages of the method, along with the potential pitfalls, are enumerated. The method is not complicated, can be done by several technicians with a few hours instruction and practice, has less margin for human errors, and gives very satisfactory results. It is believed that it is applicable to a wide variety of physiological and clinical needs.

The Effect of Positive Pressure Breathing upon the Distensibility of the Capacity Vessels of the Upper Limb. FLT. LIEUT. JOHN ERNSTING, RAF. RAF Institute of Aviation Medicine, London, England.

The presence of an active reflex constriction of the superficial veins of the forearm has been demonstrated during positive pressure breathing. The pressure within the lumen of an isolated segment of superficial vein was recorded during various maneuvers including venous congestion, positive pressure breathing with and without trunk counterpressure, and during the Valsalva maneuver. The reflex veno-constriction was abolished when trunk counterpressure was applied during the pressure breathing.

A quantitative study has been made of the distensibility of the vessels of the hand during local venous congestion and positive pressure breathing with and without trunk counterpressure. The presence of reflex constriction of the capacity vessels during pressure breathing and its absence when trunk counterpressure was applied was confirmed. When the hand vessels were distended by pressure breathing without trunk counterpressure their distensibility was found to be about 75 per cent of that when they were distended by local venous congestion.

Some Characteristics of Pressure Breathing. GEORGE H. KYDD, Ph.D. and FRED A. HITCHCOCK, Ph.D. USN Aviation Medical Acceleration Laboratory, Johnsville, Pa., and Ohio State University, Columbus, Ohio.

Dogs anaesthetized with nembutal, breathing at increased continuous intrapulmonic pressures of 50 mm. Hg., have a type of respiration characterized by periods of apparent apnea broken, intermittently, first by an inspiration followed immediately by a short, brief exhalation. This type of breathing can be continued by the animal for periods up to 25 minutes, indicating that it is characteristic of the new steady state. The animals maintain a respiratory midpoint that is less than the maximum volume expansion of the total lung, which is an indication of the tonic expiratory effort being maintained while the lungs are inflated. Very small amounts of air are infrequently detected as slow exhalations by the flowmeter during the apneic periods. Integration of flowmeter curves of this type of breathing indicate that there is a deficit in the amount of air exhaled when compared with the volume inhaled. It is suggested that this deficit is made up by the animal during the apparent apnea, and that at least part of the apnea is a slow exhalation. The peak of expired gas flow is reached immediately following inspiration but the expiratory effort is continued, reaching its peak sometime later. When the respiratory center is stimulated by adding CO_2 to the inspired air, the expiratory phase becomes more evident in the flowmeter trace, and respiration, though proceeding at a higher rate and depth, is more normal. Thus, the "apneic" respiration consists of an inspiration phase not unlike the normal, and a greatly extended expiratory phase. From these experiments, it is not possible to define the limits of the expiratory and inspiratory phases as they vary with the intratracheal pressure.

Differential Diagnosis of Hematologic Diseases Aided by Mechanical Correlation of Data. LT. MARTIN LIPKIN, (MC) USNR and J. D. HARDY, Ph.D. USN Aviation Medical Acceleration Laboratory, Johnsville, Pa.

In recent years, increasing attention has been given to problems concerned with efficient classification, correlation and transmission of large amounts of available scientific information. The purpose of this study is to approach the question of whether the basic data used in the diagnosis of hematologic diseases can be cataloged mechanically, and whether functions involving correlation of this data can be performed with sufficient accuracy to present conclusions for further evaluation. Some functions used in medical diagnosis which are not imitated by a mechanical system are noted. It was found that basic data used in the diagnosis of blood dyscrasias can be translated into a code, which can be used to facilitate storage and correlation of this information. Marginal punched cards aided correlation of data with sufficient accuracy so that correct diagnoses were presented in 73 of 80 patients examined. The remaining seven (patients having more than one disease) were then analyzed using a system in which

weighted averages were determined. Identification of the correct diagnoses here was facilitated by this method. In no case was it possible to present an incorrect diagnosis, using either method.

Physiology of Pressure Suits. WING COMDR. HENRY L. ROXBURGH and FLT. LT. JOHN ERNSTING, RAF. RAF Institute of Aviation Medicine, London, England.

In pressure suits, man's respiratory and circulatory needs are best met by a suit which gives a constant even pressure over the whole surface of the body. No suit has been made however, which, under these conditions allows full efficiency of the musculature, the nervous, and temperature control systems. Further, the special senses, in all examples examined, have been seriously interfered with. As a result, in the practical case of use in military aircraft, pressure suits have been of the partial type and range from the simple pressure demand mask of Gagge to the capstan partial pressure suit. These are compromises which, at the penalty of respiratory and circulatory loads, minimizes the effects on other systems, and are subject to limits of time and pressure. An effort is made to state (for a variety of circumstances) the factors on which the coverage necessary can be based.

The Comparative Tolerance of Negroes and Caucasians to a Standardized Cold Stress as Indicated by Body Temperature and Metabolic Rate. CAPTAIN DONALD W. RENNIE, USAF (MC) and 1ST LT. THOMAS ADAMS, USAF Arctic Aeromedical Laboratory, Ladd Air Force Base, Alaska.

A relatively high incidence of cold injury among Negro troops exposed to a cold environment is well established. Whether this is due to different behavioral characteristics or inherent ethnic tendencies is yet to be determined. In an attempt to gather more information concerning this strategically important problem, the differential responses of Negroes and Caucasians to a cold stress were evaluated. Sixteen combat infantrymen, eight Caucasians and eight Negroes, were individually exposed to an air temperature of 10°F. for ninety minutes. During the exposure time continuous temperatures were recorded from twenty-two skin areas including the extremities, and oxygen consumption was continuously recorded by indirect (open circuit) calorimetric techniques. The individuals tested were all clothed in the same type of Air Force arctic clothing. The hands and feet remained exposed. Determinations were made during August and will be repeated during February of next year. The Negro group in August exhibited a greater cooling tendency insofar as extremities are concerned. Variations in the body temperature and metabolic rate response of these groups during the two exposure periods will be evaluated; the "adaptive" effects of exposure to the arctic winter climate will be evaluated on the basis of their response to this standardized cold exposure and the Negroe and Caucasian group will be compared with respect to their ability to acclimatize according to these criteria.

Thermal Reactions to Different Ambient Temperatures of Subjects Wearing a Ventilated Full-Pressure Suit at Altitude. HERBERT R. GREIDER, B.S., and LOUIS J. SANTAMARIA, B.S. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

The impermeability of the full-pressure suit, coupled with the temperature extremes encountered in flight, necessitates the use of pilot ventilation. The objective was the determination of subjective reactions to various ambient temperatures using different ventilating air temperatures and air flows at a simulated altitude. Two trained subjects wearing a ventilated full-pressure suit were exposed separately without replication for two hours to identical conditions. The experiments were conducted at a constant temperature and altitude, using ventilating air temperatures of 60°F., 75°F. and 90°F. and ambient temperatures ranging from 50°F. to 110°F. Ventilating air flow was maintained at 140 L/min(STP). At regular intervals, subject reactions concerning thermal sensations were recorded for the determination of three thermal zones: comfortably cool, comfortable and comfortably warm. There were only slight differences in thermal sensations for each ventilating temperature reported when ambient tem-

peratures varied between 60°F. and 100°F. At 50°F. and 110°F. ambient, greater differences for each ventilating temperature were observed. Conditions for comfortably warm, comfortable and comfortably cool zones are reported.

An Evaluation of the Present Status of Human Performance in Extreme Heat Environments. JOHN LYMAN, Ph.D. University of California, Los Angeles, Calif.

Physiological effects of heat stress are known to be correlated with a time-intensity function. Specific physiological changes depend on whether time or thermal intensity parameters dominate. Performance changes are not specific to time or thermal intensity. They may be the same independently of physiological differences, indicating that performance proficiency is not correlated with specific physiological changes. With overall physiological stress sufficient to strain the compensatory mechanisms of perception, performance breakdown occurs. Ventilated clothing in which a microenvironment can be economically produced that maintains physiological processes in zones of compensation or such that intensity effects are delayed, makes it feasible to consider that adequate performance proficiency may be maintained operationally. In extreme heat where overall protection is possible there may be unprotected local areas. Sensory distractions from these areas may disrupt performance. As the thermal barrier is entered the importance of microenvironments will probably increase and future problems will concern operational situations in which pilots will be relatively well protected but in which danger may arise from the distracting effects of local thermal stress, and equipment unreliability.

The Relation of Altitude to the Gaseous Composition of Flatus in Man. F. R. STEGGERDA, Ph.D. Department of Physiology, University of Illinois, Urbana, Ill.

By inserting one end of an open tipped catheter into the lower colon four to six inches beyond the anal sphincter and attaching the other end to a series of inverted water-filled cylinders, one can collect and measure the amount of flatus that is passed upon going to various altitudes in the decompression chamber. Along with volume changes, information can also be obtained concerning its chemical composition by analyzing for carbon dioxide and oxygen and calculating nitrogen by difference. The results indicate that the carbon dioxide concentration of the collected flatus samples progressively increases upon going to altitude. At 35,000 feet the average composition of CO_2 may be from 60 to 65 per cent. At ground levels, the CO_2 concentration normally ranges from 9 to 16 per cent. As the CO_2 concentration increases with altitude the percentage of O_2 and N_2 progressively decreases. The possible source of CO_2 and its relation to flatus and expired air composition as well as motility of the gastro-intestinal tract is discussed.

The Cause of Motion Sickness. CAPTAIN JACK E. STEELE, USAF. USAF Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Motion sickness is a syndrome caused by certain types of sensory stimulation. The usual cause is not excessive stimulation; the sense organs are working well within their normal range. In some situations, increasing total stimulation may decrease the probability of illness. Motion sickness is more readily understood in terms of the information handling capacity of the brain, the compatibility within the subject's reference frame, of the stimuli reaching several sensory systems and the subject's need and ability to remain oriented. Possible modes of operation of various preventive measures are discussed in terms of these measured parameters.

The EEG, Consciousness, and Sleep. CHARLES W. SIMON, Ph.D., and WILLIAM H. EMMONS, B.A. Hughes Aircraft Company, Culver City, Calif., and Rand Corporation, Santa Monica, Calif.

Few occurrences of reliable functional relations between electroencephalographic patterns and psychological processes have been found. In the present study, twenty-one alpha-dominant subjects were each presented with ninety-six items of information during an eight hour period in which consciousness varied between wakefulness and deep

sleep. Their ability to respond at the time and to recall the information upon arising was related to their electronencephalograms at the time of presentation. As the quantity and quality of alpha rhythms decreased during the two to seven second stimulation periods, there was a corresponding decrease in the subjects' abilities to respond and recall. With the absence of alpha frequencies and the presence of delta waves, no further responses of either type were elicited, although effects on subsequent learning were found. Twenty-two electroencephalographic patterns were distinguished along the wake-sleep continuum. The use of alpha frequencies and of movements are compared as criteria of consciousness and sleep. The implications of the study for training during sleep are discussed along with the application of the EEG as a valid and reliable measure to use in applied problems related to sleep and its effects.

Aviation Ophthalmology

Recent Advances in Aviation Ophthalmology. H. W. ROSE, M.D. USAF School of Aviation Medicine, Randolph Air Force Base, Texas.

New concepts, new test apparatus, and test methods in aviation ophthalmology are discussed. Special attention is given to visual acuity, depth perception, color vision, heterophoria, perimetry, and night vision in the selection of pilots.

A Study of the Effect of Flash Rate and on/off Ratio on the Detectability of Flashing Lights. LLOYD M. CRUMLEY, M.A., and WILLIAM ATKINSON, M.A. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

This experiment investigated the effects of varying the flash rate and on/off ratio of wing-tip lights upon time to detect the lights for five subjects. Flash rates tested were 40, 60, 80, 100, and 120 flashes per minutes; on/off ratios were 1/2, 1/1, 2/1, 3/1, and 4/1. The experimental situation simulated the operational condition of a pilot in a lighted cockpit searching for a pair of simultaneously flashing red and green wing-tip lights, which could appear two miles distant from the pilot, in one of fifteen positions distributed over a quarter sphere of a star background. An analysis of variance of the average reaction time for the fifteen positions indicated that subjects, on/off ratios, and the interaction of subjects and flash rates were significant sources of variation, whereas flash rates and the other interactions were not. On/off ratios under 2/1 were detected faster than those above 2/1.

Some Theoretical Considerations of Brightness Constancy as it Relates to Cockpit Lighting. WILLIAM O. HAMBACHER, M.A. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

A systematic evaluation of theoretical explanations of brightness constancy proposed by MacLeod, Gestalt theory, and sensory-tonic theory as they are related to problems of cockpit lighting is presented. Specifically, the possibility that the optimal brightness of a given instrument in an airplane cockpit is a complex function of its location on the instrument panel and the size, shape, position, and number of other objects on the panel is explored in some detail. Problems of dark adaptation and the auto-kinetic effect are examined in relation to the above theoretical structures. An experimental program designed to discover the basic parameters of brightness constancy and their application to cockpit lighting is outlined.

Detection of Separations Between Adjacent Signals on a Simulated PPI Radar Scope. ROBERT M. HERRICK, Ph.D., HELMUT E. ADLER, Ph.D., JOHN E. COULSON, Ph.D., and GERALD L. HOWETT, M.A. USN Aviation Medical Acceleration Laboratory, Johnsville, Pa., and Columbia University, New York, N. Y.

A simulated plan position indicator (PPI) scope was used to evaluate the effects of a number of visual variables upon the minimum signal luminance increment (ΔI) required for the detection of a separation between two identical signals. The signal luminance increment is the difference be-

tween the signal luminance and the scope face luminance. All of the variables, viz., background luminance, distance between signals, scan rate, and simulated phosphorescence decay, were of importance in determining threshold log $\underline{\Delta I}$ values. Differences in threshold log $\underline{\Delta I}$ among the observers were also statistically significant. Moreover, most of the interactions among the variables were statistically significant. As the background luminance increases, an increase in log $\underline{\Delta I}$ is required for detection of a given separation. The background luminance is the most important determinant of the threshold log $\underline{\Delta I}$. In general, for a given background luminance, the threshold log $\underline{\Delta I}$ must increase as the separation between signals decreases. The influence of simulated phosphorescence decay and scan rate upon log $\underline{\Delta I}$ thresholds is relatively small.

Eye Movement Patterns in Response to Moving Objects. SQUADRON LEADER BALRAI BHATIA, Indian Air Force. Defense Science Laboratory, New Delhi, India.

The investigation of eye movements in response to moving objects is important in military aviation. Eye movements of two subjects were recorded, by the corneo-retinal potential method, while they viewed an object moving vertically downward at certain uniform speeds and appearing at regular intervals, behind an aperture. The time of appearance and disappearance of the object at the aperture was also recorded. In response to the movement of the object, the eye slowly drifts downward and soon after returns to the upper border of the aperture by a flicking movement. This pattern of the eye movements is observed irrespective of the speed at which the object is moving. During the period between two consecutive exposures of the object, the eye displays frequent downward drifts followed by quick recovery movements. In the record of one of the subjects trained to see objects moving at high angular velocities, downward flicks of considerable amplitude are seen during the period of exposure of the object at the aperture. This is attributed, in an earlier report, to the ability of the subject to recognize the fast-moving objects.

Studies of Nystagmus and Oculogyral Illusions on the Human Centrifuge. R. FLANAGAN GRAY, M.A. USN Aviation Acceleration Laboratory, Johnsville, Pa.

Studies of nystagmus and oculogyral illusions were conducted at the eight foot radius on a human centrifuge. The subjects maintained, throughout any particular run, a constant seated-erect position looking tangentially in the direction of motion of the centrifuge into a lighted box. The nystagmus occurred usually with, but sometimes without, reports of oculogyral illusions. Oculogyral illusions occurred with and without measurable nystagmus. Subjects' descriptions of the oculogyral illusions differed in several ways from descriptions of oculogyral illusions at smaller radii of turn. Oculogyral illusions were found to vary in duration as a function of the period of angular acceleration and amount of angular acceleration. Oculogyral illusions which stopped during a period of constant angular acceleration were not renewed when the amount of angular acceleration was suddenly doubled. Some indication was obtained that coriolis acceleration, because of head movement, brings about changes of response through its action on the utricles rather than its action on the semicircular canals.

Acceleration and Decelaration

Acceleration Encountered in Navy Jet Fighter Aircraft. LT. FRANK H. AUSTIN, JR., (MC) USN and HOWARD N. HUNTER, B.S. USN Aviation Medical Acceleration Laboratory, Johnsville, Pa.

Acceleration stress patterns were recorded in an F9F-8 jet aircraft during catapult take-offs (steam and hydraulic types), combat maneuvers at various altitudes, and arrested landings. The accelerations were recorded simultaneously along the three axes of the aircraft and the point of measurement was directly below the pilot's seat. The conclusions that can be drawn from these recordings are:

1. Comparison of the steam and hydraulic catapults (fore and aft acceleration):

(a) Hydraulic type catapult delivers more of a square wave input of acceleration to the pilot.

(b) Steam type catapult reaches a higher peak (4.5 *g*) of acceleration on the pilot. However, the acceleration drops off more rapidly and at the end of the stroke is 2.2 *g*. The duration of acceleration is slightly longer.

2. Arrested landings (fore and aft acceleration):

(a) Peak *g* on an arrested landing is approximately 3.7 *g*. On occasion there is, in addition, a rather high positive force of 3.25 *g*, and

3. Combat maneuver at various altitudes:

(a) At altitudes below 30,000 feet, the positive *g* time patterns of jet aircraft are of low magnitude (3 to 5 *g*) for long periods of time (30 to 60 seconds).

(b) At higher altitude (30,000 feet and above), the maximum stress put on the aircraft is 2.5 *g*.

Gravitational Stress and Visual Acuity. WILLIAM J. WHITE and WARREN R. JORVE. USAF Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Experiments were designed to determine the relation between gravitational stress and visual acuity when the factor of cerebral circulatory competence is maintained by known ameliorative, protective measures. Protective measures included the conventional anti-blackout suits as well as prone, supine, and semisupine body position. Gravitational stress was produced experimentally. Visual acuity was measured with the Ortho-Rater. Findings of this experiment were: (1) visual acuity decreases progressively as magnitude of gravitational force is increased above 1 *g;* and (2) the hypothesis that a reduction in visual acuity is due to reduction in the blood supply to the head region of the body is rejected. Two hypotheses are proposed to account for decrement in visual performance during gravitational stress. These hypotheses are: (1) involvement of the autonomic nervous system and its effect on visual acuity; and (2) changes in eyeball shape in the direction of gravity. The latter hypothesis is tentatively accepted to account for acuity changes obtained when this visual function is measured during gravitational stress.

Utilization of a System of Gimbals on the Human Centrifuge for the Control of Direction of Acceleration on a Subject. RICHARD J. CROSBIE, M.A. USN Aviation Medical Acceleration Laboratory, Johnsville, Pa.

A unique feature of the human centrifuge in this laboratory is the incorporation of a system of gimbals which is used to control the direction of acceleration on a subject. The movement of the gimbal system, which is a function of both the angular velocity and angular acceleration of the centrifuge, is accomplished by means of program cams. Consideration must be given in calculating these cam contours to the response characteristics of the respective drive motors in order that precise co-ordination between the gimbal motion and the speed of the centrifuge may be accomplished. Methods are described for determining cam contours for particular *g*-programs, and an evaluation given on the utilization of this unique feature.

Physiological Reactions to the Supine Position. LT. PHILIP J. DORMAN, (MC) USNR, and RICHARD W. LAWTON, M.D. USN Aviation Medical Acceleration Laboratory, Johnsville, Pa.

Physiological studies on the human centrifuge from this and other laboratories have demonstrated increased resistance to blackout under positive *g* in subjects placed in the supine position (85° backward tilt) relative to the vector force. Because 85° of supination is unworkable in present-day airplanes, a 65° supine seat was built and tested in our laboratory. This seat provided forward flexion of the neck and free use of the extremities. Forty volunteer subjects, including fleet pilots, were thus tested at a level of 7 *g* for 30 seconds, using loss of peripheral vision as an end point. Fifty per cent of the subjects were capable of withstanding 7 *g* for 30 seconds sitting upright with or without a Navy Z-2 antiblackout suit. The remainder failed even after being supinated to 65°. These subjects were then retested in the 65° supine position wearing Z-2 suits (7 to 9

pounds suit pressure). Under these conditions every individual has been able to withstand a 7 *g* accelerative force for as long as 30 seconds, although the unprotected *g* tolerance in some subjects was as low as 2.5 *g*.

Calibration Problems and Uses of X-ray Cinefluorography. CARL CLARK, Ph.D. USN Aviation Medical Acceleration Laboratory, Johnsville, Pa.

The calibration problems for quantitative densitometry of the x-ray motion pictures are presented. Such calibrations allow the interpretation of density as well as position variations within the subject. The potential biological application of x-ray cinefluorography to problems of acceleration is reviewed and partially illustrated.

Some Recordings of Vertigo Occurring During Aerobatics. WALTER H. JOHNSON, M.D. Institute of Aviation Medicine, Department of National Defence, Toronto, Canada.

Loss of bearings during flights is distressing and dangerous to the extent of having caused many fatal accidents. It is estimated that spatial disorientation (and vertigo) is currently responsible for about 25 per cent of air force accidents. As the results of recording involuntary eye movements both in the laboratory and in various types of aircraft (propeller driven and jet propelled), it is possible to determine the subjective sensations of the pilot during aerobatics. Moving pictures of such recordings together with an interpretation of the results are presented.

Comparison of Human Tolerance to Acceleration of Slow and Rapid Onset. ROBERT EDELBERG, PH.D., JAMES P. HENRY, M.D., PH.D., 1ST. LIEUT. JOHN A. MACIALEK, USAF, 1ST LT. EDWIN W. SALZMAN, USAF, and 1ST LT. GEORGE D. ZUIDEMA, USAF. USAF Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Blackout levels have been determined for 26 humans on the USAF centrifuge using a standard rate of onset of 1 *g*/sec. and a slow rate of 0.15 *g*/sec. The slower rate of onset produced blackout thresholds which averaged 2.2 *g* higher than for the standard run. Arterial pressure at eye level was higher in the gradual onset run than in the standard run at any given acceleration. It is believed that the more gradual rate of onset gives time for circulatory reflexes, mainly vasomotion, to become effective, hence the higher tolerance. This increment may be regarded as an index of circulatory reflex activity. In view of this, the interesting individual correlations found between the amount of *g*-protection afforded by the gradual onset run and by the anti-*g* suit implies that the *g*-suit relies heavily on intact circulatory reflexes to achieve its protection. The function of the *g*-suit may be to carry the pilot through the period before circulatory reflexes become effective.

A Study of the Feasibility of Continuous Blood Flow Measurement Under Acceleration Stress Using Radioactive Tracers and Without Taking Blood Samples: JOHN TAYLOR, M.S., and RICHARD CROSBIE, M.A. USN Aviation Medical Acceleration Laboratory, Johnsville, Pa.

On the basis of a two-volume model, it is possible to relate flow to the concentration of an isotope in one volume if the concentration of isotope in the other volume can be known as a function of time. The data that have previously been obtained indicate that it is possible to calculate the concentration of an isotope such as radioactive Kr^{79} in the arterial system. The equation relating the variables to flow is not solved for the general case since the data can be used directly in this equation. The method is illustrated by using data from previous measurements of cerebral blood flow involving blood sampling.

The Sodium and Potassium Content of Brain and Muscle of Rats Subjected to High Acceleration. LT. CDR. BENJAMIN F. BURGESS, JR. (MSC), USN, CAPT. CHARLES F. GELL (MC), USN, and LT. CDR. DORIS CRANMORE (MSC), USN. USN Aviation Medical Acceleration Laboratory, Johnsville, Pa.

Male albino (Wistar) rats were subjected to a radial accelerative stress pattern consisting of a twenty-second exposure to 20

g followed by a one minute rest period. This procedure was continued for one hour allowing each animal to receive an average of forty exposures to this sublethal stress. Upon completion of the stress pattern, the animals were decapitated and the entire brain and a section of the rectus femoris muscle were removed and analyzed for their sodium and potassium content. The results obtained indicate a significant decrease in the muscle and brain potassium. There was a significant increase in muscle sodium; however, the brain sodium remained unchanged. In one series of rats, a sublethal intraperitoneal injection of sodium amytal was given three minutes prior to decapitation. In contrast to the unanesthetized series, this group showed an increase in brain potassium in the stressed animals; however, the muscle potassium decreased in a manner similar to that of the group receiving no anesthesia. The sodium distribution in muscle and brain of anesthetized stressed animals was identical with that found in the unanesthetized stressed rats.

The Physiological Significance of the Dislocation of Organs and Tissues of Rats Exposed to Graduated Increments of Acceleration Stress and Time. CAPTAIN CHARLES F. GELL, (MC) USN, and LT. COMDR. DORIS CRANMORE (MSC), USN. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

Two studies were previously completed by the authors. In the first, the anatomical configuration of rats exposed to acceleration stress was fixed by quick freezing on a centrifuge; in the second, the rate of quick freezing of animal tissue was determined. From the information acquired in these studies, it was decided to effect a fixation by quick freezing of rats exposed to extremes of acceleration stress in order to correlate the degree of visceral displacement under progressively increasing *g*/time exposures. Despite a carefully planned and executed program it was found that within the *g*/time patterns the visceral displacements could not be classified by mensuration. It was noted that the extremes of displacement occurred early in the *g*/time pattern. It was hypothesized that the physiopathological disturbances resulting from acceleration stress were induced by the time element rather than by the degree of visceral displacement. Characteristic photographs of visceral displacement due to positive, negative and transverse *g* stress were secured. The relationship of these visceral displacements to tumbling and minimal lethal levels of exposure to acceleration stress are discussed.

Experiments on Adaptation to Acceleration with Guinea Pigs and Rats as Test Animals. LT. COMDR. DORIS CRANMORE (MSC), USN. LT. EDNA E. MCCORMICK (MSC), USNR, and H. L. RATCLIFFE, D.Sc. USN Aviation Medical Acceleration Laboratory, Johnsville, Pa.

Rats and guinea pigs were exposed to high levels of negative acceleration (20 to 30 *g* for twenty to forty-five seconds) five times per week for three weeks. During the first week the effects of these exposures were hemorrhage from the nose and ears and into the conjunctival tissues, edema of the facial and extracranial soft tissues, loss of balance and respiratory difficulty. These signs of damage were accompanied by loss of weight and pronounced decreases in hematocrit values. During the second and third weeks of exposure, signs of adaptation to acceleration were decreasing hem crrhage and edema, and recovery of weight losses and of hematocrit values. These changes were associated with moderate increases in the weights of adrenals, which, from microscopic examination, can be attributed to hyperplasia of the adrenal cortex.

The Aeronautical Medical Equipment Laboratory Linear Accelerator. RAYMOND FONASH. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

The AMEL linear accelerator is a catapult device incorporating a test sled and 350 feet of rails. It is utilized for research and development projects concerning crash protection and dynamic evaluation of structural systems and associated personnel equipment and cockpit equipment. The accelerating energy is obtained from the isentropic expansion of a fixed air mass en-

trapped in an accumulator, the outlet of which is connected to an engine cylinder. The air mass is sealed in the accumulator by a piston plunger, and the force exerted by the air mass is counterbalanced by hydraulic fluid under pressure. The acceleration pattern is controlled by regulating the hydraulic pressure. Accelerations of 2 to 40 *g* can be accurately obtained by establishing the pressure of the air mass. To satisfy linear and infinitely variable acceleration build-up requirements, a system has been designed to eliminate the hydraulic pressure and allows control of the air mass directly. Accelerations and strains are recorded through the use of a direct recording thirty-six-channel oscillograph system. In addition to this information, high speed cameras record action and displacement against a background grid.

Survivable Supersonic Ejection: A Case Study to Correlate Medical, Experimental and Analytical Data by Reconstruction of an Incident. JAMES F. HEGENWALD, JR., B.S., and W. VINCENT BLOCKLEY, B.A. North American Aviation, Inc., Los Angeles, Calif.

The seat ejection experienced by test pilot George Smith on February 26, 1955, is generally conceded to be the most severe incident of this nature ever survived by a human. This report outlines the procedure by which the information available regarding this ejection has been utilized to reconstruct in detail the force-time-direction history of the man. Secondly, the analytically reconstructed history is compared with data obtained by telemetering from accelerometers mounted in a seat and dummy ejected from a sled vehicle under conditions equivalent to those of the actual incident. Finally, the medical record of the injuries sustained by the pilot is examined in the light of the reconstructed histories in an attempt to relate the physical forces involved to human tolerance criteria, as an aid to realistic evaluation of escape system capabilities and limitations. It is concluded that by attacking specific elements in the complex trajectory of seat and man, the over-all effect of superimposed accelerations can be held within survivable limits in future designs for ejection seats to be used at high indicated air speeds.

Some Thresholds of Gross Bodily Injury in Rats Resulting from the Application of High Linear Decelerative Force. LEONARD M. LIBBER, Ph.D. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

In a factorially designed experiment, ninety-six female rats were decelerated at various levels of peak *g* (from 150 to 400 *g*) for either long (approximately 8 milliseconds) or short (approximately 4 milliseconds) durations. The two-fold objective was (1) to determine thresholds of force necessary to induce various gross bodily injuries and (2) to determine the effect of increasing the duration over which these forces acted. To avoid localized effects, the animals were imbedded in plaster-of-Paris in an electronically instrumented pendulum. The pendulum and animal were decelerated against a flat steel spring fastened to a concrete block. Two durations of *g* for each level of peak *g* were obtained by varying the dropping height and/or the spring. Thresholds for the induction of intracranial hemorrhage, bone fracture and corneal reflex loss respectively were determined. Thresholds for intracranial hemorrhage and bone fracture were close together while that for corneal reflex loss was much higher. Effects of increasing the duration are also reported.

Effects of Mechanical Force on Living Tissues. II. Supersonic Deceleration and Windblast. LT. COL. JOHN P. STAPP, USAF (MC), and 1ST. LT. C. D. HUGHES, USAF (VC). USAF Aero Medical Field Laboratory, Holloman Air Force Base, N. M.

Anesthetized chimpanzee subjects were exposed to accelerations exceeding 28 *g* during 1.8 seconds followed by decelerations exceeding 25 *g* lasting for two seconds or more with no injury except in experiments where an axillary belt restricted the chest. During deceleration, abrupt impingement of straps against the chest elevated intrathoracic pressure in those cases where the axillary belt prevented displacement. This pressure was transmitted hydrostatically to the subject's head resulting in facial edema and ocular hemorrhage. The onset of windblast in not less than 50 milliseconds to more than 2800 pounds per square foot

was sustained without injury as long as the subject's head was enclosed in a windproof helmet and head and extremities were adequately secured. Application of these findings to methods of escape from supersonic aircraft in flight are discussed.

Effects of Mechanical Force on Living Tissues. III. A Compressed Air Catapult for High Impact Forces. LT. COL. JOHN P. STAPP, USAF (MC), and 1ST. LT. W. C. BLOUNT, USAF. USAF Aero Medical Feld Laboratory, Holloman Air Force Base, N. M.

A compressed air catapult has been designed and installed at this laboratory to investigate controlled rates of change of deceleration in the range of 50 *g* per second to 5,000 *g* per second for peaks ranging from 5 to 200 *g* for durations of less than 1/10 second. Animal or human subjects can be attached to a platform mounted on slippers on a 120-foot track. An 18-foot stroke of the catapult can accelerate this platform to 150 feet per second, permitting subsequent deceleration in distances ranging from 2 to 48 inches, either by impingement on lead cones or against a piston displacing water from a cylinder through controlled openings. Up to 100 channels of direct wired intelligence from a variety of pickups on the platform and subject can be transmitted to oscillographs through a trailing cable. Precise control of body position, rate of application and magnitude of force applied during less than 1/10 second are demonstrated with this device with unlimited continuous coverage of physical and physiological phenomena by optical and electronic instruments.

Effects of Mechanical Force on Living Tissues. IV. Time Motion Studies on Escape from Air Transport Following Exposure to Crash Forces. LT. COL. JOHN P. STAPP, USAF (MC) and 2ND LT. SIDNEY T. LEWIS. USAF Aero Medical Field Laboratory, Holloman Air Force Base, N. M.

Human volunteers were subjected to decelerations of 6 *g* and 12 *g* in an aft facing and forward facing seated position on the crash restraint demonstrator. This device consists of an aircraft seat mounted on a small platform moving on rails. Abrupt release of stretched shock cords catapults the platform, seat, and occupant about 10 feet along the rails into preset mechanical pinch brakes that stop the motion in less than 2 feet, imparting the desired decelerative force to the subject. Immediately after exposure, each subject released the seat belt manually and proceeded along an aisle from 10 to 50 feet in length to an emergency exit. Time motion studies were made beginning at the instant of seat deceleration to successful completion of exit through a door. High speed motion pictures and electronic timing in addition to accelerometer and strain gauge measurements of decelerative forces were accomplished. Comparison of the reactions of more than twenty subjects are discussed. Recommendations are made regarding seating of transport passengers in relation to escape from survivable crashes.

The Development of Automatic Separation and Parachute Deployment for Navy Ejection Seat Systems. C. T. KOOCHEMBERE. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

A study of medical reports concerning emergency ejections of both Navy and Air Force pilots indicated that a high percentage of the fatalities occurred at altitudes of 2,000 feet or less above the terrain. Further investigations outlined the problem as one of time, involving separation from the seat and deployment of the personnel parachute by manual means. Reports from pilots surviving low or high altitude ejections indicated that severe tumbling, high accelerations, and air blast following ejection contributed to pilot disorientation, confusion, and inability to act quickly. Recognizing the need for an automatic system of pilot separation and parachute deployment, this laboratory embarked on a program to effect the design, development and evaluation of such a system. Theoretical ejection seat and pilot trajectories, flight paths and associated accelerations and loads were calculated to determine the optimum time of automatic separation. Static, dynamic, environmental and instrumental flight tests at altitudes of 100

to 5,000 feet above the terrain were conducted with prototype models. This automatic system is presently being installed in all operational naval aircraft incorporating ejection seat systems.

Trajectory Studies of Ejection Seat Systems in High Performance Aircraft. C. WOODWARD, B.S. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

Because the performance of aircraft has reached a point where the system of emergency escape by ejection seat is being utilized to the limit of its capabilities, and sometimes even exceeding this limit, it has become necessary to investigate more accurately the theoretical paths or trajectories of the seat and pilot over the tail of the aircraft. Each high performance aircraft requires a separate analysis, at its maximum performance, under the most adverse conditions for escape. This analysis can become extremely complicated by considering the many variables which are present. Some of these variables can be determined easily; others can be determined only through extensive wind tunnel or high speed sled tests. Other variables must, of necessity, be assumed. Therefore, the accuracy of the trajectory analysis will depend on the number of variables which are considered and the assumptions that are made. Through experience, and by comparing actual and calculated trajectories, it is possible to eliminate certain of the more complex variables and predict a trajectory within close limits. This simplified method of trajectory analysis is discussed in detail.

Passenger Transportation

Patient Passengers: A Summary of Recent Concepts and Some Considerations for the Future. OSCAR H. COMESS, M.D. Chicago, Ill.

The paper deals with the varied sources of information concerning the indications and/or contra-indications for air travel of the ill. It emphasizes the need for a national representative body of medically interested groups to formulate such criteria and to distribute this information to the medical profession and lay people. In like manner a plea is made for the establishment of a committee to formulate uniform methods in the statistical approach to the reporting of medical aviation material. It is recognized that only by an unbiased approach to the problem of establishing criteria and statistics in a well rounded educational program, transportation of the ill by air can be recommended on a more rational basis.

Medical Problems in Hostess Selection. HEINRICH J. GARTMANN, M.D. Swissair, Zurich, Switzerland.

The reasons for frequent absences due to illness among air hostesses are discussed and the motives for the professional failures are analyzed. Furthermore, different possibilities for the relief of this problem is mentioned, the most important of which depend upon rigorous selection of new candidates. The most salient features in the selection program are discussed, including such categories as professional aptitude tests, medical examinations, and a history of the background of the candidate.

Medical Problems in International Airline Operation. OTIS B. SCHREUDER, M.D. and JOSEPH G. CONSTANTINO, M.D. Pan American World Airways System, Atlantic Division, Jamaica, N. Y.

The program of the medical service of an airline encompasses the field of aviation medicine in its widest range, including the allied fields of preventive, clinical and occupational medicine. A few selected problems are presented. These include the problems of selection, maintenance of health, clinical problems, epidemiological factors, miscellaneous problems and problems of the future. In maintenance of health, particularly of the pilot, its relation to flight safety is stressed. Of particular interest and peculiar to international airline operations are the numerous clinical and epidemiological problems. These include mainly the

parasitic and tropical diseases. When one considers the increasing amount of international travel and the increasing speeds of commercial air transports one can readily appreciate the closeness of continents with their existing medical problems.

Electrocardiogram Changes and Evaluation in Airline Flight Personnel. G. J. KIDERA, M.D. and C. E. MURPHY, M.D. United Air Lines, Chicago, Ill.

For the past eighteen years electrocardiograms have been a part of the annual company physical examination of flight personnel. Many changes of both minor and major nature have been discovered on routine electrocardiography. The paper deals with the enumeration of these deviations and shows follow-up electrocardiograms in some instances over a fifteen year period. The changes are correlated with physical examination and laboratory findings, such as basal metabolic rate, gall bladder visualization, and ballistocardiography. The decision as to physical qualification for flight is discussed.

The Management of Severely Crushed Chests. EDWARD E. AVERY, M.D. Wesley Memorial Hospital, Chicago, Ill.

In this day of mechanization with increasing traffic congestion and greater speeds both on land and in the air, severe injuries of the thorax occur with increasing frequency. Upon admission to the emergency room simultaneous treatment must be carried out for shock, anoxia, hemorrhage, pneumothorax, atelectasis, bronchial obstruction, and flail chest. As treatment for shock is begun an upright chest X-ray should be taken for evaluation of the multiple injuries to the chest. Intercostal catheters should be inserted into the pleural space and connected to watertrap drainage to relieve hemo-pneumothorax. A bronchoscope, or at least an endotracheal tube, should be inserted immediately to insure an adequate airway delivery of oxygen and aspiration of secretions. A closed system with an oxygen bag should be used to ventilate a patient with flail chest until other measures can be instituted. Methods of external stabilization of the chest wall can be tried, but in severe crushing injuries they are often inadequate. A new method of stabilizing the flail thorax is presented through the use of mechanical ventilation by means of a specially designed respirator delivering a fixed volume of gases for prolonged intermittent positive pressure endotracheal ventilation. The Mörch piston-type respirator has been found very effective in stabilizing these critically crushed chests without the use of external traction. Experimental studies and the clinical application of mechanical hyperventilation to patients with crushed injuries of the chest are presented.

Electrocardiographic Disqualifications for Flying. CHARLES W. KLANKE, M.D., Houston, Texas.

Infarction and zones for injury of the heart in relation to flying, with particular reference to the 8,000 feet pressurized cabin, is discussed. Conclusions are drawn for both pilots and passengers relative to local cardiac anoxia.

Care of Aircrew Engaged in Military Air Transport Flying. WING COMMANDER JOHN R. R. JENKINS, RAF. Transport Command, Royal Air Force, Wiltshire, England.

It might appear that scant justification exists for a treatise confined to the topic of care of aircrew engaged in military air transport flying. Many of the basic problems with regard to their care undoubtedly do not differ from those of aircrew engaged in other forms of military flying. Nevertheless successful pursuit of the aim of maintaining flying efficiency and diminishing risk of flying fatigue in men regularly engaged in long range military aircraft route flying does necessitate particular attention to certain aspects of aircrew care. Military air transport crew members often spend more than one third of each year, in aggregate, away from their home bases, as transients remaining overnight in staging posts of varying type. Interests of health, flying efficiency, and flying safety require that closest attention be paid to flying hour limitations; circumstances of reception and accommodation in transit; qual-

ity, balance and timing of meals (pre-flight, in-flight, post-flight); hygiene of messes at far flung staging posts; and climate problems posed by flying routes which traverse combinations of temperate, arctic, sub-tropical and tropical zones.

The Flight Recorder in Aeromedical Research. JAMES J. RYAN. General Mills, Inc. and the University of Minnesota, Minneapolis, Minn.

Flight recorders, capable of continuously measuring altitude, airspeed, vertical acceleration, magnetic heading and flight time, if carried by every aircraft as recommended by the CAA, would make available to aviation medicine means for scientifically analyzing the performance of man and machine under all conditions of flight. Aeromedical research is dependent for its development upon scientific sources of information. The recorder presents a history of the same basic indications that the pilot observed in the cockpit. Air mishaps occur when the craft does not respond to the pilot's wishes, or when information is incorrectly interpreted through instrument error, misunderstanding, or matters of judgment. Aeromedical studies of the flight record would (1) materially aid the investigation of failure and crash, (2) correlate the effects of turns and dives under centrifugal force, (3) present a measure for human reaction to turbulent air and vertical acceleration, (4) indicate the effects on the environment through oxygen deficiency with cabin depressurization, (5) allow means for review of training and checkout evaluation of pilots, and (6) permit the analysis of individual flight techniques for comparison with performance standards.

Anthropometry in Aircraft Engineering Design. J. A. ROEBUCK, JR. Douglas Aircraft Company, Santa Monica, Calif.

The special problems of aircraft design require close scrutiny of anthropometric data in providing optimum comfort in minimal space. A program for the collection and application of anthropometric data should be integrated with design practice by including the following phases:

1. Researchers should be encouraged to obtain directly useful dimensions sufficient to establish the position of the man in the working space and to obtain other physical data, such as centers of gravity and hinge points of body parts, areas, moments of inertia and density.

2. Data should be reduced to clear presentations in engineering language. Use of normal probability paper helps achieve this goal and reduces drafting and calculating time.

3. Anthropologists should then devise means to tell the designer how much his machine should vary to accommodate various percentages of population.

4. After final product development, customer reactions should be collated with test data and mockup evaluations in order to conserve and enrich design experience. In the future, working space may be controlled by dimensioned installation drawings which define a space envelope within or around which equipment items will be placed.

Progress in Aeromedical Evacuation. COLONEL L. RENDER BRASWELL, USAF (MC). Hq. Military Air Transport Service, Andrews Air Force Base, D. C.

Aeromedical evacuation is efficially recognized as the preferable means of moving patients between military medical facilities, and has proven the ideal method of transporting the sick and wounded. Patients can travel long distances quickly and comfortably by air, benefiting sooner from highly specialized medical care. MATS transported the average patient over two thousand miles in 1954 in less than eleven flying hours. Experience indicates a patient who is transportable by any means can be moved by aeromedical evacuation.

At the outset, aeromedical evacuation operations were confronted with the problem of justifying the use of aircraft to routinely move patients on a day-to-day, sustained basis. This situation no longer exists. Specially designed airplanes are now committed exclusively to aeromedical evacuation.

Modern therapy has reduced the need to

transport patients with communicable diseases, but appropriate preventive measures are required and taken to minimize spread of infections.

This report includes progress of past five years and present status of MATS aeromedical evacuation equipment and operations.

Radioactive Contamination of Aircraft. CAPTAIN JAMES L. DICK, USAF and CAPTAIN JOHN W. LANE, USAF. Air Force Special Weapons Center, Kirtland Air Force Base, N. M.

Radioactive contamination has assumed major importance as a new industrial hazard with the advent of nuclear weapons and nuclear power sources. The lack of standardization of sampling and measuring surface contamination, and the definition of conditions under which conservative tolerance limits are to be applied, has greatly hampered routine servicing, maintenance and repair of radioactive aircraft. Mounting evidence such as the contamination of the Marshallese, individual fallout studies across the nation, and studies conducted during the Nevada test series last spring on air crew dosages and hazards experienced by maintenance personnel working on contaminated aircraft, re-emphasizes the fact that industrial tolerance limits are too low and cannot be used indiscriminately in field operations. Present industrial tolerances, in many instances, are based upon levels of radiation established for laboratory facilities which were designed primarily to insure an environment suitable for the operation of nuclear instrumentation, and as a measure of the techniques of employes in handling radioactive material, rather than on the basis of the health hazard involved. New levels of radiation tolerances should be established in terms of what constitutes a health hazard when working on contaminated equipment or in contaminated areas. These tolerance levels should be carefully determined with a thought of allowing for their practical application, and with a minimum of indiscriminate safety factors.

Noise and Vibration

Audiometric Studies of Flight Line Mechanics. CHARLES I. BARRON, M.D. Lockheed Aircraft Corporation, Burbank, Calif.

The effect of aircraft engine noise upon the auditory acuity of over five hundred flight line mechanics for exposure periods up to ten years has been studied. The mechanics were regularly engaged in the servicing of reciprocating, turbo-prop and turbo-jet engines for an airframe manufacturer. Audiometric comparisons were made on the basis of the first and last audiograms of periodic serial tests, and changes defined in terms of significant threshold elevations for the various test frequencies. Ambient noise levels and octave band distribution of the various engines were carefully measured, although it was impossible to delineate subjects by specific type or duration of noise exposure. Statistics are presented for several groups using ear protection of various types and for various time intervals. Comparative changes occurring at the 4,000 cps. frequency plotted against years of exposure are graphically illustrated.

Effect of Noise on Psychomotor Performance. HARRY J. JERISON, PH.D. USAF Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

The importance of maintaining highly reliable human performance during the pre-airborne and airborne phases of jet flight has resulted in a major research effort to determine behavioral effects of high energy noise. This paper presents some recent findings from this laboratory.

Three major results can be reported. First, certain performance tasks such as one requiring recognition of low probability, near threshold, stimuli (a vigilance task), and a task requiring keeping a complex mental count are performed less well in a

110 db OASL noise than in relative quiet. Second, time judgments (estimation of the passage of ten minute intervals while at work on the counting task) are distorted by noise. Subjects respond on the average of every nine minutes in quiet and every seven minutes in noise when instructed to respond at what they judge to be ten minute intervals. Third, individual differences in susceptibility to performance decrements under noise stress are marked, and may be related (inversely) to susceptibility to auditory fatigue. The result on vigilance confirms previous reports by Broadbent from the British Medical Research Council. Other results are new. The experiment leading to these conclusions are described and discussed.

Auditory Acuity of Personnel Exposed to the Noise Environment of an Engine Test Laboratory. ROSALIE NOBLE, B.A. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

Regular audiometric examinations of engine test laboratory personnel have been conducted in order to determine any loss of auditory acuity which could be attributed to the exposure to a noisy environment. Audiometric data in the frequency range extending from 128 cps to 8192 cps in octave intervals for seventy-six men obtained over a period ranging from five to eight years are examined. Changes in acuity from the beginning to the end of the test period are within the limits of accuracy of the instrumentation. These values are compared to available data on the auditory acuity of the general population.

Speech Communication in Noise. JAMES M. PICKETT, PH.D. and KARL D. KRYTER, PH.D. Operational Applications Laboratory, AF Cambridge Research Center, Bolling Air Force Base, Washington, D. C.

Increased noise from modern aircraft has led to a need for new knowledge on how speech is heard in noise. Practically, we need first to be able to predict the intelligibility of speech messages heard in noise, given only simple physical measurements of the speech and noise at the listener's ear. Several methods have been proposed for such prediction. Tests of their accuracy were conducted using noises of widely different spectra. It was found that some prediction methods over-estimate interference from low-frequency noise such as that from jet engines. A criterion for noise control based on such methods might lead to expensive over-reduction of noise from jet aircraft. Other methods which have a simple compensation for this effect do not allow for radio or telephone distortions of the speech signal. A compromise method is developed which allows good prediction of intelligibility under a variety of noise and speech conditions.

Criteria for Short-Time Exposure to High Intensity Jet Aircraft Noise. 1ST LT. KENNETH M. ELDRED, USAF, CAPTAIN WILLIAM J. GANNON, USAF, and HENNING E. VON GIERKE, Dr. Eng. USAF Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Criteria are presented which specify the maximum noise levels to which maintenance personnel servicing turbojet aircraft may be exposed for durations ranging from several seconds to eight hours in any twenty-four hour period. Duration of exposure versus noise levels are given for cases of both the unprotected and protected ear. Examples are given which illustrate use of these criteria to define zones around aircraft in which personnel must wear earplugs, ear muffs, or both protective devices in combination.

A Questionnaire Study of Noise Problems on Air Force Bases. CAPTAIN RONALD G. HANSEN, USAF. USAF Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

A survey questionnaire has been developed to help gather information on the noise problem at various air bases. Results are used to give an estimate of the overall magnitude of the Air Force noise problem and the specific types of operations and conditions that create this problem. The questionnaire is divided into three major sections: (1) description of the effects of noise; (2) physical layout of the base and the surrounding area; and (3) specific in-

formation on the noise generating operations. In a trial study, sixty-six questionnaires were sent to bases of four major Air Force commands. Analysis of the completed questionnaires gives a general picture of the noise situation on and off the base and provides a comparison between the different types of complaints about noise and specific noise generating activities. The number of complaints *vs.* the size of the population exposed to different noise levels from ground and flight operations was also extracted from the completed questionnaires.

Pilot and Aircrew Selection

The Application of the Exercise Stress Test in Aviation Medicine. SQUADRON LEADER G. M. FITZGIBBON, RCAF. Institute of Aviation Medicine, Toronto, Canada.

Pathological material showing moderately advanced coronary artery disease in clinically healthy members of aircrew killed in flying accidents is presented. These data gave rise to the present study which is directed towards the detection of asymptomatic coronary artery disease in Royal Canadian Air Force aircrew. Five hundred members of aircrew have been subjected to the double standard two-step exercise test of Master using a multiple lead technique. The results are presented and the value and limitations of the test discussed.

Further Developments on Adaptability Screening of Flying Personnel. S. B. SELLS, PH.D. USAF School of Aviation Medicine, Randolph Air Force Base, Texas.

This paper brings up to date, since the writer's report to the Association in 1954, significant results on development of a personality test battery for adaptability screening of flying personnel. These include: (1) new evidence of screening validity for four experimental tests; (2) validation of the first trial battery of screening tests; (3) development of a nontest predictor of pilot training success based on instructors' grade slip comments during the first ten light plane training flights; (4) development of a measure of operational adaptability as a military pilot, based on information in personnel records, and prediction of this by screening tests; and (5) analysis of combat follow-up data and prediction of combat success for a sample of pilots tested on entering training.

Anxiety about Flying among Beginning Aviators. JOHN T. BAIR, PH.D., and ENSIGN WILLIAM F. O'CONNOR, (MSC) USNR. USN School of Aviation Medicine, Pensacola, Fla.

This is a report of a series of studies designed to present a clearer concept of the beginning flight students' apprehensions about flying. Several techniques were used to determine the state of mind of naval aviation cadets during their first few training hops. Although this research was directed primarily toward tapping the typical tensions of normal flight students, illustrative material also is included of the crippling kind of anxiety demonstrated by disturbed students.

The results of this research reveal:

1. Fear of flying describes only one aspect of the total anxiety picture because other fears complicate this picture.
2. Fear of failure seems to be more important to the beginning flight student than other fears.
3. Students with critical instructors manifested more concern about the hazard of flying than any other group.
4. Most new student aviators experience some degree of anxiety about flying, but such anxiety seems to be the natural consequence of facing a new and critical task rather than an unhealthy dread of getting killed while flying.

Studies on Motivation for Flying and Career Intent. ELI S. FLYER, Ed. D. USAF Personnel and Training Research Center, Lackland Air Force Base, Texas.

The Air Force has been faced with two related problems in pilot training and selection that may be described as motivational in nature. One problem concerns the large number of pilot trainees who withdraw from the program; the other concerns the

large number of graduates from pilot training who fail to make the Air Force a career. Several research studies are underway to provide information relevant to these problems. Aptitudinal, biographical, attitudinal, personality, and flying proficiency data have been collected and are undergoing analysis. Results thus far suggest: (1) motivation among pilot trainees may be readily affected by factors beyond the training situation; (2) resignees from early training phases differ from resignees during later phases; (3) withdrawals early in training are better identified by psychological tests than resignees from later training phases; (4) aviation cadet motivational failures have different aptitude and training characteristics than similar failures among Air Force ROTC students; and (5) it may be possible to develop tests capable of identifying Air Force career types prior to acceptance into pilot training.

Versatility Potentials of Successful Naval Aviators. CAPTAIN L. E. MCDONALD, (MC) USN, CAPTAIN D. C. GAEDE, (MC) USN, and LT. D. L. BRIGGS, (MSC) USN. U. S. Naval Hospital, Oakland, Calif.

The problems of motivation for flying are increasingly important, as is interest in all phases of the human factor in aviation. Relatively little is known of the personality of the successful aviator, yet much speculation is apparent. In order to learn more of the motivations of naval aviators under actual operational conditions, a study was undertaken of eight squadrons attached to two aircraft carriers with the Seventh Fleet operating near Formosa in the spring of 1955. A Navy clinical psychologist spent about two months studying the aviators during operations, using a specially designed psychological projective test including a background information questionnaire. Approximately 60 per cent of the aviators indicated relative satisfaction with their aircraft and equipment. Three-fourths of their suggestions concerned improvement of conditions relative to human relations and the selection of aviators. Some of the specific anxieties and means of coping with them are pointed out and suggestions for means of alleviating tensions among aviation personnel are presented.

Some Psychological Factors Governing the Effects of Cerebral Depressants upon Learned Behavior. LT. COL. ROBERT B. PAYNE, USAF (MSC), and GEORGE T. HAUTY, Ph.D. USAF School of Aviation Medicine, Randolph Air Force Base, Texas.

This paper reports a series of studies designed to elucidate the manner in which the effects of motion sickness remedies upon the retention of verbal habits depend upon secondary factors which facilitate or inhibit the retention process. Such secondary factors as motivational feedback, overlearning, reproductive interference, and altered set were appraised in experiments involving both serial order and paired associate tasks. A total of 216 subjects participated in the studies. In general the experimental evidence supports the theorem that any factor which tends to prejudice the evocation of a learned response will tend also to increase the vulnerability of the response to the depressant properties of the drugs; and, conversely, any factor which tends to enhance response evocation will tend also to decrease response vulnerability. Practical implications of these results for the use of motion sickness remedies by airborne crews and troops are discussed.

Human Factors in Flight Test. MAJOR PHILIP S. SHAFER, USAF. USAF Flight Test Center, Edwards Air Force Base, Calif.

The human factors evaluation of an aircraft weapon system begins with the assumption that no airplane is perfectly designed; that there are features of the equipment which are not as good as they might be as far as the human operator is concerned. The human engineer searches out the deficiencies and studies the effects of them on aircraft and aircrewman performance in mission accomplishment. In the study of the design and functional characteristics of aircraft weapon systems as related to human capabilities and limitations many problems are introduced, such as objective measurement of human operator decrement in efficiency due to various environmental influences or limitations produced by the system. Unfortunately the performance of the pilot in a single place high speed aircraft is difficult to measure and the human engineer must often rely on

gross performance criteria: can he do the job, how well, and what does it "cost" him to do it? Serious deficiencies in performance, safety, or comfort, in the man-machine performance team study, are fed back into the production program to be modified out of the system.

Psychological Tests and the Selection and Classification of Air Force Officers. ERNEST C. TUPES and RAYMOND E. CHRISTAL. USAF Personnel and Training Research Center, Lackland Air Force Base, Texas.

The purpose of this paper is to discuss the scientific basis of present Air Force officer selection and classification procedures. Attention is given to such topics as (1) types of talent required by a modern air force and the availability of such talent in our population; (2) the concept of differential classification; (3) costs and savings resulting from a testing program; (4) effectiveness of alternative selection procedures; (5) complementary nature of medical and psychological examinations; and (6) future of psychological testing in the Air Force. The development, composition, and validity of the Air Force officer qualifying test, currently used in the selection and classification of Air Force officers, is discussed in detail.

Methods for the Rational Assembly of Individuals into Crews. SEYMOUR ROSENBERG, PH.D. USAF Crew Research Laboratory Field Unit No. 1, MacDill Air Force Base, Fla., and the Crew Research Laboratory, Air Force Personnel and Training Research Center, Randolph Air Force Base, Texas.

A major problem in rational assembly of small work groups (i.e., "crew matching") is the development of measures on individuals, pairs, triads, etc., which predict group performance. Empirical efforts in this direction have been made only recently, the most intensive program being concerned with eleven-man B-29 crews. Prominent among possible types of assembly scores are sociometric scores (i.e., measures of personal preference) between pairs of potential group members based on their contacts before final formation of work groups. Although some evidence favoring the use of such scores comes from studies of B-29 crews and from other situations, the use of this technique is not particularly satisfactory either from a practical or a long-range scientific viewpoint. Hence a concomitant research effort has been directed at determining the individual characteristics, measured before crewing, which can be combined so as to predict group performance or compatibility. The measures explored to date have included biographical information, interests, attitudes, trait measures, and technical proficiency. The hypothesis that similar persons work together best has been tested with these measures, with mixed success. Other, more complex, hypotheses have received less attention. From these research efforts, some preliminary generalizations have been formulated which need additional investigation.

Peak Oxygen Uptake of Young Men as Determined by a Treadmill Method. N. B. SLONIM, M.D., COMDR. D. G. GILLESPIE (MC) USNR, and W. H. HAROLD, M.D. USN School of Aviation Medicine, Pensacola, Fla.

The peak oxygen uptake of fifty healthy young men (naval cadets) was determined by a treadmill method. Each subject had undergone at least five weeks of intensive physical training. The treadmill speed was held constant at 3.5 mph and the tests at each treadmill grade were of six minutes duration. Subjects were tested successively at 20, 24, 26, and 28 per cent grade until failure to complete a test. The grade was then decreased in steps of 1 per cent until a test was found which could be completed. Motivation of the subjects was considered to be exceptional. Environmental temperature and humidity were closely controlled. Peak oxygen uptake is defined arbitrarily for the purposes of this study as the highest value obtained for rate of oxygen uptake as determined by measurement and analysis of expired gas collected during the 6th minute of exercise. Data is also presented for heart rate, expiratory minute volume, carbon dioxide output, respiratory rate, ventilation equivalent for oxygen, and respiratory exchange ratio during exercise. The values for expiratory minute volume exceed those generally accepted as occurring during muscular work.

Controlling Response Set on Personality Inventories. LT. (j.g.) ROBERT B. VOAS, (MSC) USNR. USN School of Aviation Medicine, Pensacola, Fla.

Personality inventories generally require an honest self report which is difficult to insure in most military testing programs. Two types of problems arise. Individuals may tend to give random responses due to a lack of motivation or inability to understand the instructions or questions, or they may slant their responses in a direction which they believe will make them appear in a favorable light. These problems can be met in two ways. Failure to follow instructions can be detected with specially constructed "lie" scales and the test scores discarded or corrected. A second approach is to develop inventories which are difficult to falsify. This has been done by increasing the subtlety of the questions, disguising the purpose of the inventory, and by forcing a choice between two alternatives of equal social acceptability. None of these methods is entirely satisfactory. More information is needed on what is considered the "best" answer in relation to the type of trait being measured and the subject's score on this trait. Research at this school has yielded some information on these questions and suggested a new method of dealing with this problem.

Characteristics of Successful Pilots. DAVID K. TRITES, PH.D., and ALBERT L. KUBALA, PH.D. USAF School of Aviation Medicine, Randolph Air Force Base, Texas.

Based on an intensive analysis of combat and training performance data, and a follow-up study of material contained in Air Force personnel records, it has been possible to describe certain personal characteristics of pilots who have successfully adapted to Air Force duties. In combat it was found that the successful pilot tends to be rated as courageous, fair in treatment of others, willing to accept his share of combat duty, a responsible person, an enforcer of necessary discipline, relatively free of symptoms of maladjustment, and well adjusted. Above all he is liked by all who come in contact with him. Using an estimate of success based on personnel records, it was found that the more successful pilot tends to be a more competent flyer and more easily trained, is not unduly concerned with self-advancement, has fewer expressed symptoms of maladjustment, and is regarded as well adjusted. Of these characteristics, those which can definitely be assessed during training are: general level of adjustment, flying aptitude and educability, need for self-enhancement, expressed symptom frequency, and likeability.

The Effects of Different Methods of Presentation of Time Information on Legibility. JOHN GAITO, M.A. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

The present experiment is concerned with the effects on legibility of eight types of aircraft clock designs presenting both time of day and elapsed time information by means of direct reading counters and/or pointers on one or two instruments. Using average number of errors, variability of errors, average time to read, and variability in time to read as criteria of legibility, a paper and pencil test administered to 127 experienced pilots revealed that the types presenting both kinds of time information by means of counters on one instrument were superior to the others for quantitative readings. A questionnaire and group interview indicated that the main uses of both time of day and elapsed time information were mainly quantitative and that the pilots preferred the types that had been shown to be more legible in the test.

A Study of Group Adaptation under Blizzard Conditions. E. PAUL TORRANCE, PH.D., G. ROLFE LAFORGE, PH.D., CAPTAIN RAIGH MASON, USAF, and MARIO LEVI, M.A. Air Force Personnel and Training Research Center, Stead Air Force Base, Nev.

The purpose of this study is to explore some of the social and psychological factors affecting group adaptation in emergencies and extreme conditions (in this case, a High Sierra blizzard with heavy snow and below freezing temperatures). Subjects included 20 airmen divided alphabetically into three groups and supervised by seven instructors and assistant instructors. Disorganization, panic, and apathy were observed when the

blizzard occurred and during the trek which followed. Most subjects experienced some degree of cold injury and seven were hospitalized for lengthy periods of time. All participants were interviewed by the authors according to an interview schedule designed to explore certain hypotheses concerned with such phenomena as: resistance to accepting the seriousness of the situation, failure to take adaptive action, maintenance of power by leaders under emergencies and extreme conditions, abdication of power, temptations to mutiny, ignoring informal power structures, lack of group cohesiveness, communication failures, loss of "will-to-survive," and "concessions to comfort." Interview protocols and sociometric data were analyzed to determine the effect of these phenomena on the disorganization, panic, and apathy observed in this training situation and the resulting cold injury.

Ballistocardiography—Its Value in Aviation Medicine. BENJAMIN SCHNEIDER, M.D., Danville, Pa.

A more accurate prognosis can be given in a case of myocardial infarction in which the BCG returns to normal after the episode than in a case in which it remains abnormal. An abnormal BCG may indicate coronary artery disease before any signs or symptoms appear. The BCG is of prognostic value clinically which is corroborated by 300 BCG's personally taken by the author. Most investigators are agreed that in clinical diagnosis and as an aid in determining prognosis, the BCG provides a method of measuring the functional state of the heart, regardless of the type of organic pathology. Warning is expressed concerning the problem of creating "ballistocardiographic heart disease" where none exists.

Personal Equipment

Evaluation Trials of A-13A Oxygen Mask Hose Connector Warning Device. FLIGHT OFFICER EWALD F. SCHROEDER, RCAF. Institute of Aviation Medicine, Toronto, Canada.

Tests conducted on the modified A-2 connector incorporating a disconnect warning device indicated that this device functions satisfactorily. The overall suctions in the oxygen system are reduced approximately 10 per cent. The disconnect warning suction (6 inches of water) is high enough to provide an unmistakeable warning, yet is not so high as to cause undue pilot fatigue if used for short periods of time, as in bail-out at low altitudes. The venting pressure characteristics (25 mm. Hg.) are suitable for emergency or bailout purposes at moderate altitudes up to 45,000 feet.

Since these tests were conducted, the USAF has standardized on disconnect MC-3, which supersedes the disconnect tested, and is so designed that it only requires modification of the mask end of the disconnect. If the inward air leakage inherent in this later design is negligible, this disconnect will provide a simpler solution to the inadvertent disconnect problem from a logistics viewpoint. The suction-flow measurements taken during these tests indicate that the suctions in existing demand oxygen systems are greater than should be allowed and may have a considerable effect on pilot fatigue at low altitude operation.

Oxygen Equipment: Put It On, Turn It On and Forget It. CAPTAIN JOHN R. POPPEN, (MC) USN (Ret). Douglas Aircraft Co., El Segundo, Calif.

Current types of oxygen equipment are subjected to a critical review to evaluate their adaptability to physiological requirements and the demands of the flight pattern of modern aircraft. The review includes an expression of the relative advantages and disadvantages of free flow, diluter demand, demand of pure oxygen, and pressure breathing equipment. Pressurization of human compartments and pressure suits are considered in their relationship to oxygen equipment. It is concluded that pressure suits must be provided for flights above 45,000 feet; diluter demand, free flow and pressure breathing equipment are not justified in modern aircraft. Demand regulators providing 100 per cent oxygen can be adapted to provide simple, lightweight, easily serviced and reliable oxygen supply for all flight patterns.

Further Studies on the Medical Aspects of Partial Pressure Suit Indoctrination. MAJOR HUGH W. RANDALL, CAPTAIN JOE H. LEONARD, and 1ST LTS. IRWIN T. TAYLOR and LONNIE S. BURNETT, USAF (MC). USAF School of Aviation Medicine, Gunter Branch, Gunter Air Force Base, Ala.

The medical implications of partial pressure suit indoctrination of aircrews are presented. Findings are based on experience with 300 candidates for indoctrination in the T-1 and MC-1 partial pressure suits at this school. Approximately 5 per cent of the candidates were physically disqualified and about 10 per cent aborted during pressure breathing or while attempting the altitude chamber flight. This gives a failure rate of about 15 per cent. The various causes of disqualification and abortion are discussed. The importance of careful medical evaluation of all indoctrinees and the significance of psychological factors are emphasized.

Oxygen Requirements in Future Commercial Transport Aircraft. ARTHUR E. MILLER, Scott Aviation Corp., Lancaster, N. Y.

Oxygen was first used in aviation 80 years ago and oxygen equipment in use today is the result of a process of evolution. Because military aviation flight altitudes have always exceeded those of commercial aviation, new developments have always been designed for military use and, subsequently, adapted to commercial usage. The equipment in use in today's commercial transports is basically equipment designed and developed five to fifteen years ago for military aviation. With the advent of commercial turbo-prop and turbo-jet transportation, there appears to be a need for new types of equipment which cannot readily be adapted or converted from existing military designs. Some features of military designs may be applicable, but new features specifically designed to provide protection for commercial transport crews and passengers at jet-operational altitudes must be incorporated. Many of the proposed features are controversial and the purpose of this paper is not to attempt to reconcile the controversy, but to stimulate consideration and discussion which will lead to a practical solution.

Trends in Personal Equipment Development. ERNEST E. MARTIN, B.S. USAF Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

In order to meet the requirements of present-day flight, man has been practically immobilized. Simple flights which formerly utilized a given item of protection have grown into present-day global flights which require protection from all the elements nature has to offer. Present-day efforts are toward integrating these items so as to permit the countless protective items to operate efficiently and easily with each other. These efforts are presented in some detail. Solutions to this problem are difficult for it is either a case of stripping the man and placing the equipment on the aircraft or continuing with the present procedure which is essentially loading the man to meet the requirement. Either the man or the aircraft is affected, no matter what the decision.

Integration of Safety and Survival Equipment for Aircrew of Naval Aircraft. CARL A. MARCKS, B.S., and EDWARD L. HAYS, B.S. USN Bureau of Aeronautics, Washington, D. C., and the USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

The design requirements for aircrew safety and survival equipment have increased in complexity in direct relationship to aircraft performance in altitude, capability, range, speed, tactical mission, and other factors which establish the potential emergencies which may arise. Individual items to provide the various safety and survival features become incompatible and tend to severely penalize the personnel. In addition, modern aircraft require aircrews to perform more complex tasks in shorter periods of time than their World War II counterparts. These factors therefore tend to compromise the man-machine combination. As a result, the integration of essential safety and survival equipment appears to offer one avenue for effective improvement. The Navy, in its initial efforts, has effectively succeeded in the integration of various components of personnel equipment. These integration efforts have resulted in multi-purpose assemblies which, by comparative evaluation, are more efficient, lighter in weight and superior

in both performance and reliability than the single articles.

Some Preliminary Tests of the Independence of Successive Dial Readings. DOROTHY E. FLETCHER, M.A., and LLOYD M. CRUMLEY, M.A. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

Speed and accuracy of reading a dial are examined as functions of the kind of dial that was read immediately before. Each of thirty-six subjects read nine panels. Each panel consisted of four each of three kinds of dials. These three kinds of dials represented are a clock, a compass, and an altimeter. The time and error scores are analyzed according to various particular hypotheses related to the general hypothesis that successive dial readings are independent. The discussion proposes hypotheses and experimental methods for further experimentation in this area.

Oro-Nasometer: Anthropometric Device for Obtaining Facial Measurements as Applied to Oxygen Mask Studies. LT. MORRIS J. DAMATO, (MSC), USNR, and AARON BLOOM, B.S. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

The past history in the field of aviators' oxygen breathing masks has been marked with continued attempts to provide a universal-fitting mask. The lack of applicable basic facial anthropometric data has precluded correlation of specific configurations. To overcome this difficulty in the problem, a simple anthropometric device for measuring facial contours has been developed. Through the establishment of a fixed reference plane to the face, three dimensional contours of a given face can be provided. Dimensional studies on 100 male subjects correlated closely with related facial areas on a 4,000-man Air Force study. This device has a practical application in establishing the size of a subject's face for the best oxygen mask fit.

The Problems of Oxygen Breathing Mask Development. AARON BLOOM, B.S., and EDWARD L. MICHEL, M.S. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

The ideal, comfortable, perfectly-fitting aviators' oxygen breathing mask is one that can be sized and shaped to the individual facial contour. Because of the cost and difficulty of manufacture and other attending factors this is not feasible. A method has been devised which will provide for relatively simple, low cost means for a close approximation to individual mask fitting. A design has been originated which provides for an oxygen mask constructed in two parts, a mask shell and a sized laminate. The shell, of semi-rigid opaque plastic, will be provided in two sizes, small and large. Laminates of unicellular plastic sponge will be provided in a complete variety of sizes and shapes. By selecting that combination of shell and laminate which most nearly suits his face, the subject then has an individually fitted mask.

An Adhesive Type Oxygen Mask. JOHN J. SWEARINGEN. CAA Medical Research Laboratory, Columbus, Ohio.

A study of the problem of supplying 100 per cent oxygen to airline passengers in the event of pressurization loss at high altitude shows that mask design is an important factor in determining the times required for individuals to obtain their first oxygen inhalation. In determining specifications to meet the human requirements in this situation, the author has constructed a mask which (1) is symmetrical; i. e., it cannot be put on upside down; (2) will fit, with one size, the different facial contours of adults and the contours of children as well; (3) can deliver 100 per cent oxygen; (4) is attached without straps, bands or buckles; (5) will not be dislodged by head movement or perspiration; and (6) is comfortable, light weight, inexpensive and disposable.

Development of Paramedic Aircraft-Field Resuscitators. HENRY W. SEELER. USAF Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

High-altitude flying by man has imposed new requirements for safety and rescue if apnea occurs in aircraft. Pararescue requires new methods in consideration of weight and resuscitator efficiency. Many kinds of resuscitator kits have been de-

veloped during the past years: the bellows type model for manual operation, the mask-to-mask type design for field use, and many mechanical resuscitator kits with a built-in oxygen supply. This laboratory, which previously developed the high altitude-controlled and adjustable resuscitator, has produced a small and lightweight independent pararescue resuscitator kit. This can be dropped with the paramedic and is operated by means of a handcrank. A manually-driven blower draws atmospheric air through a gas filter and produces air under pressure for operating the resuscitator valve. The air-blower can also be driven by a self-contained motor on either twelve or twenty-four volts at the option of the operator. At high altitude or in hospitals, 100 per cent or diluted oxygen can be applied.

Explosive Decompression: Tests of Material Failure. EMANUEL S. MENDELSON, B.A. USN Aeronautical Medical Equipment Laboratory, Philadelphia, Pa.

Experiments are described in which thin sheets of inanimate materials were exposed to explosive decompression. Test materials were chosen to represent gradations in plasticity. The results of varying several factors in the test conditions were analyzed in terms of the bursting strengths of the test materials. Some of the results appear anomalous in terms of everyday concepts about relative strength of materials. These findings appear to have potential utility in the design of protective equipment for use by aviators in pressurized enclosures.

Effect of Knob Arrangement on Consumption of Panel Space. JAMES V. BRADLEY, M.A., and NORMAN E. STUMP, B.A. USAF Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

A research program was conducted to determine which of two proposed methods of economizing on instrument panel space was the more effective. One of the proposed methods was to mount a series of knobs on concentric shafts. The other was simply to crowd a number of knobs into a closely-spaced matrix. Standard knob settings were made under both situations. Reach time, turning time, and inadvertent touching of adjacent knobs were recorded. Results indicated that, if inadvertent operation of adjacent low-torque knobs must be kept at a low level, a greater economy of panel space will be realized by arranging small diameter knobs in a closely spaced matrix than by mounting knobs on concentric shafts.

Medical Report of "Operation Handclasp." 1ST LT. R. W. BROWN, USAF (MC). Fifth Air Force, APO San Francisco, Calif.

The medical report of four pilots who participated in a non-stop 4,850 mile flight in F-84-G aircraft is discussed. The flight was accomplished in twelve hours and five minutes, and four-fifths of it was over water. It was the duty of the aeromedical advisor in this operation to (1) prepare the pilots physically; (2) provide for their comfort and nourishment in flight; and (3) study the effects of the flight on the pilots upon its completion. The study includes a discussion of the postural comfort of the pilots and efforts made to minimize fatigue of the glutial muscles. Oxygen consumption and in-flight food and fluid replacement are considered in addition to certain urological and hematological observations made on each of the pilots.

On the post-flight interview there were no symptoms of musculo-skeletal fatigue, or of headache, gastrointestinal discomfort, or visual symptoms.

Final results of the observations indicate that the long over-water flight was accomplished with virtually no adverse effects upon the pilots. High performance flying was carried out by the pilots in the two-week period following the flight testifying to the absence of delayed fatigue effects of the flight.

Utilization of Research in Operational Contents. WILSE B. WEBB, PH.D. USN School of Aviation Medicine, Pensacola, Fla.

There are increasing demands for research-established answers to real life problems. There are two general approaches in meeting these demands: laboratory oriented procedures and situational centered procedures. The methodologies and the immediate results of these approaches are likely to be quite different. The laboratory approach is

characterized by a control of variables. The results are definitive and may be stated in general terms. However, the operational situation seldom permits similar control and the translations of general statements into specific instances is difficult. The situational approach involves observing the effect of variables embedded in a complexity of uncontrolled and frequently unknown variables. Positive findings are impressive. They establish the existence of an effect as things are. However, the effect may have been the result of concomitant variables which may not continue to operate similarly in the future. Further, the use of the results are dependent upon a replication of the particular situation. The research procedures of these approaches are well established. Effective methods for translations and utilization of findings, however, must be developed. Here is our major limitation in operational research.

Aviation Pathology

An Analysis of 2400 Pilot Error Accidents. COLONEL HARRY G. MOSELEY, USAF (MC). USAF Flight Safety Directorate, Norton Air Force Base, Calif.

During the two and one-half year period, January 1, 1953, through June 30, 1955, the Air Force experienced over 2400 major aircraft accidents which were primarily the result of unsafe acts on the part of the pilot. In order to gain additional insight into the causes of the above pilot errors, each accident has been reviewed and an analysis has been made of precedent factors: (1) whether the error concerned was primarily the result of a deficiency or deficiencies in the pilot's perceptive (sensory), interpretative (intellectual) or reactive (neuromuscular) process; and (2) what act, aptitude, condition or influence was the most probable cause of the behavioral omission or commission which resulted in the accident. The behavioral factors and their causes so assessed have been further correlated with other pertinent data such as type of aircraft, mission, phase of flight, age, experience, fatalities and similar conditions or results. From the above compiled and integrated data, conclusions and recommendations have been drawn.

The Radar Beam: A Potential Health Hazard? MAJOR DANIEL B. WILLIAMS, USAF. USAF School of Aviation Medicine, Randolph Air Force Base, Texas.

This report is essentially an appraisal of the radiobiologic hazard which is presented by the modern "S" band radar (microwave) beam. Early reports in the literature suggesting acute hazards are critically reviewed through comparison with recent information to give the problem in its proper perspective. Information is presented on (1) the maximum power densities encountered in the radar beam; (2) time and power density requirements for ocular, testicular, and cutaneous injury; (3) subjective warning of irradiation; and (4) methods for both measuring and calculating of beam power density. The indications are that modern "S" band radar beams are threshold to biological significance, but that there is little risk of acute injury through brief exposure under routine operational conditions. Note is made of the need for additional information, particularly at "X" and "L" band frequencies. Emphasis is lent these requirements by the trend of development toward increasingly powerful radar transmitters. Responsible agencies are urged to continue the periodic survey of radar personnel for evidence of any cumulative effects of uncontrolled exposures at all frequencies.

Personnel Tolerance in High Power Microwave Radiation. WINFIELD W. SALISBURY, D.Sc. Remler Company, Gray Scientific Division, San Francisco, Calif.

A series of careful experiments performed at the University of Iowa Medical School and the Mayo Clinic show that certain sensitive biological tissues are permanently damaged by exposure to microwave fields of sufficient intensity. Damage may develop

some days after exposure. Comparison of pulsed and continuous fields shows that temperature rise due to average power levels is responsible. A simple field intensity meter can be used to set up tolerance levels and assure protection of factory and maintenance personnel.

Aircraft Accidents as Related to Pilot Age and Experience. ANCHARD F. ZELLER, PH.D., and COL. H. G. MOSELEY, USAF (MC). USAF Flight Safety Directorate, Norton Air Force Base, Calif.

An evaluation of the relation of age and experience to Air Force aircraft accidents indicates that young and/or inexperienced pilots consistently have the highest accident potential as measured by a rate based on flying hours. With increased age and/or experience, this potential decreases. Among older pilots, *i.e.,* those in their late thirties or older flying jet fighter aircraft, there is again an increase in the accident rate. Although this increase indicates an increased accident potential, the actual number of accidents experienced by these older pilots is extremely small because of the limited number of older individuals flying jet fighter aircraft. Older pilots flying reciprocating engine aircraft do not have a comparable increase in accident rate with advanced age up to the age of fifty, beyond which flying is so limited that figures are meaningless. Greatest accident prevention gains can be made by increased emphasis upon the training and supervision of young, inexperienced pilots, particularly those flying jet aircraft. Accidents among older pilots can be reduced by requiring formal transition training before flying jet aircraft.

Histopathologic Examination of Tissue from Pilots from Thirty Jet Crashes. H. G. SHAUB, M.D., and F. K. MOSTOFI, M.D. Armed Forces Institute of Pathology, Washington, D. C.

The brief report deals with histopathologic examination of the tissue from pilots of about thirty jet crashes. The study was limited to: (1) the tissue collected under varying circumstances, and (2) to the routine pathologic sections. The findings are classified as: (1) pre-existing and (2) related; the latter group is further subdivided into those due to primary factors and those due to secondary factors. The need for uniformity in examination of the human components and in sampling of the tissue for histopathologic examination is emphasized.

Local Vascular Response to Vibrations. ERNST K. FRANKE, PH.D., and 2ND LT. KENNETH M. HILDRETH, USAF. USAF Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Prolonged contact of the body surface, especially the hands, with vibrating tools or structures is well known to result in vascular damage. The symptoms of this damage are similar to those of Reynaud's disease. To obtain information on how this damage is produced the local vascular response to vibrations was studied, mainly by means of a flow calorimeter. Increased heat flow after application of vibration occurs indicating vasodilatation. The dependence of vasodilatation on the various parameters of vibration as well as the sensitivity of different subjects in terms of magnitude and duration of dilatation are discussed.

Aviation Medical Education

Air Power, Man Power, and Aviation Medicine. GERALD S. BACKENSTOE, M.D. Emmaus, Pa.

Can the civilian medical examiners, the aviation-minded physicians, and the flight surgeons aid in a great national problem? Do you realize the gravity of our air manpower situation in both military and civilian categories? Are you familiar with the Aviation Incentive Program and the new civilian pilot-training legislation?

We are anxious to rebuild the present anemic pilot pool of World War II. We are equally anxious to aid the revitalization of the "grass roots" airport operator, a most important and possibly unappreciated "soldier without uniform" in his country's service. Facts and figures and practical sug-

gestions for everyone's consideration are offered.

To say the least, it would seem vital that every air-minded individual and corporation should be aware of these facts, and should have opportunity to appraise the strenuous efforts being made by the aviation-minded private physicians of this nation.

Medical Education for National Defense. J. R. SCHOFIELD, M.D. Department of Defense, Washington, D. C.

Since war may come suddenly and violently instead of taking its historical slow start, the medical profession must always be prepared. One method of insuring constant vigilance is to invite the faculties of medicine to incorporate in their curriculae information about medical care of mass casualties in either military or civilian disaster situations. Since the Armed Forces and the Public Health Service have the primary experience in this area, they are obligated to make their knowledge available to the colleges of medicine. Medical Education for National Defense (MEND) attempts to form a bridge of communication between the services and twenty-five of the eighty-one medical colleges. Each college agrees to study the problem and to develop its own approach. In most schools, activities include a visiting military speakers' program; faculty visits to Government research-teaching installations; symposia held at Government research laboratories; and special projects such as field trials of emergency hospitals. Both the college group and the services heartily endorse MEND and the students are responding appreciatively to the curricular re-orientation.

Training for the Practice of Aviation Medicine. COLONEL R. HOWARD LACKAY, USAF (MC). Office of the Surgeon General, Department of the Air Force, Washington, D. C.

An account of the evolution in the Air Force of the first overall training program leading to board certification in the specialty of aviation medicine is given. The underlying educational principles and philosophies which played a part in the development of this program is discussed. An attempt is made to point out some of the more important pitfalls and problems encountered and to suggest guideposts for others planning similar programs.

Role of Pathology in Aviation Medicine. COLONEL FRANK M. TOWNSEND, USAF (MC). Office of the Surgeon General, Department of the Air Force, Washington, D. C.

Significant advances have been made in the physiologic understanding of the effects of high altitude, pressure and temperature changes, acceleration and deceleration. Limited studies have also been conducted on the pathologic changes in tissue as a result of these factors. Neither the physiologic approach nor the limited pathologic studies have yielded satisfactory answers to some of the important problems in aviation medicine. Among these may be listed the unexplained crashes, the paucity of information on the effects of chronic and repeated exposure or of the effects of exposure in persons with pre-existing subclinical disease. Indeed even the basic structural changes in hypoxia, in decompensation, in deceleration are themselves obscure if not unknown. Among areas deserving comprehensive pathologic studies are: (1) systematic, uniform and detailed pathologic examination of air crew fatalities; and (2) the application of modern histophysical and histochemical changes for the detection of the intracellular enzymes, minerals and other components in the cytoplasm and the nuclei of the exposed cells not only in human but in experimental animals. Such a program requires the wholehearted cooperation of the aviation pathologist, the aviation physiologist, aviation engineers, the flight surgeon, and the safety and flight personnel.

Aviation Pathology. CAPTAIN SIDNEY BRODY, (MC), USN. Bureau of Medicine and Surgery, Navy Department, Washington, D. C.

Aircraft accidents resulting in large numbers of fatalities in recent years have shown the value of intensive pathological investigation in providing an explanation for the cause of these accidents. Heretofore, little regard was given to the thorough examina-

tion of remains in aircraft fatalities and consequently much valuable information was undoubtedly lost. Stimulated particularly by the inquiry into the causes of the *Comet* accidents and the role played by pathological correlation, a group representing the services of the United Kingdom, Canada, and the United States was established to coordinate action in this new field of aviation pathology. The background and activities of this organization are outlined and a recent Department of Defense directive establishing a Joint Committee on Aviation Pathology is discussed. Some of the aims and future interests of this committee are presented.

Organization of Medical Coverage for the National Aircraft Show. CAPTAIN CHRISTOPHER C. SHAW, (MC) USN. Philadelphia Naval Shipyard, Philadelphia, Pa.

Participation by military aircraft together with static displays of the Armed Forces makes up the major portion of the National Aircraft Show. Philadelphia was chosen for the 1955 show because of available facilities, large population, ease of transportation and because Naval aircraft could be launched by catapult from a carrier along dockside in the Delaware River adjacent to the Philadelphia International Airport.

The Secretary of Defense directed participation of the military services and designated the senior defense co-ordinating officer for the Armed Forces. Since the Navy is in control of major military facilities of the Philadelphia area, the Chief of Naval Operations appointed the Commandant of the Fourth Naval District as the Navy coordinating commander to furnish logistical and administrative support to the maximum. The commandant nominated the commander of the Naval Air Development and Materiel Center as Navy project officer.

A report is given of the medical facilities for this occasion.

Papers Read by Title

The Electrocardiogram in the Medical Assessment of Commercial Pilots. F. A. L. MATHEWSON, M.D. Department of Medicine, University of Manitoba, Winnipeg, Canada.

The electrocardiogram is a reliable aid to the diagnosis of heart disease. When used in the medical examination of pilots it increases the accuracy of the assessment of flying fitness, a factor of major importance to commercial pilots both from the standpoint of health and economic security. Electrocardiographic abnormalities in healthy young people are usually not important. However, when discovered initially in a middle aged pilot the abnormal record is looked upon more seriously and calls for thorough investigation followed by a period of observation. The principle holds that early detection of disease permits the early introduction of corrective measures. It is therefore in the pilot's interest to have an electrocardiogram recorded early in his flying career and repeated periodically thereafter. Serial tracings are of particular value where other evidences of cardiovascular disease are present. The electrocardiogram itself seldom results in permanent grounding and such action is permissible only where there is high correlation between the specific electrocardiographic pattern and clinical disease. Electrocardiograms recorded periodically are a valuable addition to the documentation of a pilot's state of health. The views expressed are supported by case reports.

Sense and Nonsense in the Overweight. CAPTAIN RICHARD L. FRUIN, (MC) USN, San Francisco, Calif.

The paper discusses the problem of overweight which is estimated to involve approximately 20 per cent of the population in America. The principles governing the types of consultation presented to the obese individual by all authorities in this country are reviewed and exposed to logical criticism. The problem of advising the obese individual is approached with the use of a simplified food guidance chart which if adhered to will cause weight reduction with a minimum of stress to the user. The suc-

cess of this program with a large series of obese individuals is discussed.

Noise Problems for Ramp Personnel. HEINRICH GARTMANN, M.D., Swissair, Zurich, Switzerland.

The noise intensity on the ramp during arrival and departure of different types of aircraft has been measured by a frequency analyser. The possibilities of physical damage by noise are discussed. Special consideration is attributed to vegetative neurosis and the consequent illnesses due to noise. The possibilities of noise protection are discussed, *i.e.*, the various types of ear protection on the one hand and changes in the organization of ramp service on the other.

Bush Flight Surgeon Problems. GEORGE B. MCNEELEY, M.D., Bloomington, Ill.

Most people have been aware of the so-called "bush pilots" for many years, but one wonders whether they ever heard of a bush flight surgeon? The bush pilot does everything and anything he can with his airplane. Many earn their living through flying, but many fly for convenience due to distances in the country they live in. This is true for the bush flight surgeon. He has class II and III pilots, that is student, private, and commercial pilots. The bush flight surgeon differs from a flight surgeon who examines for class I or airline transport only in many ways. The greatest difference is that he is also their family physician. He treats them surgically, medically, and obstetrically. He cares for their wives and children, but first, last, and always, he is interested in his pilots and aviation medicine. A short account is presented of aviation medical practice as a bush flight surgeon.

Muscle Balance and Safety in Aviation. A. J. HERBOLSHEIMER, M.D. Bensenville, Ill.

A review of the literature in this field shows it to be very extensive. There is great diversity of opinion as to the exact nature of heterophoria, how to measure it correctly, and as to its practical significance.

A critical study of 2,000 examination reports reveals no consistency of findings and never a case beyond the maximum qualifying limits. This latter is also true for the Howard-Dolman test. Examiners do not appear to be familiar with methods that could give comparable results.

The sum total of the information indicates that muscle balance and depth perception tests cannot be justified.

A Laboratory Anoxia Warning System. JOHN H. BUSSER, B.S. American Electronic Laboratories, Philadelphia, Pa.

A new instrument used for the detection of anoxia under laboratory conditions has been developed and successfully demonstrated. The system is designed to warn personnel when blood oxygen tension falls below a certain predetermined level. Laboratory units are being made for test by a number of government establishments. Although the instrument developed is for use as a warning device, and hence is only concerned with one point on the curve of oxygen tension versus oximeter indication, the nature of the improved system should bring closer the possibility of an "absolute oximeter" with stability and accuracy which are no longer a function of the instrumentation.

Breathalyzer Technique to Determine Blood Alcohol Level. R. F. BORKENSTEIN, Indiana State Police Laboratory, Indianapolis, Ind.

The Breathalyzer technique involves the collection of an alveolar air sample in a heated chamber according to the phase principle of Haldane and Priestly. This charge of air is bubbled through a hot sulfuric-dichromate reagent at a controlled temperature. A self-compensating photometer measures the dichromate before and after the test. The entire operation takes three minutes. The method lends itself to spot-checking drivers, pilots or workers in critical positions, for alcohol. Freedom from line-voltage, photometer bulb, photocell and test solution strength make the method practically free of influence of conditions other than operation. Field operation is thus very practical.

The correlation between blood and breath is within experimental error.

Specificity is good. Odors on the breath

do not cause blanks. By applying the oxidation rate principle, several types of alcohol can be demonstrated. Under the conditions of operation, acetone does not cause blank readings.

Chemical Analyses of Postmortem Tissues as an Aid in Determining the Physiological Status of Flying Personnel Prior to Aircraft Accidents. S. S. WILKS, PH.D., DONALD D. VAN FOSSAN, PH.D., and ROBERT T. CLARK, PH.D. USAF School of Aviation Medicine, Randolph Air Force Base, Texas.

A new technique has been developed which provides a means for determining the CO saturation level of blood by analyzing tissues for CO content and correlating with the blood CO level. A series of 280 rats and ten dogs were used in establishing the relationship between CO blood level and CO content of tissues. The method has been applied to human tissue obtained from sixty-six victims of aircraft accidents. Of these sixty-six cases, the tissue analysis indicated blood CO saturation values above 30 per cent for twenty-seven. Lactic acid concentration in brain of experimental animals (rabbits) after death has been found to be indicative of blood lactic acid level immediately prior to cessation of circulation and can thus be utilized to determine after death the presence of factors which cause elevation of blood lactate. Hypoxia produces an elevation of brain lactic acid considerably in excess of the rise due to moderate exercise. It is thus possible to determine whether or not an animal was hypoxic at time of death by measuring the lactic acid concentration in the brain and comparing it with normal control animals. Supporting data is presented. Work is also in progress to determine a possible redistribution of ions as a means to differentiate between hypoxia and hyperventilation.

The Effect of Cities and Bodies of Water on the Fall-out of Pollens and Molds. HERMAN A. HEISE, M.D., Milwaukee, Wisc.

Pollen and mold counts were made at various altitudes over cities and lakes. It is found that the air over the cities and lakes contains very little pollen as long as the cities and lakes are warmer than the surrounding country. The principles involved are that upward currents of air from warm objects prevent particles from falling. A five-minute motion picture shows a model city in which the fall-out particles are observed when the city is cooler than the air above. On the other hand when the city is warmer than the air the smaller particles fail to fall and drift away from the city. These findings throw much light upon the fall-out radioactive dust and suggest a method by which cities, villages or even isolated farms can be protected against fall-out.

Air Rescue and the Physician. MAJOR HAMILTON H. BLACKSHEAR, USAF (MC). Hq. Air Rescue Service, Orlando Air Force Base, Fla.

The Air Rescue Service of the Military Air Transport Service provides world-wide rescue coverage for Armed Forces and civilian aviation. The basic mission involves penetration to accident sites regardless of weather or terrain. Lifesaving first aid and supportive care must be rendered at the site. Safe evacuation of rescued must follow. In providing initial diagnosis and treatment, the Air Rescue Service is more a medical treatment than an air transport facility. Having only seven medical officers, Air Rescue Service must ask military and civilian physicians to go on missions, determine proficiency of rescue medical personnel, and evaluate medical training methods, equipment and techniques. To respond, these physicians must understand Air Rescue Service capabilities, limitations, techniques and operating conditions. The purpose of this paper is to promote co-ordination and understanding and thus increase the effectiveness of rescue aircrews, enable the physician to request appropriate assistance, and reduce the loss of priceless aircrews.

Evolution of Oxygen Equipment. ARTHUR E. MILLER, B.S. Scott Aviation Corporation, Lancaster, N. Y.

Man is adapted for life and function under specific conditions which comprise his "natural environment." Because he is creative, man has invented and devised mechanical devices to compensate for his physical limitations, and thereby man is able to exist and function in unnatural environments.

More than one hundred years ago, breathing equipment was developed to enable man to work and survive in smoke, toxic gases, or oxygen deficient atmospheres. As industrial technology created new respiratory hazards, man devised new and improved respiratory protective equipment. When man invaded a new domain for which he was physiologically unsuited, oxygen equipment for aviation was devised. Increasing flight altitudes have necessitated constant development. Today's oxygen equipment is far more complex and costly than that of two or three decades ago, but it keeps man alive and efficient at altitudes which are far beyond the wildest dreams of the most enthusiastic of our early aeronauts. So far the development of oxygen equipment has kept pace with the increase in operational altitudes, but what of the future? Will oxygen equipment as we know it become obsolete? If so, what will take its place?

New Aircraft: New Problems

The great breadth of the field of aviation medicine is pointed up by the diversity of the problems incidental to successful flight operations . . . The most pressing medical problems, however, are connected with military aviation. The great hazard in flying is emphasized by the fact that the death rate for the military pilot in peacetime is comparable to that for the non-flying officer in wartime. . . .

The important medical aspects of military aviation center around the selection and care of the flyer, the fitness of his environment, and his escape and survival in case of accident. Although these general aspects remain the same, the specific problems keep changing with the introduction of new aircraft. There are few areas of medical research today more challenging than those belonging to military aviation medicine.—ASHTON GRAYBIEL: *Merck Report*, 64:13, 1955.