Abstracts of Scientific Papers to be Presented at 1958 Meeting of Aero Medical Association, Statler Hotel, Washington, March 24-26

Record attendance is expected at the first post-satellite meeting of the Aero Medical Association at the Statler Hotel, Washington, D. C., March 24, 25 and 26, because of the early and unprecedented number of hotel room reservations which have been received, Captain Ashton Graybiel, MC, USN, president, announced in authorizing the publication in this number of THE JOURNAL of abstracts of the scientific papers to be presented.

Dr. Graybiel also disclosed that he had invited the U.S.S.R. to send Russian aeromedical scientists to Washington for the meeting. The invitation was extended on behalf of the Association, and forwarded to the Russian Ambassador in Washington for transmittal to Moscow. "It is my hope that I will have the pleasure of welcoming aeromedical scientists from your country to this forthcoming meeting," Dr. Graybiel wrote, "and I wish to extend a cordial invitation for them to present papers on their current work in space medicine." Invitations to send representatives to the meeting were also sent to seventy-five other nations, but because of the Russians' success in launching Sputnick II with a dog aboard a place on the program will be held for them.

Prepared by the authors and edited by Dr. H. J. Schaefer, chairman of the scientific program committee, the abstracts on the following pages are listed alphabetically by the last name of the senior or sole author.

Human Physiologic Responses to a Standardized Cold Stress as Modified by Changing Levels of Physical Fitness. LT. THOMAS ADAMS, and LT. EARL J. HEBERLING, USAF, Arctic Aeromedical Laboratory, Ladd AFB, Alaska.

A number of physiologic changes in a human response to an acute cold stress have been reported and have come to be accepted as indices of acclimatization. Inherent in the design of many of these human acclimatization studies are evidenced substantial increases in physical activity levels during the prolonged acclimatizing cold exposure. This current investigation was established to determine the physiologic effects of increased physical activity levels without prolonged exposure to a cold stress. Five, adult, male, Caucasian volunteers were exposed nude to an ambient temperature of 50° F. (10° C.) for one hour before and after a physical training program. Rectal, average skin and extremity temperatures and whole body metabolic rates were determined at five minute intervals throughout the duplicate exposure periods for each individual. Physical fitness scores were measured using a treadmill to ascertain the efficiency of a three week physical training program between comparative cold room exposures. After the training program, during which physical fitness levels were significantly increased, average levels of heat production were 15 cal/hr/M^2 higher, mean rectal temperatures were as much as 1.0° C. lower, average skin temperatures, 1.0° C. higher, and foot and toe temperatures 3.0° and 4.0° C. higher, respectively, with no significant differences in average body temperatures throughout the cold room exposures. These data indicate that many of the currently accepted indices of acclimatization may be produced by changing levels of physical fitness alone.

SOCIAL HIGHLIGHTS OF 1958 MEETING

Washington, D. C.

Saturday, March 22

Airline Medical Directors Association Luncheon—Statler Hotel

Sunday, March 23

Aero Medical Association Registration—1 P.M. Statler Hotel

(Registration desk will be open daily)

Monday, March 24

Civil Aviation Medical Association Luncheon—Statler Hotel

Wives' Wing Tea and Fashion Show—Statler Hotel

Fellows' Dinner—Officers' Mess, Naval Gun Factory

Tuesday, March 25

Aero Medical Association Business Meeting—12 Noon Statler Hotel

Wives' Wing Luncheon and Business Meeting—Statler Hotel

President's International Reception—Officers' Mess, National Naval Medical Center

Wednesday, March 26

Space Medicine Association Luncheon—Mayflower Hotel

Aero Medical Association Reception and Banquet—Statler Hotel

Teaching Aids in Respiratory Physiology. WALTER APPLEMAN, M.D., Douglas Aircraft Company, El Segundo, Calif.

A mechanical model, structurally and functionally analogous to the human respiratory system is presented to demonstrate the basic physiological principles of balanced and unbalanced breathing. The thorax is represented by a cylinder with a movable piston insert in one end, and a flat plate with a venting air hose at the other end. The parietal and pulmonary pleura are represented by two elastic balloons, one placed within the other, which completely fill the closed cylinder and are pneumatically sealed to the air-vent hose. The inner balloon is smaller than the outer one, and is inflated at the time of sealing to completely fill the outer balloon. The elastic recoil of the stretched inner balloon produces a negative pressure in the potential space between the balloons. Collapsible elastic tubing containing high and low pressure hydraulic pumping systems course their way between the outer balloon and the inner cylinder wall from pneumatically sealed points of entry and exit in the cylinder walls, represent the arterial and venous vascular systems. Manometers register pressure changes as the mechanical model goes through its respiratory cycle.

Characteristics of Personnel Who Volunteer for Extra-Hazardous Duty. J. T. BAIR, PH.D., and LT. (jg) T. J. GALLAGHER, USN, USN School of Aviation Medicine, Pensacola, Fla.

Although volunteering has been common to our culture since the founding of our nation, there has been a paucity of research related to this phenomenon. Do volunteers for extra-hazardous assignments differ in adjustment, intelligence, and motivation than non-volunteers? The present project was designed to answer these and other questions concerning differences between volunteers and non-volunteers. Three hundred and ninety-five Naval Cadets volunteered and 538 did not volunteer for a research project which involved an element of controlled hazard. The two groups were then followed through the flight training program to determine what differences existed in their performance. In addition certain tests of aptitude and personality were administered to both groups. The volunteers were significantly younger, fewer quit training, more were class officers, and had higher OLQ grades than non-volunteers. Differences in personality and aptitude test scores were not significant between the two groups. The results of this research are discussed in terms of possible future extra-hazardous assignments of the Navy.

Physiological Responses to Stressful Stratosphere Flights. By CAPTAIN N. L. BARR, MC, USN, F. G. STANDAERT and R. B. VOAS, U. S. Naval Medical Research Institute, Bethesda, Maryland.

The radio transmission and electrical recording of physiologic responses has made it possible to monitor the physiologic condition of crewmen during stratosphere flights, and the chemical analysis of blood and urine samples taken before and after flights has permitted a determination of the hormonal and metabolic responses to stress. These studies have two purposes: (1) insuring the safety of these hazardous flights by constant monitoring of the condition of the pilots, and (2) the collection of data under actual flight conditions on the physiological effects of high altitude operations. This report reviews findings in two recent balloon ascents and in several stratosphere flights in high performance aircraft. Heart and respiratory rate records have demonstrated marked increases. In some subjects pulse rates as high as 165 and 180 per minute have been recorded with respiratory rates as high as 60 per minute. Of particular interest was the pulse rate increase prior to actual ascent. Heart rates in flight appear to vary with the pattern of stress encountered by the pilots. In some cases, changes in the electrocardiogram suggest oxygen deficiency in the heart muscle. Despite these indications that the physiologic and psychologic stresses encountered in high altitude flights produce changes in heart and lung activity, the measures of blood and urine constituents generally have been within normal limits with little, if any, indication of stress effects.

Observations on Simulated 12-Second Decompressions to 32,000 Feet. CHARLES I. BARRON, M.D., DOUGLAS R. COLLIER, JR., M.D., and THOMAS J. COOK, Lockheed Aircraft Corporation, California Division, Burbank, Calif.

This study describes medical observations on a total of 127 persons exposed to 12-second pressure chamber decompressions from 8,000 to 32,000 feet, simulating possible loss of a window in a high performance transport-type aircraft. The subjects were exposed with and without oxygen for various periods of time following decompression, and for a maximum of 60 seconds above 30,000 feet. Reaction times for mask donning were noted following varying time exposures to hypoxia. Rates of descent of 5,000 to 8,000 feet per minute were simulated, and subjects' reactions to the effects of rapid recompression and recovery time with and without the use of oxygen were noted. Interesting observations were made relative to breathing difficulties with a pressure demand mask following slow decompression. The need for proper physiological indoctrination and institution of various safety precautions was evidenced. Except for two women the test subjects were all men between twenty-one and fifty-one years of age, and included a number who had minor physical disorders.

Centrifuge Experiments on High G-Loads in Mice and Their Possible Alleviation by Multi-directional Anti-G Devices. HARALD J. VON BECKH, M.D., and CAPTAIN GROVER J. D. SCHOCK, USAF, Aeromedical Field Laboratory, Holloman Air Force Base, New Mexico.

Using the centrifuge, time-tolerance limits on transversely positioned mice were studied and the results compared with longitudinal G tolerance values reported by other authors. The possibilities of a multidirectional G protection during escape trajectories and the re-entry phase are discussed.

An Investigation into the Feasibility Using the Standard Ejection Seat System for Underwater Escape from Ditched Aircraft. CAPTAIN EDWARD L. BECKMAN, MC, USN, and SURGEON LT. COMMANDER J. RAWLINS and SURGEON LIEUTENANT D. MCNUTT, RN, RAF Institute of Aviation Medicine, Farnborough, England.

An investigation into the feasibility of using the ejection seat system as a means of escape from ditched aircraft has been carried out at water depths down to 34 feet. An evaluation was made of the blast pressure, accelerations, drag and decompression loads which would act upon the pilot in using the ejection seat under water. The physiologic acceptability of these loads when acting singly and combined were then evaluated clinically by experienced subjects. The function of the automatic release mechanisms were also observed. Simulated escapes from submerged aircraft utilizing standard pilot survival equipment and ejection seat equipment were then carried out. The results of these trials are shown in part by motion pictures.

Oxygen Toxicity in Aviation Medicine: Experimental Approach. DIETRICH E. BEISCHER, PH.D., LT. (jg) JESSE G. HARRIS, JR., MSC, USN, LT. DALE M. IVERSON, MC, USN, and LT. COMMANDER, DAVID P. MORRIS, JR., MC, USN, USN School of Aviation Medicine, Pensacola, Fla.

The prolonged periods of exposure of aviators to oxygen make necessary an experimental reappraisal of its toxic effects. Mainly, the aspects of vision and mental alertness were subjected to renewed tests. The influence of oxygen on the performance of work was also studied. Finally, the influence of impurities of oxygen on the toxic effect is discussed.

The Potentialities and Ramifications of Life Under Extraordinary Environmental Conditions. DIETRICH E. BEISCHER, PH.D., USN School of Aviation Medicine, Pensacola, Fla.

The objective of this paper is an extension of biological abstractions with the purpose to reduce the great discrepancies which exist between the technical means of space travel and our knowledge of the limits of life under certain severe environmental conditions. Only through consideration of the potentialities of life under the most unusual conditions of time, gravity, temperature, pressure and other factors, can one hope to anticipate dangerous situations in manned space flight. A number

of examples illustrate the broad objective of this approach.

Increasing the Proportion of Outstanding Officers Among Naval Air Training Graduates. JAMES R. BERKSHIRE, M.A., USN School of Aviation Medicine, Pensacola, Fla.

Recent reductions in naval air training quotas make it desirable to have a higher proportion of men with outstanding command potential among the graduates. Senior officers in 110 fleet squadrons were asked to identify those first four pilots who possessed outstanding command potential. The selection and training records of 230 men so identified were compared with those of random groups of entering students and graduating students. Nearly all selection and training measures were higher for the outstanding men than for the random samples. This was particularly true for scores that can be presumed to reflect general intelligence. It is shown that a program consisting entirely of U. S. Naval Academy graduates would double the proportion of outstanding officers and would ultimately (because of high extension rates) cost a third less to operate than the present program. Elimination of the Naval Cadet program, or a program made up of Academy and NROTC graduates only would also reduce costs while increasing the proportion of outstanding officers. It is also shown that raising certain minimum training standards could substantially increase the proportion of outstanding officers among graduates.

The Role of the Altitude Chamber in the Diagnosis and Disposition of Problem Aeromedical Cases. MAJOR CHARLES A. BERRY, and CAPTAIN ARTHUR H. KING, USAF (MC), USAF School of Aviation Medicine, Randolph AFB, Texas.

The altitude chamber has been used in the training of airmen since the time of Paul Bert. In some countries it has been utilized in the therapy of pertussis. Today it is used by the flight surgeon as a diagnostic aid much as the ECG or EEG and other laboratory procedures. It provides a medically controlled environment where the ills of the flier may be evaluated and the findings used with those of the history and physical examination in arriving at a proper diagnosis and deciding disposition. The chamber flight must be carefully planned for each case. Medical monitoring includes continuous electroencephalography, electrocardiography and x-ray on occasion in addition to the ordinary visual appraisal. This paper discusses the use of this diagnostic tool on numerous cases seen on the Aviation Medicine Consultation Service at the School of Aviation Medicine, Randolph AFB, Texas. Case histories are presented demonstrating its use in patients with ENT problems, loss of consciousness and head injury, pulmonary blebs, pneumothorax, and pulmonary wedge resections, prolonged hypoxia, and cardiac problems.

Some Considerations in Design of a Balloon-Borne Pressurized Capsule for High Altitude Bailout Study. EVERETT E. BESON, Balloon Department, General Mills, Inc., Minneapolis, Minn.

The balloon-borne pressurized capsule offering all the advantages of a stable platform in the stratosphere also provides a reliable, safe and relatively inexpensive means of carrying scientists to altitudes where bailout and survival studies can be conducted. The designer of such a capsule is confronted with many interesting problems. Engineers and scientists from General Mills and Wright Air Development Center's Aero Medical Laboratory working on Project High-Dive have solved such problems as (1) Selection of optimum capsule configuration for stability at high fall velocities, (2) Parachute deployment at high rates of descent, (3) Design and control of capsule artificial environment, (4) Minimization of shock during capsule landing, and other human engineering problems peculiar to this endeavor. The capsules developed for Project High-Dive have incorporated the latest aircraft structural fabrication techniques, liquid oxygen converter systems and chemical absorbents for "climate" control, as well as other unique design features to form a highly efficient specialized vehicle.

Subjective Effects of Transverse Accelerations on Subjects Immersed in Water. CAPTAINS WILLIAM BLANCHARD and STUART BONDURANT, USAF (MC), CAPTAIN NEVILLE CLARKE, USAF (VC), and 1ST LT. FRANKLIN MOORE, USAF, Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

To explore the acceleration protection offered by complete submersion in water forty-six centrifuge runs were made on four human subjects lying flat in a water filled container. Compressed air for respiration was supplied through an aqualung valve positioned to maintain a balance between endotracheal pressure and extrathoracic pressure. In each run the subjects were held at peak G for 15 to 55 seconds, after which their subjective impressions were recorded. The tolerance to chest to back G (supine) was limited by increasingly severe substernal pain. The onset of this pain occurred at an average level of 4.1G with the maximum tolerable level being about 7G. In the prone position (back to chest G) the chest pain did not appear at the same levels noted above but the absolute limit of tolerance was not determined due to difficulties with respiration and chest buoyancy. In contrast to the unimmersed situation all subjects noted a feeling of weightlessness with freedom of limb and head movement. These preliminary experiments do not indicate any marked gain in transverse G tolerance due to water immersion.

A Study of Quick Donning Oxygen Mask Suspensions; Some Theoretical and Practical Considerations. AARON BLOOM, Sierra Engineering Co., Sierra Madre, Calif.

Aviators' oxygen oro-nasal type breathing masks by their very nature can never fully satisfy the comfort requirements dictated by the individual user. The multitude of variables in any subjective evaluation provides inadequate data for a finite analytical study. Appropriately, then, it is necessary to attack the supplemental problems of mask design to overcome the basic objection of prolonged mask usage. This is particularly true in commercial air line type aircraft where cockpit oxygen altitudes are only attained after decompression. The subject study was undertaken to develop a unique type of mask suspension which would permit extreme rapid donning with minimum effort and maximum immediate oxygen safety. The study, though not completely analytical, presents a number of theoretical design approaches and illustrates several practical designs.

The Spatial Vector Cardiogram during Acceleration. CAPTAIN STUART BONDURANT, USAF (MC), and 2D LT. WILLIAM A. FINNEY, USAF (MSC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Spatial vectorcardiograms have been recorded during the following acceleration patterns:

1. Positive G (18 subjects, 58 runs)
   (a) Rapid onset to blackout, unprotected
   (b) With anti-G suit, rapid onset to unprotected blackout level, maintained 60 seconds.
   (c) Gradual onset to blackout
   (d) Gradual onset to 3.0-5.0 G plateau maintained ½-60 minutes
2. Transverse G (8 subjects, 20 runs)
   (a) Supine and prone 4.0 G for 30 seconds
3. Complex G (6 subjects, 17 runs)
   (a) Seated subject with back-to-chest G vector 2.0 and 3.0 G for 3-30 minutes.
4. Negative G (5 subjects, 10 runs)
   (a) Supine 1.5 and 2.0 G for 7 seconds

The results showed: (1.) Positive and transverse G: tachycardia to 150, occasional extrasystoles, exaggerated respiratory shift of QRS loop. No change in QRS-T angle, S-T or T waves; (2.) Complex G: as above except for one episode of paroxysmal tachycardia, probably ventricular, (rate 224); and (3.) Negative G: bradycardia, occasional extrasystole and sinus pause, but no change in QRS or T loops. There was no consistent change in the electrical axis of the heart. There was no evidence of myocardial hypoxia or "ventricular strain." With one exception (complex G) there was no evidence of dangerous or potentially dangerous arrhythmia.

Experience Gained in Evacuating 400,000 Patients by Air in Ten Years. COLONEL L. RENDER BRASWELL, USAF (MC), Headquarters, Military Air Transport Service, Scott AFB, Ill.

What the practicing flight surgeon should know about aeromedical evacuation has been crystallized from ten years' experience. The role of the art of medicine still looms large, despite rapid advances in the sciences of medicine and aviation, the merger of which is epitomized in aeromedical evacuation. Pertinent case histories are discussed. Casualty staging units will vastly improve the ground-handling of patients, presently the chief source of patient complaints. Versatility has been demonstrated on several notable occasions to be a prime virtue of aeromedical evacuation.

Cumulative Effects of Repeated Hyperventilation in Normal Adults. FLIGHT LT. H. P. BRENT, RCAF, DR. W. J. SCOTT, and GROUP CAPTAIN W. R. FRANKS, RCAF. RCAF Institute of Aviation Medicine, Toronto, Canada.

In the course of work on the summation of physiologic stimuli to produce disturbances in consciousness, it was noted that repeated hyperventilation seemed to produce some cumulative effects. Accordingly, a study was undertaken to determine the significance and extent of this cumulation. Subjects repeatedly hyperventilated at intervals of one hour or more with each individual breathing at his own maximal voluntary rate and depth. EEGs were recorded and specific questions asked after a standard recovery period. Because of the known effects of changes in blood sugar on the EEG pattern, the times of hyperventilation were spaced with respect to food intake so as to avoid large differences in levels of glycaemia. Results indicate that cumulation effects, as evidenced by EEG changes and by symptoms, occur in a large proportion of cases, when brief periods of hyperventilation are carried out repeatedly.

Contemporary Pilot Selection. A Comparison of Pilot Selection in the Air Services of the United States, Canada, Great Britain, and France. CAPTAIN ROBERT R. BURWELL, USAF (MC), and SAUL B. SELLS, PH.D., USAF School of Aviation Medicine, Randloph AFB, Texas.

Comparisons were made of the prerequisites for entrance into pilot training (age, education) and the psychologic tests used for selection of pilot candidates in the United States Air Force, the United States Navy, the Royal Canadian Air Force, the Royal Air Force, and the French Air Force. Data obtained indicates that despite (1) the introduction of jet aircraft into pilot training and (2) higher performance operational jet aircraft, there have been no drastic changes in the methods of pilot selection since the close of World War II, prior to the "jet age." Some implications of this study with regard to future selection of aircrews for very high altitude, very long range vehicles are discussed.

Aviation Medicine on the Threshold of Space: Significant Events of the Past Year. COLONEL PAUL A. CAMPBELL, USAF (MC), Air Force Office of Scientific Research, Washington, D. C.

The past year has been marked by a series of events, a rapid accumulation of knowledge, and an out-pouring of popular interest which, within the foreseeable future, will enable man to cross the threshold of space. This paper attempts to fit the bits and pieces of the accumulation of the past year together to show a pattern demonstrating where aviation medicine stands today in relation to the art.

Aircraft Passenger Oxygen by Continuous Flow Techniques. EARL T. CARTER, M.D., PH.D., Ohio State University, Columbus, Ohio.

Economy and simplicity favor the use of continuous flow oxygen systems instead of demand systems by airline passengers during emergencies. However, oxygen flow rates in continuous flow systems must be based on the flow rate-time pattern of the single breath rather than minute ventilation. Experimentation reveals that normal peak inspiratory flow rates vary from 30 to 50 L/min. while during respiratory stimulation flow rates as high as from 70 to 90 L/min. may be obtained. Assuring 100 per cent inspired O_2 even during quiet breathing thus requires rather high O_2 flow rates from the aircraft system (i.e., 30 to 50 L/min. if no rebreather bag used). Cal-

culations show that a moderate increase in ventilation, which must be expected during an emergency, would result in significant dilution of the breathing O_2 with air. By merely doubling the normal ventilatory rate, an equivalent altitude of 15,000 to 20,000 feet would result during emergency use of such a system at 30,000 feet when commonly selected continuous O_2 flow rates are employed (20 to 30 L/min.). Incorporation of a rebreather bag lowers the equivalent altitude according to the ratio of respiratory tidal volume to rebreather bag volume. Prediction of this ratio during actual usage is difficult, but it should be unity or greater to minimize mixing in of ambient air.

Vertebral Injuries from Ejection Forces. R. L. CARTER, North American Aviation, Inc., Columbus, Ohio.

A review of the literature on human tolerance to ejection forces is presented. Factors abetting spinal injuries from such forces are discussed. Evidence is presented that indicates all thoracic and lumbar vertebrae have essentially the same tolerance to positive G of high magnitude and short duration. Criticalness of body position while being subjected to these forces is emphasized.

MK5 Constant Wear Anti-Exposure Suit. FRANK A. CATROPPA, B.S., and MURRAY SLOANE, B.CH.E., Air Crew Equipment Laboratory, Philadelphia, Pa.

The prototype MK5 anti-exposure suit is designed to be worn by Navy fighter pilots flying over cold waters. This suit utilizes an impermeable neoprene coated stretch nylon fabric to provide a form fitting garment without restricting mobility. Provisions for ventilating have been included either by the plane's air conditioning supply or by a portable blower that can be installed in the plane. The suit incorporates exhaust valves that seal automatically when immersed in water, a watertight slide fastener as the entrance portal, improved wrist and neck seals, and detachable insulated light weight boots.

A Closed Food Cycle Atomic Conservation for Space Flight. CARL C. CLARK, PH.D., Aviation Medical Acceleration Laboratory, Johnsville, Pa.

For flights exceeding several days, weight limitations require a change from an "open" food cycle, in which sufficient food and oxygen are taken along and wastes are stored or vented, to a "closed" food cycle, in which certain amounts of metabolic wastes are converted with the expenditure of energy into food. Historically, initial emphasis has been placed on the recovery of oxygen from carbon dioxide, but for flights of long duration, a complete atomic conservation will be required. The chemical energy required to maintain a closed food cycle will be presented. The advantages and limitations of including other animals or particularly plants in the food cycle will be reviewed. The requirement for continuous automatic monitoring of the molecular constitution of "waste", intermediate conversion products, and "food" as part of the automatic atomic conservation conversion system will be presented, with preliminary steps to meet this requirement.

Physiologic Response to "Back to Chest" G Forces on Seated Human Subjects. CAPTAIN NEVILLE P. CLARKE, USAF (VC), CAPTAIN STUART BONDURANT, USAF (MC), CAPTAIN SIDNEY D. LEVERETT, USAF, and PAUL YUDKOFSKY, Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Transverse G patterns have previously been studied on human subjects in the standing, prone, supine and semi-supine positions. The present study involves an evaluation of the effects of prolonged back to chest G (longer than 5 seconds) acting on seated subjects on the human centrifuge. This attitude differs in that, with the arms and legs extended, there will be a pooling of blood in the extremities which simulates the effects of positive G loadings. Subjective symptoms, performance ability and bioelectric measurements were used as criteria for evaluation of changes occurring during a series of experiments in which both the magnitude and duration of acceleration were varied. Human tolerance to G of this type is limited by the develop-

ment of petechial hemorrhages in the extremities, subject fatigue, tachycardia and dyspnea. Tentative tolerance limits for the unprotected subject appear to be on the order of 2 G for 30 minutes, 3 G for 7 minutes and 5 G for 7 to 10 seconds. Protective devices may significantly increase human tolerance to this type transverse G force.

Effects of Various Mask Configurations on Simulated Lung Pressure During Rapid Decompressions. D. R. COLLIER, JR., M.D., C. I. BARRON, M.D., and THOMAS J. COOK, Lockheed Aircraft Corporation, California Division, Burbank, Calif.

This report details a study performed to evaluate the relative lung pressure changes occurring during explosive and rapid decompressions, with various types of oxygen mask configurations. The decompressions were accomplished in a simulated lung-mask system at speeds varying from 0.1 to 1.0 second, a constant pressure differential of 5 psi, and pressure altitude changes of 20,500 to 52,500 feet. Two rigid canisters with volumes of 3,500 and 5,500 cc. were used to simulate maximum lung volumes during normal and maximum inspiratory efforts, and an aerodynamically effective orifice of 3.9 to 4.5 mm. was achieved. Decompressions were performed using a standard A-13A mask, the mask plus the Hardman mask retention kit, and the mask-kit combination with the addition of a pressure sensing dump valve incorporated in the T block at the quick disconnect. A motion picture study of the actual tests was made and correlated with each decompression. The relative effects and possible applications of the various configurations are discussed in accordance with the comparative findings.

The Pathologic Findings in Experimental Animals Subjected to Rapid Acceleration and Abrupt Deceleration. CAPTAIN J. E. COOK, USAF (VC), and COLONELS JOHN P. STAPP and FRANK M. TOWNSEND, and CAPTAIN V. A. STEMBRIDGE, USAF (MC), Forensic and Aviation Pathology Section, Armed Forces Institute of Pathology, and Aero Medical Field Laboratory, Holloman AFB, N. Mex.

Animals are frequently utilized in experiments designed to gain data concerning individual tolerances and safety margins. While those animal tests are not intended to replace actual human participation in evaluating man's ability to withstand physical stress, the properly selected and utilized animals allows for both the examination of living tissues and varied environments without the initial use of human volunteers. This paper presents the pathologic lesions observed in experimental animals subjected to rapid acceleration, abrupt deceleration, supersonic thrust wind blast and prolonged high transverse G. The advantages and disadvantages of the various experimental animals (primates, bears, swine) is given together with pertinent anatomical comparison of the different species.

Change in Plasma Transaminase of Rhesus Monkeys after Exposure to Vibration, Acceleration, Heat, or Hypoxia. FREEMAN W. COPE, M.D., and B. DAVID POLIS, PH.D., Aviation Medical Acceleration Laboratory, Johnsville, Pa.

Significant increases in plasma glutanic-oxalacetic transaminase levels in monkeys have been produced by exposure to vibration, acceleration, heat, hypoxia, and noise and confinement stress. In all but one of seventeen animals, no specific tissue damage was evident. The increase in plasma transaminase is interpreted in terms of the general adaptation syndrome. The data suggest that caution should be exercised in basing clinical judgments on serum transaminase levels.

Evaluating Audio Warning Displays for Weapon Systems. DWIGHT E. ERLICK, PH.D., Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

The advent of high speed complex weapon systems has been paralleled by a necessity of keeping the operator aware of the performance of the system in a greater number of critical areas and in shorter time intervals. The use of audio with its inherent advantages as a warning indicator needs thorough investigation. Four major problem areas are discussed in terms of the variables that should be considered when evaluating and using audio warning dis-

plays. These problem areas relate to the determination of the criticality of events, the human and equipment characteristics involved in the selection of audio warning displays and the task dimensions essential to evaluate audio warning displays. The merits of a two-step warning display are discussed; the first step being designed to bring about detection and identify two or three general categories; the second, using spoken words which serve to identify specific malfunctions within these categories.

The Combined Effect of Vitamins A and E on Dark Adaptation in Man. H. S. FANG, M.D., COMDR. A. L. HALL, MSC, USN, and T. F. HWANG, M.D., National Taiwan University, Taipei, Taiwan.

Pre-dark adapted human subjects showed no improvement in dark adaptability with single doses of Vitamin A (100,000, 200,000 or 300,000 I.U.) or with single doses of Vitamin E (300 or 500 mg.). Vitamin A and E given simultaneously (200,000 I.U. of A and 500 mg. of E) resulted in a significant increase in dark adaptability.

The Effects of Positive Acceleration on Performance of an Air-to-Air Tracking Task. DOROTHY E. FLETCHER, PH.D., and LT. (jg) C. C. COLLINS, USN, Aviation Medical Acceleration Laboratory, Johnsville, Pa.

A tracking task which represented the problem of air-to-air pursuit was instrumented in the gondola of the human centrifuge. The display consisted of a symbolic representation of an aircraft presented on a cathode ray oscilloscope. The aircraft moved on the scope face in a random fashion. Horizontal movements on the scope face were preceded by appropriate banking of the wings. The motion of the aircraft on the scope face could be controlled by a subject seated in the gondola. Subjects were provided with a right-hand console stick and a conventional center stick. The effectiveness of the two control sticks on performance of the tracking task by subjects exposed to acceleration forces was compared. Four subjects were exposed to a variety of acceleration patterns. The maximum level of acceleration was 4 G and the maximum duration 30 seconds. Individual runs were slightly more than 2 minutes in length and included, at the most, two acceleration exposures in a single run. The results in the experiment indicated a definite superiority of the right-hand console stick for performance in the tracking task. In addition there was a significant interaction between acceleration and the control stick which was used, indicating that the right-hand console stick increased in superiority under conditions of acceleration. Performance was significantly better at lower and shorter acceleration exposures. It was concluded that tracking performance will show a decrement as a result of exposure to acceleration. It was further concluded that a right-hand console stick is superior for performance of a tracking task of the kind employed under control conditions as well as experimental conditions in which subjects are exposed to acceleration.

Thoracotomy and Rehabilitation of the Flyer. LT. COLONELS FRANCIS E. FOLEY, and STANLEY H. BEAR, COLONEL JULIAN A. JARMAN, and MAJOR WILBER R. WHITSELL, JR., USAF (MC). U. S. Air Force Hospital, Maxwell AFB, Ala.

In the four years, January 1, 1954 to December 31, 1957, twenty-six major chest surgical procedures have been performed on twenty-four flyers at this hospital, 13.5 per cent of the thoracic surgical workload. At present it appears that twenty have been, or will shortly, return to flying status, a rate of 82.7 per cent. Of the remainder, two are permanently grounded for relative pulmonary insufficiency, and one for an acid-fast infection revealed by surgery. All of these patients would or should have been grounded by their preoperative conditions alone. Of those returned to flying, fourteen were salvaged as flyers by fifteen thoracotomies, (70 per cent). Six had resections of lesions which, in themselves, would not necessarily contraindicate flying. One, whose return to flying was anticipated, died in an automobile accident while on convalescent leave.

The Navy Full-Pressure, High-Altitude Suit. CAPTAIN CHARLES F. GELL, MC, USN, E. L. HAYS, B.S., and J. V. CORREALE, JR., B.S., Air Crew Equipment Laboratory, Philadelphia, Pa.

A review of the Navy's efforts in the design and development of a full pressure suit for the protection of aviators at extreme altitudes. The critical detail design features and their bioengineering aspects are presented.

Experiments During Weightlessness: A Study of the Oculo-Agravic Illusion. SIEGFRIED J. GERATHEWOHL, PH.D., and MAJOR HERBERT D. STALLINGS, USAF., USAF School of Aviation Medicine, Randolph AFB, Texas.

According to Graybiel's "law of the otoliths", changes in gravity produce the so-called oculogravic illusion. Experiments were made to investigate the apparent movements of visual after-images during the subgravity and zero-gravity states. A F-94C type aircraft was used for producing short periods of subgravity and zero-gravity during the dive and flight parabola, and radial accelerations of from 2 to 3 G during pull-outs. The observer, seated in the rear part of the cockpit, induced a strong after-image by looking at a bright light for 20 seconds immediately prior to transition from 1 G into subgravity, from 1 G into 3 G, and during the parabola pattern. He then closed his eyes and described the apparent motion of the after-image. Pilot statements about flight condition and report of the observer were recorded on tape, and transcribed and evaluated after each flight. The reports obtained so far by seven sophisticated observers indicate that the apparent movements of the after-image are associated with changes of gravity and acceleration; and that motion occurs in the direction "up" or "down" according to the changes of the gravitational vector. The motion observed during the weightless condition was designated as the "oculo-agravic" illusion.

Dynamic Testing of Energy-Absorbing Materials. F. GIRLING and E. D. L. TOPLIFF, Defence Research Medical Laboratories, Toronto, Canada.

During investigation on a project concerned with the mechanics of brain damage, a technique was developed which permitted a dynamic classification of energy-absorbing materials. The technique consists of dropping an agar-filled plastic shell from various heights against a striker. When this is done, liquefaction of the agar occurs at the pole opposite to the point of impact. The volume of liquefaction varies with the square of the height. Below a certain height no liquefaction occurs, and this has been termed the "critical height". Interposition of an energy absorbing material between the test object and the striker does not alter the shape of the curve but changes the "critical height". Using this "critical height" as a criterion of protection afforded, and plotting the "critical heights" against the densities of the materials used, a hyperbolic relationship is indicated. That is, protection against impact afforded by energy-absorbing materials is inversely proportional to density.

Coronary Sclerosis as a Factor in Aircraft Accident Fatalities. CAPTAINS W. M. GLANTZ and V. A. STEMBRIDGE, USAF (MC), Forensic and Aviation Pathology Section, Armed Forces Institute of Pathology, Washington, D. C.

Coronary sclerosis continues to be an unsolved mystery confronting the medical profession at present. Formerly considered a disease of an aging population, it is recognized today to exist clinically unsuspected in younger age groups as shown in the study of Korean War casualties. Utilizing autopsy material from fatalities occurring as a result of aircraft accidents, there has been an opportunity to study the occurrence of coronary sclerosis in a group of young males who have been subjected to rigorous, periodic, physical examinations. Although coronary sclerosis and subsequent myocardial infarction have been implicated in a few aircraft accidents, these cases have been in the distinct minority. However, many of the aircraft accident autopsies do show varying degrees of unsuspected coronary sclerosis. This paper points up the need for further intensive research for tests to detect subclinical coronary sclerosis and raises questions regarding the role of such factors as hypoxia, decom-

pression and stress in the etiology and pathogenesis of coronary artery disease.

The Detection of Therapeutic Amounts of Drugs in Postmortem Tissues. L. R. GOLDBAUM, PH.D., Forensic and Aviation Pathology Section, Armed Forces Institute of Pathology, Washington, D. C.

With the newer high performance aircraft there is even less margin for a misjudgement on the part of the pilot. This point indicates the increasing importance of drug detection in aircraft accident fatalities even when such drugs exist in therapeutic concentrations. This paper indicates the procedures used at the Armed Forces Institute of Pathology for the detection of relatively minute amounts of certain drugs such as: tranquilizers, anti-histaminics and alkaloids.

The Effect of Shouting on Arterial Blood Oxygen and Alveolar Carbon Dioxide. COMMANDER A. L. HALL, MSC, USN, and LT. (jg) HERBERT KELLEY, MSC, USNR, USN School of Aviation Medicine, Pensacola, Fla.

Common symptoms of both hypoxia and hypocapnia often include dizziness and blurred vision. These early symptoms cannot be subjectively differentiated. It has been determined that shouting increases arterial blood oxygen. An attempt was made in this paper to determine if certain words, volumes, and number-of-words-per-exhalation would increase alveolar carbon dioxide tensions. The word "peak" was shouted four times per exhalation for one minute by eight human subjects at 40,000 feet (breathing 100 per cent oxygen). An average increase of 1 mm. CO_2 and 0.57 per cent O_2 was obtained from this procedure.

The Effects of Direct Infusion of Pure Carbon Dioxide into Animals. F. G. HALL, PH.D., and JOHN SALZANO, PH.D., Department of Physiology and Pharmacology, Duke University, Durham, N. C.

Pure carbon dioxide was infused into the femoral vein of anesthetized dogs at various rates and volumes. Arterial and right atrial pressures were recorded. Rheopneumograms were used to determine tidal air, minute volumes and breathing rates. Blood samples were drawn at intervals for oxygen, carbon dioxide and hemoglobin content. Electrocardiograms and roentgenograms were also made. It was found that large quantities of pure carbon dioxide could be infused into dogs before gas emboli occluded pulmonary blood flow. While marked alterations in the blood picture occurred, this did not seem to be a limiting factor for the rates and volumes of gas infusion.

The Present Status of the Navy Fatigue-Relieving Pneumatic Seat Cushion. T. D. HANNA, B.S., and L. M. LIBBER, PH.D., Air Crew Equipment Laboratory, Philadelphia, Pa.

Previous studies have indicated that a subjective evaluation in the form of a structured questionnaire was the only valid criterion that lent itself to seat evaluation studies. Using this criterion it had been found that some form of air cushion covered with Trilok possessed greater fatigue relieving properties than the other prototype seat cushions evaluated. A static air cushion and a pulsating air cushion were redesigned and submitted along with the original pulsating air cushion to an operational squadron for evaluation. Results strongly indicated that the redesigned static air cushion covered with Trilok is the most acceptable. A complete description of the most recent static air cushion is given together with the results of the most recent operational evaluation.

Effects of in Vivo and in Vitro Hypothermia on Rat Ventricular Metabolism and Function. JOHN P. HANNON, PH.D., Arctic Aeromedical Laboratory, Ladd, AFB, Alaska.

The effects of *in vivo* and *in vitro* hypothermia on the metabolism and activity of rat ventricular tissue was studied. *In vivo* cooling to 15°C. by whole body immersion to the axillae resulted in an increase in the endogenous metabolism of slices and homogenates of ventricular tissue when subsequently incubated *in vitro* at 38°C. Homogenate incubations in the presence of several intermediates of the tricarboxylic acide cycle also indicated no deleterious effects were induced by hypothermia. Evidence suggesting the occurrence of an oxy-

gen debt during hypothermia was found. *In vitro* measurement of metabolism at temperatures ranging from 5°C. to 35°C. showed that a least two temperature velocity constants were present in ventricular muscle. Thus, Arrhenius plots of oxygen consumption versus incubation temperature, utilizing several different substrates, all had one constant characteristic of temperatures above 21°C. and another characteristic of temperatures below 21°C. The latter of these had about twice the value of the former. Measurements of heart rate during hypothermia showed that the rate decreased steadily as the rectal temperature approached 21°C. Between 21°C. and 20°C. (corresponding to the break in the Arrhenius curve) ventricular rate became abnormal showing partial and complete A-U block ectopic rhythms and short periods of fibrillations.

The Feasibility of Re-cycling Human Urine for Utilization in a Closed Ecological System. CAPTAIN WILLARD R. HAWKINS, USAF (MC), USAF School of Aviation Medicine, Randolph AFB, Texas.

The author discusses the general techniques presently available for reconstitution of human urine in the form of potable water. Both physiologic and psychologic aspects are presented. Consideration is given to the volume, weight, and technical difficulties involved in the re-cycling of this body waste for utilization in a closed ecological system. Data on the practicality of such techniques is presented with reference to prolonged flights.

Pulmonary Emboli; Its Occurrence in Aircraft Accident Fatalities and Comparison with Hospital Autopsies. CAPTAINS J. L. HICKEY and V. A. STEMBRIDGE, USAF (MC), Forensic and Aviation Pathology Section, Armed Forces Institute of Pathology, Washington, D. C.

Utilizing the autopsy material from aircraft accident fatalities, a detailed study is made of the lungs in search of fat, bone marrow and tissue emboli in the pulmonary vascular bed. A comparison is made of the type, frequency and significance of pulmonary emboli as found in aircraft accident fatalities, and hospital autopsies of both traumatic and non-traumatic deaths.

A Comparative Evaluation of Two Ejection Controls: The Standard Face Curtain vs. A "D-Ring" Located on the Front of the Ejection Seat. J. H. HILL, PH.D., and JOHN LOTT BROWN, PH.D., Aviation Medical Acceleration Laboratory, Johnsville, Pa.

A cock-pit mock-up consisting of (1) an F9F ejection seat equipped with face curtain and the experimental D-ring ejection control, (2) throttle, (3) stick, (4), rudder pedals, and (5) two signal lights were mounted in the gondola of the human centrifuge. Five subjects were tested in their ability to perform the ejection procedure with the two methods of ejection under three orientations of acceleration, positive acceleration up to 6 G, transverse chest-to-back up to 6 G, and transverse back-to-chest up to 5 G. From the results of this investigation, it was concluded that an ejection control located on the front of the ejection seat is superior to the standard face curtain.

A Leg Retention Device for High Performance Aircraft. GALEN A. HOLCOMB, North American Aviation, Columbus, Ohio.

Subjects exposed to high wind blast forces in an open ejection seat require retention of the extremities to prevent flailing. Reduction of area exposed to wind blast during ejection also assists in the control of horizontal impact peak G forces by reduction of D/W ratio at the expense of time. Low level-high speed escape requires the feet to be positioned automatically within 0.2 second after system initiation and released automatically after launching. The development of a system accomplishing these objectives is discussed. The kinematics and mechanical components are described as reduced to practice for newer Navy weapon systems.

What's New in Mask Mounted Regulators and Mask Mounted Systems. LEON JONES, Robertshaw-Fulton Controls Company, Anaheim, Calif.

The paper briefly reviews the problems of developing a hypersensitive automatic pressure breathing demand type mask mounted regulator. Test data on sensitivity, endurance, response time and effects of en-

vironment, is given. The compromises and dangers involved when installing regulators in an A-13A mask are discussed. A radically new approach to mask mounting, and the methods and principles used to eliminate all the present problems and return the pilot to natural breathing, are presented.

Simplicial Analysis in the Naval Air Training Program. MARSHALL B. JONES, PH.D., USN School of Aviation Medicine, Pensacola, Fla.

The correlation of training grades is a long-standing practice in training research. However, the principal existing method for analyzing these correlations, factor analysis, was developed with the idea of analyzing the intercorrelations of psychological tests, not training grades. The result is that the theory and practice of factor analysis is not congenial to training data. The most glaring example of this incompatibility is the total absence in factor analysis of any method which orders the training grades themselves in some sort of sequence. Clearly, however, the ordering of stages is of the very essence of training. First one takes pre-solo, then precision and so on. Training is a growth process and growth by its nature implies order. Therefore, no system of analysis which lacks the idea of order can hope to do justice to the data. Quite recently, however, Guttman has developed a technique for the analysis of correlation matrices which is based on the idea of order. However, Guttman was led to simplex theory, as he called it, from its mathematical origins. He seems never to have considered its applications in training research. In the last year, however, Guttman's ideas have been applied to a great variety of correlative material taken from the naval air training program. The results of these studies enable us to assert that from a simplicial analysis of the correlations between stages of training we may plausibly conclude in what order the stages should be taught and we may do this without the expense and delay of an experimental attack. The technique can also be used to define criteria of training. This paper is a discussion of the results and of the logic upon which these propositions are based.

End Point Variation at Constant Acceleration. GEORGE H. KYDD, PH.D., and RICHARD L. FENICHEL, PH.D., Aviation Medical Acceleration Laboratory, Johnsville, Pa.

Unanesthetized monkeys have been observed on the 8-foot centrifuge at from 2 to 15 G, and an end point for unconsciousness has been observed. This end point has been described as the beginning of a period of inactivity on quiescence which separates periods of activity on the part of the animals. Further observations are reported at this time in which the experimental procedure has been altered to indicate some of the variation to be expected. The animals have been given multiple runs of varying duration at constant G separated by 5-minute rest periods and the occurrence of the end point has been observed. The duration of the first run was 30 seconds and succeeding runs were increased by increments of 30 seconds. The experiments indicate that the animals withstood the initial run much better than any of those that followed. The differences between the times of occurrences of the end points in the later runs were decreased indicating that there is some adaptation and the resistance of the animal is not improved under these conditions.

Pulmonary Cavitary Disease in Jet Pilots; Report of Two Cases. CAPTAIN ROBERT H. LANG and MAJOR MAX J. NAREFF, USAF (MC), U. S. Air Force Hospital, Wiesbaden, Germany.

Among the diverse problems of high altitude flight, the role of reduced atmospheric pressure and its effect on the human mechanism is a most important one. Recently, two cases of cavitary pulmonary lesions were encountered in active jet pilots. In one, a senior pilot with many years of jet experience, symptoms of a disabling character developed at altitude. Evaluation led to a diagnosis of bilateral cystic disease of the lungs. The second case was asymptomatic and discovered on routine x-ray survey. He was found to have a solitary cavitary lesion of infectious

nature. The implications of cavitary lung disease are discussed in relationship to the hazards and problems of high altitude flight.

A Hearing Conservation Program Applicable to Commercial Aviation Turbo-Prop Operation. LUDWIG G. LEDERER, PH.D., M.D., Washington National Airport, Washington, D. C.

Comprehensive surveys of sound intensity and frequency analyses were made on the turbo-prop Viscount type aircraft operated by Capital Airlines. Sound analyses within the aircraft during flight, overhead sound analyses compared with conventional piston type aircraft, and sound analysis in a 360° radius during ground procedures were made. From the data obtained and personnel involved, categories of noise exposure were set up. Another phase of study was the within-plant sound levels caused by engine test cells. This paper deals with the necessary steps taken by an airline operating turbo-prop equipment to protect its personnel and to provide for proper medico-legal implications. The presentation gives in detail the results of a survey made after approximately one year of exposure to turbo-prop noise levels. Interesting individual case data are presented, as well as an overall analysis on the effect of turbo-prop noise problems.

Influence of 5 Per Cent CO_2, Exercise, and Adrenalin on Post-Mortem Brain Lactate Levels in Hypoxic Mice. C. S. LENNOX, J. CHISHOLM, and GROUP CAPTAIN W. R. FRANKS, RCAF, Banting and Best Department of Medical Research, University of Toronto, Toronto, Canada.

Early work by Franks and Shimizu established that elevation of post-mortem brain lactate provided useful information in detecting pre-mortem hypoxia experimentally. In subsequent studies of the influence of hyperventilation on the mechanism in dogs, difficulties were encountered due to the action of anaesthetics on the mechanisms involved. Experiments were undertaken with unanaesthetized mice rendered hypoxic by progressive exposure to 5 per cent carbon dioxide in nitrogen, thereby eliminating acapnia, consequent on any hyperventilation. These showed that the addition of carbon dioxide decreased somewhat the hypoxic lactate level, but not to that of the non-hypoxic controls. The influence of muscular activity and of injected adrenalin in the presence of normal oxygenation had previously been found not to raise significantly the post-mortem level to that of hypoxia. The influence of exercise and of adrenalin with hypoxia on the post-mortem test have now been studied and found to be additive with the hypoxia under these conditions. Addition of the CO_2 tended to counteract the additive effect.

Changes in Force of Contraction of the Heart during Positive Acceleration. CAPTAINS SIDNEY D. LEVERETT, JR., USAF, and NEVILLE P. CLARKE, USAF (VC) Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Using the strain gage arch technique, qualitative changes in the force of contraction of the left ventricle of dogs were observed simultaneously with the arterial pressure at head level and the EKG when the animal was exposed to varying positive force fields on the centrifuge. The arterial pressure overshoot following a 20 mm. Hg. The Valsalva maneuver was used as one of the pre-run indexes of the responsiveness of the autonomic nervous system in affecting the cardiovascular reflexes. Drugs known to affect the contractility and rate of the heart were selectively administered to qualitatively test the responsiveness of the strain gage pick-up unit sutured to the myocardium. Preliminary experiments indicate: (1) a reflex increase in force of contraction of the heart during steady, short-duration (15 seconds) positive G runs; (2) positive G runs of either a prolonged low level G or high level G (above 5 G) but of shorter duration resulted in a degradation of the initial cardiovascular compensation and eventual cardiovascular collapse; and (3) a complete loss of all of the above reflex compensatory mechanisms following the administration of a post-ganglionic sympathetic blocking agent.

Dehydration Effects on Moderately Heat-Stressed Subjects Wearing a Full Pressure Suit in Ambient Conditions Requiring a High Ventilating Air Flow. L. M. LIBBER, PH.D., L. J. SANTA MARIA, B.S., and V. VACCARO, B.S., Air Crew Equipment Laboratory, Philadelphia, Pa.

To maintain personnel wearing impermeable full pressure suits in at best a comfortably warm state, while exposed to high cockpit temperatures, large volumes of ventilating air must be pumped through the suit. A study was undertaken on sitting, resting subjects to determine what dehydration effects might be expected from a comfortably warm state involving 90° F. ventilating air flowing at 900 L/min. STP. Rectal and skin temperatures and pulse were measured during the trials. Total weight loss, evaporative weight loss and weight deficit were calculated for each set of conditions. Various hematologic and chemical tests were made on the blood and urine. Control values were obtained from subjects wearing unventilated summer flying suits at 70° F. ambient temperature. The applied thermal stress on sitting, resting subjects wasn't severe in itself The probable additive stress induced by the work involved in piloting a plane while wearing a pressure suit is discussed.

Morphologic Changes Associated with Acute Hypoxia in Experimental Animals. MAJOR F. W. LOVELL, USAF (MC), Forensic and Aviation Pathology Section, Armed Forces Institute of Pathology, Washington, D. C.

In an effort to detect antemortem acute hypoxia from postmortem tissues, adult Wistor rats were exposed to simulated altitudes for varying periods of time and sacrificed. Following autopsies, vital organs were examined by routine and special methods for the presence of clues indicating acute hypoxia. Correlation of the degree of hypoxia with central nervous system lactic acid levels was also accomplished.

Cerebral Anoxia Resulting from Hyperventilation a Dangerous Paradox. CAPTAIN W. G. MALETTE, USAF (MC), and B. EISEMAN, M.D., University of Colorado, Denver, Colo.

Increasing interest in the deleterious effects of hyperventilation in flying personnel and a report on the paradox of high brain lactic acid content in autopsy material from hyperventilated subjects has prompted a study of the physiologic effects of hyperventilation and hypocapnia on brain metabolism. Hyperventilation both of air and of 100 per cent oxygen produces a respiratory alkalosis by blowing off carbon dioxide. Under these conditions oxyhemoglobin even though present in large amounts will not release oxygen to the tissues and cerebral anoxia may result. This hypothesis was tested by hyperventilating anesthetized dogs with 100 per cent oxygen and securing blood and brain samples for analysis at the peak of alkalosis. These samples were assayed for lactic acid content and compared with similar samples from control dogs breathed on room air at a normal rate. The accumulation of lactic acid that was found in the brain of the hyperventilated animals provided evidence that a paradoxic tissue anoxia exists when a subject is hyperventilated with 100 per cent oxygen. The practical significance of these findings as they pertain to flying personnel is discussed.

Effect of a Fatty Meal on Cardiac Force. LT. RONALD A. MALT and LT. WILLIAM R. HARLAN, MC, USNR, USN School of Aviation Medicine, Pensacola, Fla.

Studies in laboratory preparations suggest that altered flaw-characteristics and diffusion properties of lipemic blood within the coronary arteries result in compromised myocardial function after a fatty meal. To help determine whether a comparable situation exists in man, relative cardiovascular forces were compared in twenty-five subjects in the fasting state and three and five hours after a meal of 120 grams of butterfat. The forces were recorded by a standardized ultra-low frequency ballistocardiographic system (Reeves, Jones, and Hefner) having a recording fidelity from 1 to 25 cycles per second. No deterioration of cardiac function was noted on ten normal subjects or in fifteen patients with ischemic heart disease. Five of the normal subjects and eight of the abnormal

showed increased ejection forces at peak of lipemia. No attacks of precordial pain were induced in patients subject to angina pectoris. The results indicate that a meal high in fat content will not impair cardiac function either in normal pilots or in those with inapparent heart disease.

Urinary 17-Hydroxycorticosteroid Levels in B-52 Crews in Relation to Stress on a 22½ Hour Mission. COLONEL V. H. MARCHBANKS, JR., USAF (MC), Loring Air Force Base, Maine.

"Operation Long Legs" was an 11,000 mile non-stop flight during November, 1957, of six B-52 aircraft from Florida to Argentina to New York in 22½ hours. The author participated in the flight as a medical observer, and made evaluations of flying stress. Urine samples were collected from four crew members during the flight and control samples were collected during a rest period on a non-flying day. The urine specimens were evaluated for the 17-hydroxycorticosteroids; stressful conditions were tabulated during the flight and crew activities were charted. The subjects showed a mean average during the flight of 15.2 mg. compared with 8.9 mg. on the control day over a twenty-four hour period. The instructor pilot, who was engaged in most of the flying, had 20 mg. on the flight day compared with 11 mg. on the control day. The findings are in accord with other studies indicating the increase in adrenal cortical activity in subjects emotionally disturbed and in stressful situations. Quantitatively the 17-hydroxycortiocosteroids in urinary output of flying personnel is a favorable index for evaluating stress.

A Unified Concept of Stress Tolerance; Its Relationship to Drugs and the Airman and Its Relationship to a System of Aircrew Selection Based Upon Physiologic and Psychologic Criteria. CAPTAINS T. F. MCGUIRE and F. J. LEARY, USAF (MC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

A unified concept of stress tolerance, utilizing all available data plus original experiments, is presented. The relationship of therapy with such drugs as the corticords, tranquilizers, and the amphetamines, is discussed in relationship to stress tolerance. With newer high performance aircraft and increased destructive potential of aircraft lofted weapons, fewer combat aircraft are needed. But the physical integrity of the entire aircrew has become more important to the mission than ever before while the potential stresses to which they may be exposed have increased. Selection of special or "premium" aircrews based on physiologic and psychologic criteria, aside from technical capability, is discussed.

Remarks on the Human Auditory Reflex in Relation to Aircraft Engine Noise. EMANUEL S. MENDELSON, A.B., Air Crew Equipment Laboratory, Philadelphia, Pa.

The middle ear muscles have an important reflex function when the inner ear is overloaded by acoustic stimuli. In this reaction, the intratympanic muscle contractions attenuate the transmission of sound by the auditory ossicles. The conditions under which the protective response is elicited and those under which it is maintained have not been determined in sufficient detail for practical utilization in aviation medicine. A review of existing knowledge shows that technical difficulties have retarded experimental work in this field. Recently, new methods have been developed in various laboratories for the detection, measurement, and registration of certain features of the auditory reflex. Classical research dealing with the phenomenon can now be re-checked by more rigorous biophysical methods and can be extended to areas of present interest. Experiments of this sort have been conducted in our laboratory on dozens of volunteer subjects. Divergent results in the nature of the reflex response, both to pure tones and to recorded engine noise, raise new questions about its character and possible value as an intrinsic noise suppressor. These questions are closely related to permissible exposure to aircraft engine noise.

Comparison of Pure Tone and Jet Engine Noise in Eliciting Reflex Displacement of the Tympanic Membrane. E. S. MENDELSON, A.B., LT. R. W. LANGEVIN, MC, USNR, and CAPTAIN R. A. BOSEE, MSC, USN Air Crew Equipment Laboratory, Philadelphia, Pa.

Among the known features of the auditory reflex, tympanic membrane displacement can be registered manometrically. Accepting such displacements as an index of the incidence and nature of the reflex response in individual subjects, experiments show that noise elicits the reflex more readily than pure tone at the same nominal sound pressure level. The significance of this finding is uncertain, since it depends upon unknown limiting conditions of the stimulus environment and of the subject's responsiveness. However, it appears likely that a loud pure tone stimulus can do more damage to the inner ear than can an equally loud noise.

The Determination of the Effective Dead Air Space of Respiratory Equipment and Systems Through Physiological Measurement. EDWARD L. MICHEL, M.S., and HERMAN S. SHARMA, A.B., Air Crew Equipment Laboratory, Philadelphia, Pa.

The measurement of dead air space in respiratory equipment such as oxygen breathing helmets, masks, and related systems using only physical methods is likely to produce misleading results. A method is described which allows the measurement of only that portion of a dead air space volume which effects the physiologic status of individuals using the particular equipment. Tidal volume changes in these individuals, during periods of controlled respiratory patterns, gives an accurate measurement of the effective dead air space volume.

Insidious Intoxication by Noxious Gases in the C-118 Aircraft; Possibility and Prevention. LT. COLONEL EDWARD S. MILLER and CAPTAIN JOHN C. MCDONALD, USAF (MC), McGuire AFB, N. J.

The Military Air Transport Service encourages all crew members to inhale 100 per cent oxygen for 15 minutes prior to all landings. This procedure was designed to dissipate any noxious gas which might insidiously compromise the crew member's performance. The difficulties of complying with this suggestion are noted. A discussion of the various gases which one might expect to encounter in the C-118 type aircraft in flight is presented. In-flight tests were performed on crew members taken from their duty stations during trans-Atlantic flights to determine if carbon monoxide is a hazard. The results of these tests are presented. The possibility of carbon monoxide intoxication is discussed and appropriate recommendations made.

Duration of Tolerance to Positive G. CAPTAIN HUGH MILLER, USAF (MC), FIRST LT. MITCHELL B. RILEY, USAF, CAPTAIN STUART BONDURANT, USAF (MC), and E. P. HIATT, M.D., Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Acceleration forces of great magnitude or of long duration will be encountered with anticipated flight velocities. A study was designed to evaluate the duration of tolerance of the unprotected seated subject to a sustained positive G as produced by the human centrifuge. Fifteen subjects made thirty-one runs at 3.0, 3.5, 4.0, 4.5, or 5.0 G. Acceleration was increased 0.07 G per second and the selected G-level was maintained until a subjective limit of tolerance was reached. Electrocardiograms were monitored continuously. At 3.0 G two subjects ran until stopped arbitrarily at the limit of one hour. Tolerances varied as follows: (in minutes) 3.0 G, 18-60; 3.5 G, 15-43; 4.0 G, 1-9; 4.5 G, 3-9; and 5.0 G, 1/2-4. Tolerance was limited usually by general fatigue, neck and back pains. Blackout above 4 G, and pre-syncope (once) also occurred. Petechiae were common. There were no significant electrocardiographic abnormalities. It now seems evident that the unprotected human subject may safely tolerate positive acceleration for durations much longer than previously supposed. The influence of G-suits upon tolerance is now being examined.

The Detection of Spherical Targets in a Homogeneous Visual Field. JAMES W. MILLER, PH.D., Kresge Eye Institute and USN School of Aviation Medicine, Pensacola, Fla.

It has been known for sometime that when an individual is confronted with a visual field which is totally devoid of visible detail, it becomes extremely difficult to detect the presence of objects. Such a

homogeneous visual field may be encountered in the extreme polar regions or during high altitude flight. A new technique has been devised whereby subjects may be presented with a totally homogeneous visual field in which either stationary or moving targets may be employed. Provision has been made to move these targets over a wide range of angular velocities. Target acquisition time has been investigated as a function of both size and location of target. Early results indicated that observers are quite uncertain as to the presence or absence of targets even though they may be substantially above threshold in size. It has been found that targets exceeding the size threshold by as much as a factor of 10 to 15 times can disappear while being fixated by an observer in a homogeneous field. It is felt that this phenomena cannot be accounted for by fluctuations in the accommodative mechanism of the eye, and that other factors, as yet unexplored, must be involved.

Studies on the G Tolerance of Invertebrates and Small Vertebrates While Immersed. LT. COMMANDER DAVID P. MORRIS, JR., and COMMANDER JERRY J. ZARIELLO, MC, USN, and DIETRICH E. BEISCHER, PH.D., USN School of Aviation Medicine, Pensacola, Fla.

With increasing speed and duration of expected flights the problem of tolerance to and protection from acceleratory forces becomes more complex. A technique for protection of mice against acceleratory forces by immersion in fluid while the animal breathes oxygen is illustrated. The tolerance of unicellular and multicellular animals to these forces is discussed. It was found that Euglena withstood 25,000 G for five hours; guppies survived 10,000 G for one hour. The paper discusses possible means of alleviating the effects of acceleratory forces that may be encountered in the future of aviation medicine.

Motives Determining Decisions to Remain in the Naval Air Training Program. ENSIGN ANTON S. MORTON, USN, JOHN T. BAIR, PH.D., MARSHALL B. JONES, PH.D., and ROSALIE K. AMBLER, M.S. USN School of Aviation Medicine, Pensacola, Fla

On September 20, 1957, trainees in certain procurement categories in the Basic Training Command were officially informed that they had five days to decide whether to accept new contracts extending their active service by one and one-half years. Alternatives, dependent upon previous contract, ranged from immediate separation to completion of two years service obligation as a non-flying officer. During the decision period interviews were held with forty-three students beginning flight training. A series of "decision ballots" were compared with ultimate decisions. Finally, a sample of students not having the option of immediate release indicated in a questionnaire what they would have done, had such an option been available. The interviews revealed that, despite contrary claims, students were influenced by the decisions of friends and the feelings of wives and parents. Other determinants were initial degree of commitment to the program, availability of civilian employment, and length of service in alternative options. Most decisions made immediately after the official announcement were maintained. Decision reversals tended to conform to the group attitude.

Relation of Injuries to Force and Direction of Deceleration in Aircraft Accidents. COLONEL HARRY G. MOSELEY, USAF (MC) and ANCHARD F. ZELLER, PH.D., Directorate of Flight Safety Research, Norton AFB, Calif.

To gain further insight into the phenomena of force and its direction in aircraft accidents, every major accident involving transport type aircraft which occurred in the USAF over a two-year period was reviewed to determine the pitch, roll and yaw the airframe took during deceleration. These directional findings were correlated with the magnitude of force at points of significant impact and resultant injury to occupants. Related factors such as position of occupant, effectiveness of restraints and presence or absence of fire were evaluated. From these observations, measures designed to protect occupants are suggested.

The Effects of Rapid Deceleration; Lethal and Injurious Limits. CAPTAIN JOHN D. MOSELY, USAF (VC) and COLONEL JOHN P. STAPP, USAF (MC), Aero Medical Field Laboratory, Holloman Air Force Base, New Mexico.

Twenty experiments using chimpanzee subjects were conducted on the rocket sled track facility at Holloman Air Force Base, New Mexico. After acceleration to supersonic speeds the sled was decelerated by a water brake system. Injurious levels were found at 120 G with rate of onset in excess of 5,000 G per second. Lethal effects were noted at 237 G with rate of onset 11,250 G per second.

Behavioral Effects of Whole Body Vibration. LT. (jg) MAXWELL M. MOZELL, MSC, USNR, and LT. DAVID C. WHITE, MC, USNR, Aviation Medical Acceleration Laboratory, Johnsville, Pa.

The effect of whole body vibration on human performance was studied using appropriate statistical designs. The specific tasks investigated were the ability of humans to read the digits of an aircraft mileage indicator and their ability to do a tracking task which simulated the control of an aircraft. Vertical sinusoidal vibration of frequencies ranging between 0 and 50 cycles per second with amplitudes of .05, 0.1, and 0.16 inch double amplitude were used. It is concluded that increasing the frequency of vibration over 8 cps has an increasingly detrimental effect on visual performance. This effect reaches a maximum between 40 and 50 cps. Variation of amplitude of vibration from 0.05 to 0.1 inch double amplitude has no effect upon visual performance. Therefore, the possibility that G *per se* is not an important determiner of detrimental vibration effects must be considered. It is further concluded that vibration, within the limits of the experiment, has little effect upon tracking ability.

Oxygen Toxicity in Aviation Medicine. A Review. LT. P. F. MULLINAX, JR., MC, USNR, and D. E. BEISCHER, PH.D., USN School of Aviation Medicine, Pensacola, Fla.

Priestley in 1775 suggested that ". . . the air which nature provided for us is [only] as good as we deserve." Since that time, many observations, some pertinent to aviation medicine, have been made concerning possible toxic effects of oxygen. With prolonged breathing of oxygen at greater than normal tensions there are cardiorespiratory and neuromuscular findings. Lower respiratory tract damage is suggested by the quite common early cough and decrease in vital capacity. Substernal pain may be experienced after 4 hours (O_2 at 1 atm.). Subjects who breathe 100 per cent O_2 (at 1 atm.) for two days become fatigued and anorectic. They vomit and become ". . . depressed, irritable, taciturn and distracted" (Ohlsson). High concentrations of oxygen act chiefly on the lungs, the blood and the central nervous system. The lungs of animals exposed to a pure oxygen environment show disruption of the alveolar-capillary membrane and inflammatory changes. In the blood, high tensions of oxygen provide more dissolved oxygen; less reduced hemoglobin is formed and carbon dioxide transport is slightly impaired. Central nervous system changes predominate with oxygen at pressures greater than 1 atm. Paradoxical reactions (e.g., depressed respiration, bradycardia and hypotension) may occur when hypoxia is suddenly relieved. The effects of long-continued administration of oxygen at high tensions need further study.

Effects on Cerebro-spinal Fluid Pressure of Hypercapnia, Hypoxia and of Combined Hypoxia and Hypercapnia. GABRIEL G. NAHAS, M.D., PH.D., and CAPTAINS HAROLD S. SMALL and STANLEY W. WEITZNER, MC, USA, Walter Reed Army Institute of Research, Washington, D. C.

All experiments were performed on dogs paralyzed with succinyl dicholine chloride and ventilated with different gas mixtures at a constant rate and tidal volume, or under conditions of "apneic oxygenation" or of "apneic hypoxia." Along with circulatory and respiratory variables, cerebrospinal fluid pressure (CFP) were measured continuously. Ventilation with 8 per cent O_2 in N_2 produced little change in CFP. Apneic oxygenation or ventilation with mixtures of 5, 10, 15 per cent CO_2 in O_2, which increased alveolar pCO_2 from

38 mm. Hg. up to 119 mm. Hg., produced a rise in CFP ranging from 65 to 284 per cent of the control value (83 mm. of H_2O). These changes could occur in the presence of insignificant changes in blood pressure or cardiac output. The combination of hypoxia and hypercapnia occurring during "apneic hypoxia" produced a rise in CFP comparable to that observed with hypercapnia alone. These findings will be discussed in relation to the low tolerance of mammals to hypercapnia.

Vertebral Fractures in USAF Aircraft Accident Survivors. MAJOR SAMUEL E. NEELY, USAF (MC), Directorate of Flight Safety Research, Norton AFB, Calif.

As the most prevalent injury in aircraft survivors is vertebral fractures, a two year survey of this type of injury was completed. The accident reports were analyzed for possible cause relationship with seats, restraining devices, and protective equipment. Conclusions are drawn and suggested remedial measures outlined.

"Emotional G" in Airsickness. CAPTAIN PHILIP B. PHILLIPS, MC, USN, School of Aviation Medicine, and LT. GEORGE M. NEVILLE, MC, USNR, Saufley Field, Pensacola, Fla.

The concept of G involving the factors of weight and mass is well known as a measure of acceleration. Students experiencing airsickness while undergoing primary flight training suffer an "emotional G" of attraction to the earth (or distaste for leaving it) to a greater degree than students not suffering airsickness. A study of 2,893 primary flight students showed that 69 experienced either severe airsickness before completing six training flights or continued airsickness beyond this point. These students were carefully evaluated as to their past history of motion sickness, anxiety toward flying, and initial and current motivation for flying. A past history of motion sickness was not a suitable criterion of a student's chances of completing primary flight training but clinical appraisals of anxiety and motivation were quite significant. Reassurance by the flight surgeon enabled 40 of the 69 students to complete the primary flight training phase. No medications were used. It is suggested there is an "emotional G" force which acts to keep airsick flight students on the ground and that this includes potent emotional components of anxiety and poor motivation. Along the lines of the familiar $F=\frac{MV^2}{r}$ a new equation is offered: $F^{a/s}=\frac{A^{nx}}{M^{otiv}} \cdot K^{ps}$ where $F^{a/s}$ indicates failure due to airsickness, A^{nx} is anxiety, M^{otiv} is motivation and K^{ps} is a constant recognizing the physiologic sensitivity of the individual.

Physiology of Scotopic (Night) and Photopic (Daylight) Vision. LOUIS F. RAYMOND, M.D., East Orange, N. J.

The paper covers the recent work of Wald and his associates on the biochemical physiology of visual purple and visual yellow, its effects on peripheral vision both night and during the hours of daylight. It will also consider normal time adaption curves, for daylight flight (photopic) twilight and night flight (scotopic vision); its application to safe flight. The paper will also cover some of the practical applications necessary to reduce the number of mid air collisions, physiological variations which reduce visual perception time.

Man in a Vacuum. HERBERT REICH, Litton Industries, Beverly Hills, California, and FRANCIS BERCHMANS QUINN, JR., M.D,. University of California Medical Center, Los Angeles, Calif.

Man's inevitable exploration of space emphasizes the early recognition of the problems to be encountered in this new environment. Before shooting a man off into space and expecting him to survive, all the vital aspects relating to his existence in space must be anticipated and investigated. To compensate for conditions unacceptable to the human, suitable systems must be developed, tested and proved. A clarification of the space concept in the applicable frame of reference and a definition of the anticipated problems are necessary. For the engineer, as well as the physiologist, space problems begin at the level where the various conditions necessary to sustain human

life fade out; this is where the transition to artificial substitutes must be completed. The problems associated with sustaining life in a space-like environment include consideration of the breathing, cooling and heating requirements, protection from the effects of cosmic radiation, unfiltered solar ultraviolet and x-ray radiation, and meteorite collision. Coordination between the physiologist and the engineer is apparent throughout the stages of system development. The system takes form as a space suit, space capsule, space ship or combination of these. Once designed and constructed, the entire system is tested and refined until maximum reliability is achieved. Successful performance is finally evidenced by the launching of the manned vehicle and the safe return of the human occupant.

Measurement of Behavioral Effects Attributed to Certain Ataractic and Analeptic Drugs. CAPTAIN RICHARD M. RITTER, USAF, S. B. SELLS, PH.D., and LT. COLONEL JOHN C. MEBANE, USAF (MC). USAF School of Aviation Medicine, Randolph AFB, Texas.

In the frame of reference of performance effectiveness, this study examined objectively and compared the influence of certain ataractic and analeptic drugs upon manifest affect and efficiency. Two hundred twenty-five healthy basic airman trainees were administered eight affect and four efficiency tests, then were assigned randomly and equally to five treatment groups, consisting of: (1) 400 mg. meprobamate, (2) 2 mg. pipradrol, (3) 10 mg. methylphenidylacetate, (4) lactose placebo, and (5) absolute control. The affect tests were repeated at one and two hours post treatment and alternate forms of the efficiency tests were administered at one and one-half hours post treatment. Significant differences between adjusted means on a tranquil adjective scale, supported by clear trends on four of the other seven affect tests, permitted the conclusion that subjects who received methylphenidylactate expressed improved affect with respect to the absolute control group. Similar but inconclusive response tendencies were noted in the placebo and the other drug groups. Underlying the treatment variation there were marked, situationally accountable shifts of all groups on successive affect measurements. The efficiency measures did not reveal any differential treatment influences.

In-Flight Studies of Hypoglycemia. CAPTAINS J. H. ROBBINS and C. H. KRATOCHVIL, USAF (MC), and JAMES P. ELLIS, M.A., USAF School of Aviation Medicine, Randolph AFB, Texas.

Spontaneous hypoglycemia is not an uncommon entity in clinical practice. Since hypoglycemia is known to impair psychomotor performance it has been implied that this is a possible cause of some of the unexplained aircraft accidents. Emotional stress has been shown to alter glucose metabolism. It was felt that this problem was of sufficient interest and importance to evaluate pre- and post-flight blood sugars and post-flight response to glucose tolerance test in flying personnel. Accordingly, 144 aircrew members were studied in the B-52, F-100, and T-33 types of aircraft. Dietary histories were taken, blood sugar levels evaluated, and glucose tolerance tests performed. Results were evaluated as to the change in blood sugar level as well as the absolute basic level. There was no consistent maintenance of blood sugar levels with high protein diets. Glucose tolerance tests revealed an incidence of approximately 10 per cent "flat" curves which is thought to be consistent with emotional stress. The implications of these findings with regards to the flying situation will be discussed.

A Preliminary Study of the Effects of Hyperventilation on Speech and Hearing. SQUADRON LDR. H. C. ROBINSON, RCAF, Defence Research Medical Laboratories, Toronto, Ontario.

Determinations were made of (1) speech intelligibility and (2) auditory threshold for a 4,000 cycles per second tone before, and after 5 and 13 minutes of hyperventilation. Subjects hyperventilated voluntarily at 24 respirations per minute for a total of 16 minutes. The CO_2 level in the subjects' exhaled air and respiratory rate was recorded continuously. Electroencephalog-

raphic and electrocardiographic recordings were made on 6 of the 8 subjects. The analysis of the data indicated (1) a statistically significant increase in speech intelligibility, and (2) no change in the auditory threshold for a 4,000 cycles per second tone. It was indicated that the increase in speech intelligibility was accompanied by an increase in signal-to-noise ratio and a decrease in the precision of articulation. Results of this preliminary investigation indicated that further studies should be conducted to determine the effects of hyperventilation on (1) the auditory threshold for various frequencies and (2) the interaction between signal-to-noise ratio and precision of articulation in the determination of the subjects' speech intelligibility.

Vibration, Buffeting and Impact Research. CAPTAIN JAMES ROMAN, USAF (MC), DR. ING ROLF COERMANN, and DR. MED. GERD ZIENGENRUECKER, Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

In the past decade, need for information of human tolerance to severe vibration, buffeting or impact has become acute. This problem is basically different from that relating to steady acceleration and bears directly on escape, re-entry, low-altitude-high-speed-flight, and helicopter operation. The topics discussed are (1) tolerance to transient accelerations, (2) research into mechanical properties of the human body which affect degree of physiological stimulation or injury, and (3) development of protective devices compatible with crew duties. The work accomplished has (1) led to development of a "vertical accelerator" simulating dynamic loads expected of future craft and of equipment designed to study effectiveness of protective devices, (2) shown several mechanisms productive of injury in severe vibration or buffeting, (3) indicated that vibration protection and effective impact protection are intimately related and possible by simple means, and (4) shown that by judicious simplification of mathematical models of organ systems used for analysis present knowledge of vibration physics may be brought to bear directly on rational development of protective equipment. Status of studies in progress are presented as well as plans for research necessary to provide designers of manned vehicles with comprehensive data regarding human tolerance to transient acceleration.

Explosive Decompression of Animals with a Full Bladder Suit (MC-4 type), Helmet and Automatic Regulator. DONALD A. ROSENBAUM, M.Sc., Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Unanesthetized dogs were decompressed through 10 psi and 14 psi (8,000-65,000 feet and ground level to 72,000 feet) in 30 m. sec. The animals were wearing a full-bladder type pressure suit and full head helmet and were breathing from a modified MB-2 regulator. Autopsy studies showed little or no pulmonary damage and clinical studies revealed no abnormalities. It is felt that transient atelectasis occurs but is "blown-out" by the high breathing pressure. No residual pathology was evident.

Present Status of Aircraft Liquid Oxygen Breathing Systems. ROBERT W. ROUNDY and CLYDE G. ROACH, Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

A brief description or review of the state of the art of the aircraft liquid oxygen program which was presented to the Aero Medical Association in 1947 will be given. Slides will be employed to show the liquid oxygen system then as compared to the present models. A listing of the aircraft which are presently equipped with liquid oxygen will be given in order to show the rapid growth of the liquid oxygen program. A very brief discussion will also be presented outlining the possible use of liquid oxygen in commercial aircraft since the aircraft have increased altitudes and of necessity demand an appreciable amount of oxygen. The most recent changes and advances will be presented and slides will show the improved model and the item that has been replaced. Some of the specific areas which will be covered will include (1) reduced space and weight of the new systems (2) advantages of the new capacitance gaging system (3) combining the filler valve and the buildup and vent valve

into a single assembly and (4) removal of the evaporator coils from the converter to provide a more flexible installation.

The Role of Human Factors at the Air Force Flight Test Center. LT. COLONEL BURT ROWEN, USAF (MC), Air Force Flight Test Center, Edwards AFB, Calif.

The Air Force Flight Test Center is located approximately one hundred miles northeast of Los Angeles and includes a precision bombing range, the National Advisory Committee for Aeronautics high speed flight station, a 20,000 foot high speed track, the USAF experimental flight test pilot school, and captive firing rocket engine test facility. The Human Factors Branch actively participates in the initial evaluation of aircraft entering the flight test inventory. Several areas of special interest are mentioned. *The Handbook of Instructions for Aircraft Designers* is referred to and briefly discussed. The increased emphasis on human factors efforts within the aircraft industry encompassing medical, physiologic, psychologic and basic science personnel presents an interesting expanding career field.

The Effects of Ventilating and High Ambient Temperatures on Flow Rates Necessary to Maintain Comfort in a Full Pressure Suit. L. J. SANTA MARIA, B.S., H. R. GREIDER, B.S., and S. J. KLEIN, PH.D., Air Crew Equipment Laboratory, Philadelphia, Pa.

An experimental program was undertaken to investigate the effects of high ambient temperatures on subjects wearing a full pressure suit. Maintenance of thermal comfort was attempted by varying ventilating flow according to the demands of the subject. Three subjects undergoing each set of conditions twice were tested in an altitude chamber maintained at 18,000 feet for two hours. Ambient temperatures of 150° F. and 125° F. and ventilating temperatures of 90° F. and 60° F. were employed. In addition to ventilating flow, some physiologic variables such as total and evaporative water loss, mean skin temperature, and rectal temperature were measured and analyzed statistically. Using 60° F. ventilating air in an ambient of 150° F., subjects were comfortable thermally with flows averaging 800 LPM/STP. Under the extreme conditions of 150° F. and 90° F. ventilating air, flows as high as 900 LPM/STP were inadequate to maintain thermal comfort.

New Knowledge Concerning Cosmic Radiation. H. J. SCHAEFER, PH.D., USN School of Aviation Medicine, Pensacola, Fla.

The concept of the composition of the truly extra-atmospheric cosmic ray beam has considerably changed. Next to the atmosphere, the most powerful shielding force preventing low-energy cosmic ray particles from reaching the earth is the geomagnetic field. Several lines of experimental evidence indicate that the common assumption of a plain dipole field does not adequately describe the interplanetary field configuration. Severe modifications seem to be produced in this configuration by electrodynamic effects from moving ionized gases of the sun's corona. Measurements have shown that particles of much lower energy than the "classical" geomagnetic theory would permit can reach the earth. Since the biologic effects heavily center on the low-energy part of the spectrum the implications for the problem of radiation hazards in space flight are obvious. In addition to satellite observations, soundings at altitudes of one to several earth radii seem desirable. At present no informed guess seems possible with regard to the ionization dosage in interplanetary space.

Accident Data and Instructor Comments as Indicators of Problem Areas in Transition Training. LT. (jg) LEONARD M. SEALE, MSC, USNR, and WILSE B. WEBB, PH.D., USN School of Aviation Medicine, Pensacola, Fla.

Accident data were collected on students undergoing transition from one type of propeller aircraft to another and from propeller to jet aircraft. Also collected were instructor comments pertaining to student difficulties encountered during the transition training period. The data were analyzed with the objective of identifying training and human engineering problem areas occurring during transition training.

The results indicate that both sources of data contribute information indicative of transition training problem areas. Differences between the accident and instructor comment patterns exist both within a given type aircraft and between the propeller and jet aircraft.

Methods for Evaluating Cardiovascular and Respiratory Reserves of Preselected Normal Individuals. R. R. SECREST, M.D., W. RANDOLPH LOVELACE II, M.D., CLAYTON S. WHITE, M.D., ULRICH C. LUFT, M.D., and R. B. STREEPER, M.D., Lovelace Clinic and Foundation, Albuquerque, N. Mex.

Methods for evaluating deviations from normal cardiovascular and respiratory capacity and the reserve capacities of these have evolved from a combination of clinical data and special testing procedures. The methods which are currently used in our evaluation program are outlined. The relationship of the various testing procedures to each other and to the picture of reserve capacity of the cardiovascular and respiratory systems is discussed. The theoretical implications of these procedures to specific stress situations which might arise in aviation are also enumerated.

Adaptability Screening of Flying Personnel: Cross-Validation of the Personal History Blank Under Field Conditions. S. B. SELLS, PH.D., DAVID K. TRITES, PH.D., and MAJOR ROBERT C. TEMPLETON and CAPTAIN MAURICE R. SEAQUIST, USAF (MSC), USAF School of Aviation Medicine, Randolph AFB, Texas.

In September, 1956, a battery of experimental tests for adaptability screening of flying personnel, assembled from tests previously validated in developmental research, was established for field try-out under operational testing conditions. This battery has been administered to 8,700 students reporting for pre-flight training for pilot and observer at Lackland Air Force Base, from September, 1956, through January, 1958. Analysis of results awaits receipt of information concerning success in training and the first formal report based on training criteria may not be ready for another year. The present report is based on the personal history blank, for which a flying interest key was previously developed by Seaquist, and covers results in primary pilot training for 1,708 student officers and 363 aviation cadets. In addition to pass-fail, this sample includes another criterion reflecting motivation for military aviation, namely, exercise by each man in the program in certain classes of an option to sign up for five years or withdraw from training. The validity and practical usefulness of the test in these samples is demonstrated, as well as its independence of factors measured by the present aptitude test batteries.

Circulation Time with the Valsalva Maneuver as a Possible Test for Patency of the Foramen Ovale. ENSIGNS DONALD D. SMITH and JOSEPH S. CASSELLS, USNR, and LT. RONALD A. MALT, MC, USNR, USN School of Aviation Medicine, Pensacola, Fla.

"Paradoxical" aeroembolism through a patent foramen ovale has been indicated as a cause of death during explosive decompression. In an attempt to develop a simple test diagnostic of interatrial septal defects, arm-to-tongue circulation time with 20 per cent sodium dehydrocholate solution was determined on 112 aviation cadets as each performed a Valsalva maneuver at 40 mm. Hg. for 15 seconds; the premise was that the increased intrathoracic pressure would cause a short circuit of the pulmonary blood flow through any septal defect and result in a short circulation time. Circulation times ranged from 13 to 31 seconds. The frequency-distribution was tetramodal with means at 14.6 ± 0.25 sec., 18.8 ± 0.17 sec., 24.2 ± 0.22 sec., and 29.5 ± 0.37 sec. Within the respective modes lay 9.8, 42.9, 35.7, and 11.6 per cent of the sample. The earliest mode may contain the subjects with patent foramina ovalia, for it is known that about 10 per cent of the population have sizable interatrial septal defects. In addition, the fact that one-half the population had circulation times of less than 23 seconds under the experimental conditions indicates that venous return is maintained during the Valsalva maneuver in a significant number of people.

Health Hazards of Present-Day Propellants. MAJOR ALFRED R. STUMPE, USAF (MC), USAF School of Aviation Medicine, Randolph AFB, Texas.

Recent advances in aeronautical engineering have dictated the development of new and more powerful propellants for present day aircraft and rockets as well as for future weapons systems. The health hazards of these fuels and oxidizers are discussed, and the degree of toxicity of each chemical compound emphasized. Mention is made of the requirement for additional toxicologic studies of vital importance to aviation medicine.

Post-Prandial T-Wave Lowering in Apparently Healthy Young Aviators—1957. FLIGHT LT. W. J. R. TAYLOR, RCAF, DR. A. J. KERWIN and GROUP CAPTAIN W. R. FRANKS, RCAF, RCAF Institute of Aviation Medicine, Toronto, Canada.

Equivocal non-specific T-wave changes have been observed in a small proportion of the electrocardiograms taken routinely on apparently healthy, young aviators in the Royal Canadian Air Force between the ages of eighteen and thirty-five years. T-waves may be depressed, flattened or even inverted in both precordial and limb leads, in such a manner that the presence of coronary artery disease might be suspected. Repeat tracings, taken with the subjects fasting 12 to 18 hours show marked improvement in T-wave amplitude often to the point of a complete disappearance of the apparent electrocardiographic abnormality. A comparable T-wave lowering can be experimentally induced 30 minutes following the oral ingestion of 50 to 100 grams of glucose. Conversely, T-wave amplitude can often be improved following a high potassium drink such as orange juice. These aviators have been assessed clinically and been found to be cardiovascularly fit in all other respects. The T-wave lowering is thought to be a physiologic, post-prandial phenomenon associated in some way with carbohydrate metabolism. It is extremely interesting and somewhat perplexing, but it is felt to be of little clinical significance. An attempt will be made to try to explain the probable physiologic mechanisms. Similar observations of other workers will be considered.

Ear Defenders for Protection from Noise. G. J. THIESSEN, and E. A. G. SHAW, National Research Council, Ottawa, Canada.

Vibration of the whole ear protector is the main mechanism by which low-frequency sound reaches the ear when a well sealed protector is used. In the case of the cover type of ear defenders this vibration can be minimized by means of a cushion which uses a high Young's modulus sheath to contain a high bulk modulus filler. In this way a cushion spring constant can be achieved which exceeds many times that of the flesh around the ear and at the same time the equalization of the pressure on the head contributes greatly to comfort. The spring constant of the flesh may be increased by pressure but to this the comfort requirements of the wearer will set a limit. Cup volume and enclosed head area also play their part. A suitably designed ear defender can easily provide 20 db attenuation at 50 cps.

A First Approach to the Use of Ventilating Air in the APH-5 Crash Helmet. P. R. TILLER, B.S., and L. M. LIBBER, PH.D., Air Crew Equipment Laboratory, Philadelphia, Pa.

Pilots wearing the one piece aviators crash helmet (APH-5) in desert and tropical climates may experience a considerable amount of thermal discomfort, headwise. To relieve this condition, a study was conducted on the effects of ventilating the helmet using the suction port of a commercial blower. Simulated solar radiated tropical and desert climate conditions were imposed on the subjects and temperatures at various locations on the helmet and head were measured by thermocouples. The head skin temperatures attained under these simulated climatic conditions are compared to those obtained with the unventilated standard helmet.

Prediction of Flight Training Attrition by Grade Slips for the First 10 Flights. DAVID K. TRITES, PH.D., BART B. COBB, M.S., and WILLIAM F. BROWN, ED.D., USAF School of Aviation Medicine, Randolph AFB, Texas.

In a previous study using a number of aptitude predictors the authors found that scores derived from daily grade slips for the first 10 flights in beginning pilot training were the best single predictor of success in pilot training. Previous validation was based on the prediction of combined primary and basic training outcome and was subject to possible criticism on the grounds that primary school instructor judgments affected both predictor and criterion measures. Further study of these and additional data have demonstrated that the same scores predict basic training outcome efficiently. The previous study developed a score, based on flight instructors' written comments on daily grade slips, which was superior to average daily flying grade for the first 10 flights. However, a combination of the two was significantly superior to either used alone. Using a cutting score for comment rating, for a sample of 638 student officers, only thirteen (3.1 per cent) of 420 graduates of primary and basic training were screened, as compared with forty-five (25.7 per cent) of 175 primary eliminees and five (11.6 per cent) of forty-three basic eliminees. For 792 cadets in the same classes, the comparable figures were seventeen (2.9 per cent) of 583 graduates, nineteen (15.6 per cent) of 122 primary eliminees and eight (9.2 per cent) of eighty-seven basic eliminees. Utilization of instructors' comments and average grades for the first ten flights, by the methods developed, offers a feasible method of reducing flight training attrition. Based on the present samples, and considering only early identification of basic eliminees by the comment score alone, a saving of approximately $130,000 might have been realized at the risk of false elimination of only thirty of 1,000 ultimate graduates.

Clinical Observations on Centrifuge Subjects. LT. COMMANDER MARTIN G. WEBB, JR., MC, USN, Aviation Medical Acceleration Laboratory, Johnsville, Pa.

This paper describes the various effects of centrifugation on human subjects as observed in this laboratory. Primary cardiovascular effects, such as petechiae, hemorrhages, venous distension which causes arm and leg pain as well as hemorrhoids, pulse changes and arrhythmias are described and discussed. Disturbances of the central nervous system, such as an observed serious disturbance of equilibrium, point up the necessity of accepting a certain calculated risk in centrifuge work, as well as the assumption of responsibility by the laboratories involved. Observations following episodes of unconsciousness suggest that current instructions to pilots who experience loss of consciousness should be changed. Other effects of centrifugation such as fatigue, irritability, inability to breathe under certain conditions, sinus pain and chest pain are also discussed. Acceleration levels, direction of application, time duration and frequency of application are included.

Closed Breathing-Ventilating Systems Using Recirculated Oxygen. PAUL WEBB, M.D., Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Oxygen economy is important in flights of long duration. A closed breathing system recirculates the oxygen in the expired volume, and requires supply oxygen only at the rate of the man's actual utilization. The recirculating system passes the oxygen through elements which remove carbon dioxide and water vapor before it is offered again for inspiration. In addition, the oxygen circuit can have the function of cooling the man. Normally, air or other gas used in a ventilating garment is expended. The recirculating oxygen can be passed through a ventilating garment, and an element can be added for removing heat and, again, water vapor. By combining the respiratory and ventilating functions certain economies appear in equipment, and there may be certain advantages for the design of the man-occupied space. Combining is logical too if one views the two functions as inherent features of a proper microclimate for man.

Hazard to Pilot from Bird-Windshield Impact. COLEMAN M. WHITLOCK, JR., M.D., Convair, San Diego, Calif.

It is known that aircraft collision with birds can occur up to approximately 20,000 feet, and that bird-windshield collision can impose a serious hazard to the pilot personally, and as an aircraft operator. In addition, the hazard increases with velocity of the aircraft. In connection with the development of jet transports, Convair has recently completed a study on the hazard to the pilot of bird-windshield impact at the velocities expected of its jet transports. A styrofoam dummy mockup was placed into pilot position behind windshields into which 4-pound chickens were fired from an air gun at velocities up to 435 mph. The styrofoam dummy was chosen, since styrofoam has been calibrated for tissue equivalency of penetration. Results of the study will be reported.

Effects of Continuous Exposure to Carbon Monoxide. MAURICE H. WEEKS, M.S., NELSON P. MUSSELMAN, A.B., WILLIAM A. GROFF, A.B., and FRED W. OBERST, PH.D. U. S. Army Chemical Warfare Laboratories, Md.

This experiment describes the results of exposing rats, rabbits, and dogs continuously (24 hours per day, seven days per week) for three months to low concentrations of carbon monoxide (50 ppm). The effects of exposure to CO under these conditions will be determined by hemotological studies, behavior changes, as well as macroscopic and microscopic examination of tissues. The data will be evaluated with reference to existing information on chronic intermittent exposures in an attempt to define a hygienic standard for continuous exposure.

The Relationship Between Cardiovascular Response and Positive G Tolerance. COMMANDER J. J. ZARRIELLO, MC, USN, MARY E. NORSWORTHY, and LT. (jg) LEONARD M. SEALE, MSC, USNR, USN School of Aviation Medicine, Pensacola, Fla.

This study determined the relationship between several measures of cardiovascular response and tolerance to positive radial acceleration. The measures included the circulatory efficiency index and the magnitude of the post Valsalva overshoot of the systolic arterial blood pressure. The measures were obtained prior to centrifugation on the human centrifuge. The sample consisted of eighty-four young, adult, normal men. The correlations between these obtained measures and peripheral light loss and blackout were determined. The results indicate low predictability from the measures employed. The implication of these findings to the general problem of predicting G tolerance is discussed.

Human Ability and High Performance Flight. ANCHARD F. ZELLER, PH.D., Directorate of Flight Safety Research, Norton AFB, Calif.

Past evaluations of jet fighter accidents have indicated a consistent trend for a decreased accident rate. In view of the increased performance being designed into current high performance fighters a critical question is whether this decrease can be expected to continue or whether the increased performance will place demands on the pilot with which he cannot cope. Analysis of the accidents experienced in a number of the latest high performance aircraft indicates that although the margin for error has decreased Air Force pilots can successfully operate this high performance equipment. Material failure was the predominant accident cause and maintenance error had increased. The proportion of pilot error accidents was considerably less than in former evaluations. The transition phase was particularly critical. Greatest operator difficulty was experienced during the landing process. The accidents emphasized the need for precision knowledge of all procedures, particularly emergency procedures. Indications are that materiel and engineering rather than crew limitations may be the critical factors in future flight.

Papers to be Read by Title

Uropepsin Changes Attendant to Flight Oriented Stresses. SECOND LT. R. H. BONNER and AIRMAN SECOND CLASS J. E. JOHNSON, USAF, and CAPTAIN L. J. FILER, JR., USAF (MC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Stress is frequently evaluated by the type and level of ketosteroids excreted in urine. Epinephrine and norepinephrine excretion levels have been similarly studied. Another index for the evaluation of stress, that is readily determined in the laboratory, may be the level of uropepsin excretion. The administration of ACTH and cortisone or the presence of acute anxiety has been found to increase uropepsin excretion. These factors led us to investigate uropepsin excretion in Air Force oriented situations. Urine specimens collected before and after prolonged positive G rides on the centrifuge, exposure to high altitude-high temperature chamber flight, prolonged crew confinement, and isolation were analyzed for uropepsin. Levels of uropepsin were found to be elevated in all pre-test urine specimens except those collected from subjects undergoing isolation. Uropepsin excretion decreased as a result of simulated flight stress and was maximal in those situations where physical stimuli were the most intense.

Biologic Effects of Low Temperatures. COLONEL HOWARD F. CURRIE, USAF (MC), and C. MURRAY, Arctic Aeromedical Laboratory, Ladd Air Force Base, Alaska.

The effects of below normal body temperatures are considered. These include respiration, glandular function, kidney function and cardiovascular phenomena. Deterministic biochemical reactions are related to metabolic processes and allied physiologic functions. The effects of cold on cells and tissues are reviewed and some theoretical and practical issues considered. Freeze-drying of biologic therapeutic agents such as human serum, plasma, bone and tissue is considered. Conditions permitting the revival of profoundly chilled small animals are discussed. The large number of problem areas remaining before we can extend our facility for cold storing cells and tissues to the whole man is emphasized.

Some Recent Contributions to Cold Environment Military Medicine. COLONEL HOWARD F. CURRIE, USAF (MC), and C. MURRAY, Arctic Aeromedical Laboratory, Ladd Air Force Base, Alaska.

Recent additions to our knowledge of cold injury are presented. These include the physiologic effects of cold and the use of anti-fibrillatory, ganglioplegic drugs and anaesthetic agents. Complications related to hypothermia such as ventricular fibrillation, fat necrosis and capillary fragility are considered. Prophylaxis and therapies of cold injury including rewarming by diathermy and ultrasonics, and drugs diminishing the adverse physiological effects are reviewed. Acclimatization findings having military implications are considered. Parasitic infection in the Arctic and Sub-arctic is placed in perspective. Diverse medical problems encountered in cold environment operations including carbon monoxide poisonings, snow blindness and psychologic maladjustment are considered.

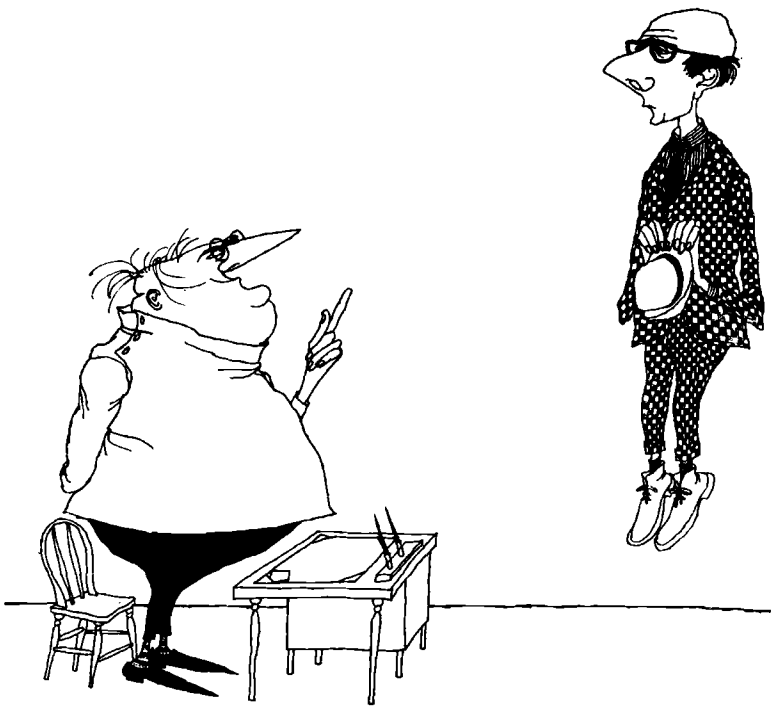
The Effect of Unilateral Acquired Myopia on Depth Perception in Airline Pilots. STANLEY DIAMOND, M.D., Pan American World Airways, Pacific-Alaska Division, San Francisco, Calif.

Increasing speeds of high performance aricraft will call for high degrees of stereoscopic acuity. Maximum stereopsis is dependent on excellent binocular visual acuity, and a decrease of vision in one or both eyes may produce a decrease in stereopsis. The Howard-Dolman findings of five pilots were studied prior to and after the development of unilateral myopia. The findings illustrated that small degrees of unilateral visual loss (20/25 to 20/40) may cause a corresponding decrease in stereoscopic threshold. This was reflected as a one to three-fold loss in threshold of stereopsis based on parallax disparity. Annual

Howard-Dolman tests may reveal early and small decrements of depth perception in pilots who show decreased vision in one eye due to uncorrected acquired myopia. These pilots probably should wear corrective lenses for maximum stereopsis.

The Importance of Vertical Stretch in the Brain Stem as Noted by Alteration of Reflex Action. N. R. HOLISTER, M.D., Dayton, Ohio.

Stretching force on the neck of the anesthetized cat was obtained by suspending the animal about the neck in a vertical position in a stock. The animal was then permitted to fall a specified distance at the end of which the stock was abruptly stopped. Inasmuch as the test produced a blow to the head, as well as a stretching of the neck, this simple test alone would not indicate the dominant factor causing concussion. To provide a test in which the neck stretching force was eliminated while retaining the blow, an isolation transformer was used to tetanize certain cervical muscles. Animals dropped under circumstances in which the stretch was eliminated, are completely protected from the usual symptoms of concussion. By contrast it was shown that 9 out of 10 cats were concussed when dropped untetanized with the neck free to stretch. Values of acceleration were displayed on a multi-channel oscillograph. Analysis of the resulting curves which showed acceleration as a function of time, provided data on impulse or blow. The instrumentation indicates that comparable blows were being delivered and therefore equal pressure changes and gradients probably exist. The records indicate that a peak of 140 G is attained within 3 milliseconds.



"We call it hyperventilation."

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