EFFECT OF SIMULATED AIR COMBAT MANEUVERING ON MUSCLE GLYCOCEN AND LACTATE. B. Bain* and E. Bucsko*. Defence and Civil Institute of Environmental Medicine, North York, Ontario, CANADA, M3M 3B9.

INTRODUCTION. Previous investigations have attempted to assess the contribution of anaerobic metabolism to the anti-G strain placed on maneuvers during simulated air combat maneuvering (SACM). However, muscle glycogen utilization and lactate production has never been assessed before and after SACM. This study attempted to quantify these variables using the percutaneous muscle biopsy technique. METHODS. The subjects were 6 healthy males, age 25-43 y. Muscle glycogen and lactate were determined from biopsies of m. vastus lateralis and the whole blood lactate was analyzed from finger-tip blood samples before and after subjects were exposed to a +4.07 G simulated air combat maneuvering in the centrifuge profile. RESULTS. G-tolerance was 230 ± 37 s (Mean ± SEM). In glycogen, m. vastus lateralis and m. vastus lateralis 1 mmol kg⁻¹ dry wt. (p<0.05). The rate of glycogen utilization was low, averaging 0.4 ± 0.1 mmol kg⁻¹ dry wt. per minute in m. vastus lateralis and m. vastus lateralis 1 mmol kg⁻¹ dry wt. per minute in m. vastus lateralis. Muscle lactate (LaM) increased significantly from 28 ± 2 mmol kg⁻¹ dry wt. pre-SACM to 51 ± 4 mmol kg⁻¹ post-SACM. Post-SACM blood lactate was 4.2 ± 0.3 mmol L⁻¹. Neither final blood nor muscle lactate values were significantly different between pre and post SACM. LaM concentrations were related to G-tolerance time.

CONCLUSIONS. Glycogen availability, at least in m. vastus lateralis, is not a limiting factor during high G exposure to this type and duration. The lactate values, while high, cannot fully explain the metabolic strain that appears to be taking place during the centrifuge exposures. The suggestion by some investigators that anaerobic muscle metabolism is the crucial factor limiting the ability to resist fatigue during exercise in SACM is not supported.

FACTORS INVOLVED IN EMS HELICOPTER OCCUPANT INJURY. B.E. Doerr*, Johns Hopkins University Injury Prevention Center, Baltimore, MD 21205 INTRODUCTION. Since 1972, 64 helicopters engaged in emergency medical service (EMS) operations have crashed. During 1980-1989, the mean EMS helicopter crash rate was 19.1, roughly 2.5 times that of FAR part 135 helicopter air taxis, a comparable population. The mean fatal crash rate for EMS helicopters of 5.0 was 5 times the mean rate for air taxi helicopters. The National Transportation Safety Board investigated the operational safety of EMS helicopters in 1988 and found, among other things, that the medical modifications to the interior of numerous EMS helicopters may have a negative impact on occupant crash tolerance. METHODS. Survivors of EMS helicopter and air taxi crashes were studied to determine occupant injury. Information was requested on age and weight, function in the helicopter, seating position, individual restraint availability and use, damage to the seat, personal protective equipment, damage to the cabin, number of engines, type of operation, and other variables. RESULTS. The most important pilot influencing survival was non-use of shoulder harnesses, which quadrupled the odds of fatal injury. Other important factors were aircraft fire (Odds Ratio=7.8), off-airport location of the crash (OR=5.2), and IMC weather (OR=3.8). One crash in six involved postcrash fire. The combination of fire and explosion, although not common, increased the fatality rate from 11% with neither present to 69% with both. CONCLUSION. High priority should be given to increasing shoulder harness use and reducing postcrash fires. The possibility of improving the potential for rescue in off-airport locations and at night should also be explored.

FACTORS RELATED TO PILOT SURVIVAL IN CRASHES OF COMMERCIAL AIRPLANE AND HELICOPTERS. S.P. Baker* and G. Li. Johns Hopkins Injury Prevention Center, School of Public Health, Baltimore, MD 21205 INTRODUCTION. Among civilian workers, pilots are second only to loggers in rates of work-related injury deaths. During 1983-1988, 176 pilots-in-command were killed in crashes of scheduled commuters and nonscheduled air taxis in the U.S. The proportion of crashes in which the pilot was killed was 17% and 20%, respectively, for the two types of operation. METHODS. To identify the factors related to fatal outcome, we used NTSA computer data in logistic regression models. The results are adjusted for age, sex, flight time, aircraft type, helicopter, number of engines, type of operation, and other variables. RESULTS. The most important pilot influencing survival was non-use of shoulder harnesses, which quadrupled the odds of fatal injury. Other important factors were aircraft fire (Odds Ratio=7.8), off-airport location of the crash (OR=5.2), and IMC weather (OR=3.8). One crash in six involved postcrash fire. The combination of fire and explosion, although not common, increased the fatality rate from 11% with neither present to 69% with both. CONCLUSION. High priority should be given to increasing shoulder harness use and reducing postcrash fires. The possibility of improving the potential for rescue in off-airport locations and at night should also be explored.

INTRODUCTION. Accident investigation records of U.S. Army helicopter crashes indicate that approximately 25% of the inertia reels field tested failed to lock either failing to lock or not locking soon enough. Sled test analysis revealed that the inertia reel locking mechanism, manually locked before testing, can disengage during dynamic tests. These phenomena are also induced by hypoxia. Performance scores also showed marked inter- and intra-individual variability.

METHODS: Airbag systems were installed on the gunights in simulated Cobras and Apache cockpits, then sled tested at 7 and 25 g. RESULTS: The tests indicated airbags reduced head accelerations by 65 percent, head injury criteria by 77 percent, and head, neck, and chest injuries by 71 percent of the Cobras tested. In the Apache tests, the airbags reduced those same indicators by 68, 52, and 83 percent. CONCLUSION: The study concludes that an airbag system is likely to prevent severe or fatal head and chest injuries in an Apache or Cobra crash.


INTRODUCTION. The inertia reels utilized in U.S. Army helicopters are regulated by MIL-B-20364. This performance specification lists, and states that inertia reels lock automatically when the restraint strap is subjected to an acceleration between 1.5 and 3 g and remain locked until manually released. Inertial reel performance characteristics have become suspect due to increased upper torso injuries received during mishaps. METHODS: A sample of 110 inertia reels from Fort Rucker rotary-wing aircraft was determined if calibration settings are greater than 3 g. RESULTS: A number of critical and fatal injuries have occurred in survivable or fatal head and chest injuries in an Apache or Cobra crash. A NEW RAPID DEPRESSURISATION AND HYPOXIA TRAINING SIMULATOR FOR AIRCREW. A. G. Dawson* L. J. Thompson. * Auckland, New Zealand.

INTRODUCTION: Professional aircrews are trained to react appropriately to rapid depressurisations. Tradiional simulators can provide practice control and give crew confidence in equipment and procedures, but they must be safe, realistic and affordable: Hypobaric chambers are used but they involve a significant health risk and considerable financial cost. METHODS: A chamber has been constructed with eight typical airline cabin stations with the main criteria by which a hypoxic simulator is assessed. Hypobaric hypoxia is induced by exposure to hypobaric conditions. This study was conducted to assess the psychological and physiological reactions to hypobaric hypoxia. METHODS: 30 subjects were exposed in identical conditions in a hypobaric chamber at 46.5 kPa (20,000 ft). Ambient air or oxygen was administered (subject-blinded) through a mask. ECG, respiration rate, end-tidal CO₂, oxygen saturation, EEG were continuously recorded. Psychological performance was continuously assessed by a battery of tests. RESULTS: Mean group values of the physiological parameters confirmed earlier results in literature. However, marked inter- and intra-individual differences in the physiological responses were observed. Two cases of asystole were observed. Mean group performance scores showed significant effects of hypoxia. Performance scores also showed marked inter- and intra-individual variability.

DISCUSSION: In the assessment of physiological and psychological effects of hypobaric hypoxia marked inter- and intra-individual variability has to be anticipated. This has implications for the hypoxia indoctrination of aircrew. Hypoxia stimulates the vagal reflex arc, which might lead to SA node depression. As hypoxia also depresses AV nodal tissue and impairs conduction in the ventricles, asystole might occur. Implications with respect to medical monitoring during hypobaric chamber demonstrations are discussed.


INTRODUCTION: When erythropoietin is administered in vivo, erythrocyte colony forming units(CFU-E) increase accelerated. These phenomena are also induced by hypoxic stimulation; the hypoxic state in the living body corresponds to hypoxia rats. METHODS: Fifty male rats were continuously exposed to a simulated altitude of 15,000 feet for 3 weeks. The animals were divided into 6 groups. 1) In the erythropoietin group, significant increases were observed in red blood cell (RBC), hemoglobin(Hb) and hematocrit(Hct) until 5 days after hypoxia. 2) In blood gas analysis, O₂ content showed a significant increase in the erythropoietin group but not in the saline groups. CONCLUSION. These results suggest that the administration of erythropoietin before hypoxic stress improves the ability of oxygen transport of the body and increases the resistance to hypoxia. These findings are considered to be important in clarifying the mechanism of adaptation to hypoxia.
THE ROLE OF PULMONARY SURFACANT IN EXTREME ALTITUDE EXPOSURE. M. H. England, Jr., B. C. Milcox, Jr., G. A. McClean. FAA Civil Aeromedical Institute, Oklahoma City, OK 73125-5066.

INTRODUCTION. A guinea pig model was being used at the HAPF to test the efficacy of various treatment modalities to protect against exposure to near vacuum. The incidence of respiratory arrest and the difficulty of pulmonary resuscitation have led to the hypothesis that normal lung surfactant function is disrupted in extreme altitude exposure. METHODS. Scanning and transmission electron microscopy (with special stains for surfactant) have been used to compare the lung ultrastructure between altitude-exposed and control animals. Low pressure vascular perfusion fixation has been utilized to minimize disruption of the alveolar surface lining layer. RESULTS. Preliminary analysis indicates that, in comparison to controls, the lungs of exposed animals demonstrated a reduction in thickness of surfactant lining alveolar spaces. Animals which survive the exposure demonstrate a marked increase in surfactant production 48 hours later. Otherwise, no significant ultrastructural disruption of normal morphology is noted. CONCLUSIONS. Pulmonary surfactant is reduced by altitude exposure in this model. Artificial surfactant may have a role in the clinical treatment of ebullism.

COMPARISON OF TOLERANCE TO PRESSURE BREATHING BETWEEN TWO SCHEMES OF COUNTERPRESSURE. D. H. C. Oks, Institute of Aviation Medicine, Beijing 100036, P. R. China.

INTRODUCTION. In order to improve compatibility to positive pressure breathing (PPB), two counterpressure schemes were compared. METHODS. Twelve healthy young men underwent PPB with a pressure differential of 65 mmHg at 100% O2 and 100% N2. O2 air for 5 min each with counterpressure scheme A, a constant 100% O2, W2O4, and on the second day, scheme B, a constant 100% O2 until the air was breathed in PPB, the responses were similar to those with pure O2, only oxygen readings were 82% and 84.5% respectively. With both schemes provided safety in scheme B was better due to a slower return and more stabilized was the diaphragm. CONCLUSIONS. Counterpressure with an anti-G suit might be of choice. With cruising altitude of 16 km and utilizing an O2 assembly of 120 mmHg differential, anti-G suit not only protects equally well, also in simpler, causes less heat stress and one piece of gear can serve two purposes.

COMPARISON OF PORTABLE CREWMEMBER PROTECTIVE BREATHING EQUIPMENT (CPBE) DESIGNS. B. C. Milcox, Jr., G. A. McClean, Jr., M. H. England, Jr., FAA Civil Aeromedical Institute (CAMI) Oklahoma City, Oklahoma, 73125-5066.

INTRODUCTION. CPBE presently certified for transport category aircraft allow three types of oxygen production systems: charcoal, candle, potassium superoxide, and compressed oxygen. CPBE performance was evaluated to expose significant differences based on this distinction. METHODS. CPBE tests employing humans were conducted in accordance with FAA Technical Standard Order C-116. All CPBE were tested for oxygen production, carbon dioxide concentration, internal pressure, moisture and breathing resistance for 15 minutes at ground level (1,300 ft) and cabin altitude (8,000 ft), while subjects exercised. RESULTS. All CPBE produced a mean oxygen level of at least 95% and maintained carbon dioxide level below 5% at ground level. Differences in internal temperature and humidity were found. Performance at altitude generally paralleled these findings. CONCLUSIONS. Oxygen and carbon dioxide levels provide little discrimination about the relative merits of particular CPBE. However, differences in the wearability of CPBE based on internal temperature, humidity and weight, were dependent on the type of CPBE oxygen production system.

VARIATION OF TIMES-TO-INCAPACITATION (t50) AND CARBONMONOXIDE (CO) LEVELS FOR RATS EXPOSED TO TWO CARBON MONOXIDE (CO) CONCENTRATIONS. V. S. Sanders, B. R. Endecott, and A. K. Chaturvedi*. FAA Civil Aeromedical Institute, Oklahoma City, OK 73123.

INTRODUCTION. It has been proposed that passenger protective breathing equipment protect the wearer from smoke and toxic gases for 5–min during an evacuations phase and for 35–min during an In-flight plus-evacuation phase. Although CO is considered the primary toxic smoke component and incapacitation is an end-point related to incapacitation, CO levels may not necessarily be indicative of incapacitation. COMPARISON OF MOLECULAR SIEVE OXYGEN CONCENTRATORS (MSOC) FOR POTENTIAL MEDICAL USE ABOARD COMMERCIAL AIRCRAFT. M. H. England, Jr., B. C. Milcox, Jr., G. A. McClean, FAA Civil Aeromedical Institute, Oklahoma City, Oklahoma, 73125-5066.

INTRODUCTION. Medically impaired air travelers requiring supplemental oxygen must depend on airlines to provide oxygen, which is a costly, cumbersome, and space and cost hinder this service. Tests were conducted in an altitude chamber to assess the viability of MSOC as an alternative. METHODS. Tests were conducted at 28,000 ft with an alternative placed in the altitude chamber, and connected to a mass spectrometer for monitoring. Analog gas concentration data were digitized at one sample-per-second and stored online via a microcomputer. RESULTS. Tests at ground level showed 4 of the 5 MSOC produced oxygen of 95% purity at 2 liters per minute flow, which was maintained until 13,000 ft. Increasing altitude resulted in graded reductions of oxygen levels. At 25,000 ft., only two MSOC produced acceptable levels of oxygen. Only these two MSOC withstood sudden decompression. CONCLUSIONS. Results of this study indicate that some MSOC hold the potential to provide oxygen for medically impaired air travelers.


INTRODUCTION. Current Navy flight helmets do not provide sufficient sound attenuation of the high-intensity, low-frequency noise present in some naval aircraft. As a part of a program to provide improved hearing protection and speech intelligibility for aircrew in MH-53E helicopters, we conducted sound attenuation and speech intelligibility evaluations of a helmet-integrated active noise reduction (ANR) system. METHODS. Objective real-life ear attenuation measurements (utilizing a miniature microphone placed at the entrance to the subject's ear canal) and speech intelligibility measurements (utilizing the NAMRL-developed Tri-Word Modified Rhyme Test) were obtained on ten male emigents in the Naval Aviation Flight Training Program. RESULTS. A comparison of the sound attenuation values obtained in the ANR "on" mode (combined active/passive attenuation) to attenation values obtained in the ANN "off" mode (passive attenuation) revealed 10-15 dB greater attenuation at 125, 250, and 500 Hz and 1-3 dB less attenuation at 2000, 3150, and 4000 Hz. A comparison of the mean percent correct speech intelligibility scores obtained in the ANN "on/off" modes under four noise level conditions (75, 95, 105, and 115 dB SPL) revealed equivalent intelligibility scores except at the highest noise level where slightly reduced intelligibility scores were obtained in the ANN "on" mode. A 3-5 dB decrease in signal level when the ANN system was changed from "on" to "off" undoubtedly accounted for the reduced intelligibility. CONCLUSIONS. Active noise reduction technology can be utilized to improve the hearing protection of aircrew performing in high-intensity, low-frequency noise environments.
EFFECTS OF SIMULATED HEARING LOSS ON SPEECH PERCEPTION IN NOISE.
A. H. McCarty and D. G. Thomas, Naval Aerospace Medical Research Laboratory, Pensacola, FL 32508-5700.

INTRODUCTION: Hearing standards for aviators often permit relatively large pure-tone losses at the higher audiometric frequencies. This study investigated the effects of simulated hearing loss at 2 kHz and 4 kHz on speech perception in cockpit noise. METHODS: Four lists of the Tri-Word Modified Rhyme Test (TMR7), two lists at a +4 dB signal-to-noise (S/N) ratio and two lists at a 0 dB S/N ratio, were administered to 26 student naval aviators. Before testing, standard air-conduction, pure-tone audiograms were administered to each subject. During one list at each S/N ratio, the speech signal was narrow-band attenuated to simulate a 25 dB hearing loss at 2 kHz and a 50-60 dB hearing loss at 4 kHz. The other two lists were presented without attenuation. RESULTS: The results indicated that performance differences due to S/N ratio were significant, p < .0001, and that performance differences due to attenuation were significant, p < .0001. No interaction effects were noted. Interestingly, there was a tendency for those subjects with the poorer audiograms to be affected less by the simulated loss of hearing. This suggests the possible development of a compensatory perceptual/cognitive mechanism in those subjects. CONCLUSION: Subjects' normal-hearing performance on the TMR7 is significantly better than their performance while experiencing simulated hearing loss equivalent to 25 dB at 2 kHz and 50-60 dB at 4 kHz. Subjects with poorer pure-tone thresholds may develop compensatory perceptual/cognitive mechanisms to partially offset their hearing loss.


INTRODUCTION: A new 2-way communication system integrated into an ear plug with a piezoelectric accelerometer to pick up the human voice as the direct vibration through bone and tissue in the auditory canal. Previous studies indicated the feasibility of transmission of incoming speech signals, was investigated for the fitness of communication in loud ambient aircraft noise. METHODS: Monosyllabic word intelligibility tests were conducted for 15 individuals wearing the ear plug in one ear and 12 of them wearing the ear plug in only one ear and 12 wearing it in both who were concurrently exposed to white noise of 104 dB with and without an extra ear muff. Additionally this system was used in place of the normal hearing protection helmets for ground crews during routine fighter pre-flight checks. The subjective impressions were validated with a questionnaire. RESULTS: Without additional ear-muffs the rate of error was 70%. With ear-muffs the error-rate decreased by more than 70% to 19.9%. There was no difference whether the ear plug was worn in one or both ears. During the pre-flight checks the comprehensibility of speech was good for both the ground and the cockpit crew. DISCUSSION: The great safety and comfort advantages of this new system are: A) ground crews are able to work unencumbered, B) the heat and restriction of a helmet are eliminated, C) the visual field is broader and D) breathing noises in microphones that interfere with communication are eliminated. A future option would be the integration of this system into a whole body climatized suit for fighter pilots.


Auditory responses including the well-characterized auditory brainstem response have been used extensively in clinical investigations. Evoked responses have not been adequately developed to investigate the vestibular system. The purpose of this study is to describe a new method for the evaluation of the short-latency vestibular evoked potentials in human subjects. Standard ABR equipment is employed using a custom-designed solid-state modification of the triggering mechanism. Signal averaging is used to record responses to multiple accelerations. Normal and vestibular deficient subjects were tested. Results indicate the presence of a short latency wave V which is absent in vestibular deficient subjects. The literature is reviewed and illustrative cases are presented. It is felt that vestibular evoked potentials are a promising new modality in investigating vestibular physiology and motion sickness.

EVALUATION OF A VOICE-RECOGNITION SYSTEM FOR THE AUTOMATION OF THE VORPET TEST. E. A. Molina, Naval Aerospace Medical Research Laboratory, Pensacola, FL 32508-5700.

INTRODUCTION: The Votan-OsloReflex Performance Evaluation Test (VORPET), developed at the Naval Aerospace Medical Research Laboratory, gives a measure of left- and right-directed gaze-stabilization threshold time. Automation of the VORPET requires the use of a voice-recognition system to collect and score the subject's voice responses. We compared the accuracy of the Votan voice-recognition system to that of the present method that uses a test administrator to listen and record subject's responses when administering the VORPET. METHODS: Thirty-six subjects were administered the VORPET under three different conditions: (a) direct viewing of the stimulus digits presented on the CRT, involving no head movement, (b) VORPET administration using a test operator for subject's voice acquisition and manual data entry, and (c) VORPET administration using the automatic voice-recognition system for subject's voice acquisition and recognition. Two, three, and four digits were used as visual stimuli for each method. RESULTS: Analysis of variance of test results indicated significant differences between the thresholds obtained when methods (b) and (c) were used to administer the VORPET. CONCLUSIONS: The Votan automated voice-recognition system cannot be used to automate the VORPET. Present speed and accuracy of the automated voice-recognition systems still need additional technological advancement or improvement in order to replace the present "human-based voice-recognition system."