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EVALUATION OF THREE METHODS FOR TESTING COLD WEATHER COMBAT BOOT SYSTEMS. D. A. DiRaimo, W. R. Santee, and R. R. Gonzalez*. U.S. Army Research Institute of Environmental Medicine, Natick, MA 01760-5007.

INTRODUCTION. Studies were conducted on a static copper model of the foot, which is sectioned into twenty-nine heat transfer regions. This foot model is used to determine the dry insulation properties of commercial and prototype cold weather combat boot systems (CWCBS). Heat flux through the boot sole is an important criterion in selecting CWCBS. The insulation of air (I_a) between the foot and the boot sole is the key variable in the amount of heat flux through the sole. I_a , which incorporates both the radiative heat transfer (h_r) and the convective heat transfer (h_c) coefficients, is reduced as the boot sole is compressed, thus increasing the heat flux through the sole. The heat flux is further augmented with the addition of a cold substance, such as mud, water, or snow in an actual cold/wet field environment. Methods were developed for comparing the amount of heat flux through the boot sole of CWCBS using a dry compression test method (to simulate standing in cold/dry environmental conditions) and a wet compression test method (to simulate standing in cold/wet environmental conditions). **METHODS.** Eight CWCBS were evaluated on the foot model according to three test methods: a free suspension (FS) control test, a cold/dry environmental compression (CDC) test, and a cold/wet environmental compression (CWC) test. Across all test conditions, the chamber temperature was kept at 20°C and the model surface temperature was kept at 30°C. For the CWC test, 5 cm of lead shot were interposed between the boot sole and a metal compression plate to simulate mud, water, or snow. Lead shot was used to ensure uniformity throughout the test and to maintain a replicable test material. **RESULTS.** The insulation values between the different test methods did not vary significantly ($p > 0.05$). The CWC test provided no better basis for distinguishing between boot systems than either the CDC test or the FS test. **CONCLUSION.** It was expected that the CWC test method would be more responsive than either the FS or the CDC test method, but it was not. Further studies are needed to develop more quantitative methods for evaluation of I_a as a means of discriminating between CWCBS.

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Test and Evaluation of Two Personal Cooling Systems in Simulated Helicopter Flight Operations. L. Meyer*, D. Horrigan*, D. Siniff, and W. Lotz*. Naval Aerospace Medical Research Laboratory, Pensacola, FL 32508-5700.

INTRODUCTION. Helicopter operations conducted in high ambient temperatures expose aircrews to potentially dangerous physiological conditions. We tested two personal cooling systems to evaluate their effectiveness in reducing heat strain on aircrews. **METHODS.** One of the systems was a long-sleeved shirt, while the other was a vest with an attached head unit. Both were cooled with cold liquid pumped continuously through tubing in the garment. Ten student aviators wearing standard USN helicopter aircrew flight equipment were exposed to both 35°C/55% RH and 50°C/25% RH with and without cooling for 90 min. Heart rate, blood pressure, and mean skin and rectal temperatures were monitored before and during heat exposure. Additionally, sweat rate and subjective thermal sensations were recorded in the heat. Subjects performed 30 min of continuous submaximal work on a bicycle ergometer (50 W for 10 min, 100 W for 10 min, 150 W for 10 min). Oxygen consumption, metabolic rate, and rating of perceived exertion were determined during exercise in the heat. Venous blood samples were drawn before and after each test. **RESULTS.** Both systems effectively improved the physiological response to heat stress at rest and during exercise in both environmental conditions. The shirt-type system proved better at controlling all dependent variables during exercise. Thermal sensation ratings were also cooler with the shirt. The decrease in serum osmolality from pre- to post-heat exposure was greater with the vest. **CONCLUSION.** Both systems effectively reduced heat strain with the shirt-type system providing the greater benefit in physiological and subjective response both at rest and during exercise.

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HEAT STRESS AND A COUNTERMEASURE IN THE SHUTTLE RESCUERMAN'S SUIT. D.E. Doerr*, H. Reed, and V.A. Convertino*. NASA, Kennedy Space Center, FL 32899

INTRODUCTION: Rescue of the astronaut flight crew from a contingency landing may risk exposure of the rescue crew to toxic propellants spilling from potentially ruptured tanks in the crew module area. An Aquala dry diver's suit has been in service by the rescue team to preclude exposure, especially in the water rescue scenario. Heat stress has become a factor of concern in recent years when older and less physically-fit team members work in this suit. **METHODS:** Field testing was initiated using fully instrumented rescuemen in a simulated scenario to determine the extent of heat stress. Two tests were accomplished, one in the normal (N) configuration and one with a proposed cooling countermeasure, the Steele vest (S). **RESULTS:** Heat stress was high as indicated by average rectal temperatures (Tre) of 38.28°C (100.9°F) after the 45 min protocol. Slopes of the regression equations describing the increase in Tre with time were greater ($P < 0.05$) with N ($0.073 \pm .008$) compared to S ($0.060 \pm .007$). Projection of time to the 38.89°C (102°F) limit for Tre was increased by 15.3% with the vest. Mean skin temperature (Tsk) was higher ($P < 0.05$) in N ($38.33 \pm .11^\circ\text{C}$) compared to S ($34.33 \pm .07^\circ\text{C}$) even when the two skin temperatures recorded from the sensors located on the torso, under the vest, were eliminated from the calculation of Tsk ($38.22 \pm .17^\circ\text{C}$ vs. $37.33 \pm .39^\circ\text{C}$). Average heart rate was higher ($P < 0.05$) in N than S. Sweat loss, as measured by weight loss, was more ($P < 0.05$) for N ($1.09 \pm .09$ kg vs. $0.77 \pm .06$ kg). Air usage, while slightly less for S, was not statistically different. **CONCLUSION:** The use of the cool vest provided significant relief from thermal stress inspite of the addition of 3.4 kg (7.5 pounds) weight and some loss in mobility.

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PHYSIOLOGICAL RESPONSES DURING SHIPBOARD FIRE FIGHTING. B.L. Bennett*, R.D. Hagan, G.B. Banta*, and F.W. Williams*. Naval Health Research Center, San Diego, CA, 92186-5122 and Naval Research Laboratory, Wash., D.C. 20375-5000

INTRODUCTION. Fire fighters dressed in full protective ensemble and combating shipboard fires are subjected to extreme heat strain. However, physiological responses have not been well documented. Environmental chamber simulations to date have not been true representations. Therefore, the purpose for this study was to document the physiological responses of U.S. Navy Damage Control personnel while combating fires aboard a fire fighting demonstration ship. **METHODS.** Nine male volunteers (36.7 yrs, 181 cm, and 81 kg) experienced in fire fighting were monitored for heart rate (HR), four skin temperatures (T_{sk}) and rectal temperature (Tre) during three days of fire fighting (n=4 per day). Each subject wore the standard Navy fire fighting ensemble (fire retardant suit, gloves, boots, flash hood, helmet and breathing apparatus). Peak fire temperatures reached 600°C, while temperatures in the adjoining fire fighting compartment ranged from 40-100°C. **RESULTS.** As expected, significant ($p < 0.05$) heat strain occurred during approximately 25 mins of fire fighting. However, the magnitude and rate of change of Tre, T_{sk}, and HR were greater than expected. Mean responses were: peak Tre = $39.1 \pm 0.8^\circ\text{C}$; Tre slope = $.04^\circ\text{C}/\text{min}$; peak T_{sk} = $39.5 \pm 0.7^\circ\text{C}$; T_{sk} slope = $.1^\circ\text{C}/\text{min}$; peak HR = 186 ± 13 ; and % of predicted maximum HR = $103 \pm 8\%$. **CONCLUSION.** Actual shipboard fire fighting wearing protective ensembles can lead to extreme heat strain and potential heat injury. These data have implications for operational training, generation of exposure guidelines, and development of protective ensembles and heat strain countermeasures.

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ACCLIMATION AND MICROCLIMATE COOLING CONSERVE PLASMA VOLUME DURING EXERCISE IN THE HEAT. J.H. Heaney, K.M. Wilmore, M.J. Buono, G.J. Noffal, M.D. Hurst, N.A. Pimental, G.B. Banta*. Naval Health Research Center, San Diego State University, San Diego, CA and Navy Clothing and Textile Facility, Natick, MA.

INTRODUCTION. Effective thermoregulation during heat exposure is partially dependent on maintenance of plasma volume (PV). Navy engineroom personnel, who typically work 4-6 hour shifts in thermal environments exceeding 32°C, are constantly subjected to heat strain. This study investigated the effects of microclimate cooling on PV conservation during exercise in the heat following a baseline acclimation (AC) protocol. **METHODS.** Eight engineroom personnel underwent an 8-day acclimation process (35°C, 70% RH) followed by 6 simulated engineroom watches (EW) in an environmental chamber. Two duplicate EW tests, with and without a passive ice vest (IV), were performed in three thermal conditions: EW1=43.3°C, 48%RH; EW2=50.6°C, 33%RH; EW3=57.2°C, 24%RH. During AC, a 2-hr exercise protocol (exercise 25-min, rest 5-min) alternated treadmill walking with stationary cycling. The EW protocol consisted of a 20-min treadmill walk (3mph, 3%grade) and 40-min of seated rest each hour to a maximum duration of 6-hrs or volitional withdrawal. PV changes were determined from seated (20-min) blood samples obtained prior to entering and exiting the heat chamber. **RESULTS.** PV changes (%) across day-1, day-3, day-5 and day-8 (-5, -1.3, -1.7 and +6 respectively) of AC showed a trend towards conservation but were not statistically significant ($p > 0.05$). End of test PV changes during IV EW showed a similar conservation trend except for EW3: EW1=-7.1, -1.1 ($p < 0.05$); EW2=-8.5, -4.2 ($p > 0.05$); EW3=-6.3, -9.7 ($p > 0.05$) for non-IV and IV conditions respectively. **CONCLUSION.** PV loss decreased over time during AC and was less in the IV conditions for EW1 and EW2. EW3 PV findings may be the result of a considerably longer IV test duration in combination with the high heat. When expressed relative to test duration non-IV PV losses were twice those in the IV exposures. These results suggest that heat acclimation will conserve PV and microclimate cooling can provide continued support of PV conservation during exposure to high heat.

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COMPARISON OF ICE-BASED PERSONAL COOLING SYSTEMS. S.D. Hart*, J. Zarinczuk*, L.E. Bernard*. College of Public Health, University of South Florida, Tampa, FL 33612-3899.

INTRODUCTION. Heat stress becomes a notable problem when there is a need to wear impermeable clothing for protection against biological, chemical and radioactive contaminants. The purpose of this project was to evaluate the cooling performance of five commercially available personal cooling systems having ice as the heat sink. The five systems included one ice vest, two liquid cooling vests (one with a hood), and a whole-body liquid cooling suit with hood configured two ways (as a portable system and as a tethered system). Elapsed time was used as the performance measure. **METHODS.** Overall, there were seven subjects (3 men and 4 women). The subjects walked on a treadmill at about 260 W in a controlled environment (T_{db}=38°C and T_{wb}=30°C) while wearing polycoated Tyvek coveralls and hood, rubber gloves and full-face respirator. For each cooling system, three men and two women were assigned to a trial. For the no-cooling control, the three men completed two trials and each woman one (10 control trials). Melted ice was replenished as needed. Heart rate and rectal temperature were recorded. Elapsed time was the time until a volitional or physiological limit was reached. **RESULTS.** For the control, ice vest and both liquid cooling vests, trials were terminated for high rectal temperature (38.5°C). The average elapsed times (\pm SD) in minutes were control: 30 \pm 8; liquid-cooling vests: 39 \pm 15 and 43 \pm 8; and ice vest: 62 \pm 20. Trials for the two configurations of the liquid cooling suit were arbitrarily stopped at 120 min, and there was no important increase in heart rate or rectal temperature during that time. **CONCLUSION.** The superior performance of the liquid cooling suit is attributed to the large surface area covered by the suit. When long work times are required and there is a method to replenish the ice, the liquid cooling suit can provide sustained protection from heat strain.

OPERATIONAL CONSEQUENCES OF A-6 AND F-14 WORK/REST CYCLES DURING DESERT SHIELD/STORM. I. EFFECT OF OPERATIONAL TASKING ON LSO SCORES AND SUBJECTIVE READINESS. S.A. Shappell and D.F. Neri. Naval Aerospace Medical Research Laboratory, Pensacola, FL 32508-5700.

INTRODUCTION. Operational demands placed on naval aviators during sustained or continuous operations continue to be an area of intense laboratory investigation. The recent Gulf War provided a unique opportunity to collect data examining aircrew work/rest cycles and operational tasking in a combat environment. **METHODS.** For four consecutive weeks during Operations Desert Shield and Desert Storm, nine A-6 and nine F-14 pilots onboard the USS AMERICA (CV-66) provided detailed daily activity data while conducting operations from the Red Sea. The pilots completed daily work/rest logs to a resolution of one-half hour. In addition, flight data was obtained including: 1) takeoff and landing time, 2) flight duration, 3) mission type, 4) consecutive days during which a flight occurred, 5) landing signal officer (LSO) scores, 6) arresting wire engaged on landing, and 7) subjective reports of the needed delay before an air-to-ground strike mission could be flown (a measure of subjective readiness). **RESULTS.** Data analysis indicated that the amount of sleep obtained 6, 12, 18 and 24 hours prior to a combat mission may influence LSO scores and subjective readiness. Mission type, the number of consecutive days in which a flight occurred, time of day, and flight duration also were related to LSO scores and subjective readiness. **CONCLUSIONS.** These data provide valuable information for air wing commanders and senior mission planners when tasking carrier-based aviators. These data also provide an essential database for squadron and air wing flight surgeons to draw upon when assessing aircrew readiness.

OPERATIONAL CONSEQUENCES OF A-6 AND F-14 WORK/REST CYCLES DURING DESERT SHIELD/STORM. II. CIRCADIAN CONSIDERATIONS. D.F. Neri and S.A. Shappell. Naval Aerospace Medical Research Laboratory, Pensacola, Florida 32508-5700.

INTRODUCTION. A significant amount of laboratory research has focussed on the impact of sustained and continuous operations on naval aviation. The Gulf War provided a rare opportunity to collect field data examining the effect of wartime operations on the work/rest schedules and subjective fatigue of carrier-based aviators. **METHODS.** For four consecutive weeks during Operations Desert Shield and Storm, 18 A-6 and 23 F-14 aviators aboard USS AMERICA (CV-66) provided detailed daily activity data while conducting operations from the Red Sea. The officers completed logs of activities and sleep to a resolution of one-half hour. Subjective measures of fatigue, quality of rest, and sleep need were also collected. **RESULTS.** Data analyses indicated that the cyclical flight operations during Operation Desert Storm yielded few indicators of sleep disturbances, although aviators generally desired more sleep. Aviators averaged a little more than 6 h sleep per night during both operations. Frequency and duration of naps increased slightly during Desert Storm, while sleep onset times became later for A-6 aircrew. Both squadrons showed significant shifts in flight times during Desert Storm. **CONCLUSIONS.** Two factors may be responsible for the relatively small impact of the war on work/rest schedules and fatigue. The first is the obvious observation that high force levels in theater allowed work/rest schedules to be well-managed. A generally overlooked factor may be the relationship between direction of ship travel and the phase of the circadian rhythms of the aircrew.

SUBJECTIVE FATIGUE OF A-6 AND F/A-18 AIRCREWS ABOARD THE USS AMERICA DURING OPERATIONS DESERT SHIELD AND DESERT STORM. C.A. DeJohn, S.A. Shappell, and D.F. Neri. Naval Aerospace Medical Research Laboratory, Pensacola, FL 32508-5700.

INTRODUCTION. The U.S. Navy has long been interested in the effect of combat flight operations on aircrew fatigue. A research team embarked aboard the USS America to collect data from an A-6 squadron and an F/A-18 squadron during Operations Desert Shield and Desert Storm. The purpose of their study was to determine the effects of air combat missions on subjective fatigue. **METHODS.** Twenty-nine aircrew members, 22 pilots, and 7 naval flight officers (NFO's), completed the Stanford Sleepiness Scale (SSS), Mood Scale II from the Unified Tri-service Cognitive Performance Assessment Battery (UTC-PAB), and the fatigue subscale from the Addiction Research Center Inventory (ARCI). The questionnaires were completed before and after each mission flown between 12 January and 3 February 1991. **RESULTS.** Post-mission reported fatigue was greater than pre-mission reported fatigue on all scales for pilots, but not for NFO's. Similarly, post-mission fatigue scores were greater than pre-mission fatigue scores for A-6 aircrews. However, this was not the case for F/A-18 aircrews. **CONCLUSIONS.** Pilots appear to experience greater fatigue than their NFO counterparts, while A-6 aircrews seem to report greater fatigue than F/A-18 aircrews. This disparity in reported fatigue between pilots and NFO's, and the attack and fighter-attack communities has important implications for operational planners.

PREDICTING FATIGUE EFFECTS ON PERFORMANCE. J. French*, K. Neville, A. Rowe-Hallbert, D. Eddy and S. Schiflett. Armstrong labs /CFTO, Brooks AFB, TX 78235-5000.

INTRODUCTION. Opportunities for fatigue related accidents are greatest when extended duty cycles must be maintained. A means to plan for the influence of fatigue would be useful to utilize crew resources best. An equation was derived that predicts performance degradation associated with fatigued cognitive abilities. **METHODS.** During a 30 hour sleep deprivation study, 9 male subjects were required to perform a 45 minute performance battery every 120 minutes and variables sensitive to fatigue were determined. Plasma melatonin levels also were obtained. Composite response time and accuracy scores were then derived. **RESULTS.** The equation that best described the composite scores included a linear component (hours awake weighting) and a circadian component (melatonin weighting). The respective prediction equations accounted for 36.7% and 36.9% of the variance in response time performance and 12.4% and 19.9% of the accuracy performance ($p < .001$). These percents indicate that accuracy predictions were more enhanced by the circadian component than were those for response time. **CONCLUSIONS.** This work represents a mathematical description of fatigued performance that is sensitive to circadian cycles and requires minimal input data. The results might be used to recommend when additional crew should be employed as performance falls below critical thresholds or the best crew rest times during sustained operations.

SHIFT SCHEDULES IN SPACE: ADAPTATION SIMULATION. A. Samei*, H.M. Wegmann*, M. Vejvoda, and H. Allmers*. DLR-Institute for Aerospace Medicine, Cologne, Germany.

Astronauts are often required to work in shifts during space missions. To test adaptation procedures and circadian system effects, a study was performed using head-down bedrest (HDT). Eight male subjects were studied over a 25-day period: 4 control days, 7-days pre-bedrest adaptation, 7-days HDT, and 7-days readjustment. Based on the D-1 mission schedule, an advance shift of 7-hrs was selected for pre-bedrest adaptation during which the sleep-wake cycle was shortened by 1-hr/day. The circadian system was assessed by continuously monitoring ECG and body temperature (BT), and by 3-hr collections of urine for hormones and electrolytes. Body rhythms did not achieve complete adjustment within the pre-bedrest period. Synchronization during HDT varied from 1-day for Na excretion to 7 days for melatonin (6-OHMS). Post-bedrest the time shift was reversed by a 7-hr delay within two days. Satisfactory resynchronization required 3 days for Na to 5 days for BT. 6-OHMS rhythm remained unsynchronized at the end of the study. **Conclusion:** Pre-mission adaptation similar to that used in this study will not achieve acceptable synchronization with target shiftwork schedules and will be associated with rhythm disturbances lasting longer than expected. Under operational conditions when the pre-mission schedule cannot be strictly followed as under laboratory control, the situation could worsen and the circadian system of astronauts may lengthen and become more destabilized than in our subjects.

OPTICOGRAVIC NERVE: ANATOMIC CONSIDERATIONS FOR A CENTRAL NERVOUS SYSTEM (CNS) / +Gz-STRESS SENSOR. B.S. Shender*, J.E. Whinnery*. Aerial Combat Maneuvering Enhancement Laboratory, NAVAIRDEVEN, Warminster, PA 18974-5000

INTRODUCTION: To understand how the CNS protects itself against +Gz-stress, the anatomic location of key neurologic and vascular structures at eye-level must be known. **METHODS:** Cadaver sections of CNS and vascular structures were analyzed with respect to the hydrostatic theory of +Gz-stress and neurophysiologic theory of G-LOC. **DISCUSSION:** Transverse sections 0.5 to 1.5cm above the orbitomeatal line reveal a transition from pons to midbrain, and contain the Reticular formation, Internal carotid, Ophthalmic, and Basilar arteries and a portion of the Circle of Willis (CoW) about the Optic nerves (OpN). OpN, by structure and development, are considered as a prolongation of the brain, unlike ordinary cranial nerves. Also, by virtue of their position, the tone of CoW vessels may impact on OpN function. The brain is protected from +Gz-stress both anatomically (by the skull and the pressure compensation provided by the cerebrospinal fluid, CSF) and physiologically (cardiovascular reflexes and functional buffer period, FBP). Compared to the rest of the CNS, the eye has a similar tissue structure, about the same FBP, 15-20 torr greater pressure (intraocular, IOP) and is not protected by CSF. Under +Gz-stress, the location in the brain where perfusion pressure falls sufficiently to alter vision but not cause G-LOC corresponds to a region somewhat higher than eye-level. The above theories, OpN structure, IOP and lack of CSF support endow the eye with a unique capability to be affected by +Gz prior to the rest of the CNS. This establishes the eye as an early warning visual and +Gz sensor as part of an integrated CNS protective mechanism, which includes G-LOC, pressor and muscular components. As such, the Optic nerve could more appropriately be considered as the "Opticogracic" nerve.

AN INVESTIGATION OF MIDDLE CEREBRAL ARTERY BLOOD FLOW VELOCITY AND ARTERIAL OXYGEN SATURATION UNDER SUSTAINED POSTIVE Gz. S. L. Johnston*, L.D. Tripp* and D.W. Repperger*. Department of Aerospace Medicine, Wright State University, Dayton, Ohio 45401.

Introduction. The purpose of this study is to evaluate and compare the physiologic parameters of middle cerebral artery blood flow and eye level oxygen saturation with peripheral light loss in sustained +Gz gravitational forces. **METHODS.** This experiment was conducted with the Dynamic Environment Simulator (DES) at Wright Patterson Air Force Base. Seven subjects, three women and four men, were tested in the advanced prototype retrograde inflation anti-G suit (RiAGS) and standard CSU 3B/P anti-G suit. The subjects were instrumented with an Eden Medical transcranial doppler (TCD), and a Nellcor pulse oximeter. Middle cerebral artery blood flow velocity and eye level oxygen saturation were measured during 4.5 to 7 Gz endurance runs on the DES. End points of endurance were peripheral light loss to a 60° cone, graying, and fatigue. **RESULTS.** Middle cerebral artery blood flow was maintained in all subjects during sustained Gz. However, O2 saturation showed a linear degradation until peripheral light loss or pre-GLOC conditions. **CONCLUSIONS.** In sustained Gz the pulmonary system (due to ventilation-perfusion mismatch and shunting) may be the limiting physiologic component in pre-GLOC, with the percent oxygen saturation of the blood reaching the cerebral circulation being a critical factor. Therefore, maintaining adequate blood flow to the cerebral circulation alone is not sufficient in developing countermeasures to optimize G-tolerance and preventing and/or warning of impending GLOC in sustained fighter aircraft combat maneuvers.

ASSESSMENT OF A PHYSIOLOGICAL MODEL OF G STRESS IN THE OPHTHALMIC ARTERY PRESSURE. A. Gonzalez and F. Rios*. Biophysics and Bioengineering Lab, Faculty of Medicine, Univ. of Barcelona and SAF Aeromedical Center (C.I.M.A.). Arturo Soria 82. 28027 Madrid. SPAIN.

INTRODUCTION. The purpose of this work is to provide a complimentary method, to assess the tolerance for +Gz acceleration using a digital simulation model, concerning the visual effects induced by the caudalward shifting of blood volume. A parametric model of the cardiocirculatory system is developed to predict the effects of high sustained acceleration (HSA) in the retinal flow. **METHOD.** In previous studies it was demonstrated that the model was sufficiently validated including a cardiac control and it was susceptible to gravitational stress modification. The computer model shows 8 segments and includes variations in pressure of the ophthalmic circulation under high G onset rate. Each segment is defined by concentrated parameters: resistance to flow, elastance of the vessel walls and blood inertia. **RESULTS.** The variations of ophthalmic pressure under + Gz from 1 to 8 G's and selected onset rate at 2,4,6,8 and 12 G's/sec shows black out at 3,2,1,25,1 and less than 1 sec respectively, and pressure below 20 mmHg. **CONCLUSIONS.** Tolerance to positive acceleration in a craneocaudal direction by a computer model constitutes a practical way to optimize the HSA in a lab.

EFFECT OF HYPOXIA AND HYPEROXIA ON +Gz-DURATION TOLERANCE. E.L. Besch*, J.F. Wiegman*, T.E. Nesthus*, A.R. Shahed and P.M. Werchan*. Flight Motion Effects Branch, Crew Technology Division, Armstrong Laboratory, Brooks AFB, TX and KRUG Life Sciences, San Antonio, TX 78235-5000.

INTRODUCTION: While available information suggests the metabolic basis for tolerance to high sustained G (HSG) is primarily anaerobic capacity and the ability of the body to use that capacity, little is known about the role of aerobic metabolism and its influence on +Gz-duration time. Understanding that role is necessary to determine the importance of supplemental oxygen for operational use. **METHODS:** Utilizing the Armstrong Laboratory (Brooks AFB) Centrifuge, 8 human subjects were exposed to the +4.5 to 7.0Gz simulated aerial combat maneuver (SACM) until fatigued, light loss criteria were reached, or protocol/medical reasons terminated the centrifuge run. These runs were repeated, on 6 different days, with the subjects breathing gas mixtures containing different concentrations of oxygen ranging between 12% to 60%. Blood oxygen saturation (SaO2) and heart rate were monitored continuously and blood lactates sampled periodically during all centrifuge exposures. **RESULTS:** A positive relationship between +Gz-duration times and inspired oxygen (FiO2) was detected in subjects breathing 12% to 20% O2 gas mixtures; no change in duration time was detected between the 20% and 60% FiO2 groups. Although fatigue and light loss were the end points of interest, only about 50% of the centrifuge runs were terminated for those reasons. Heart rate was negatively related and SaO2 positively related to FiO2. SACM resulted in increased heart rates but decreased SaO2; these SACM effects were additive to effects of FiO2. A positive relationship was detected between peak blood lactates and SACM duration time. **CONCLUSION:** Whereas +Gz-duration is limited by reduced SaO2, it may not be enhanced by hyperoxia.

COMPARISON OF THE HYPOXIC AND HYPEROXIC RESPONSE TO MAXIMAL ANAEROBIC EXERCISE AND SUSTAINED +Gz EXPOSURE. J.F. Wiegman*, E.L. Besch*, T.E. Nesthus*, A.R. Shahed and P.M. Werchan*. Flight Motion Effects Branch, Crew Technology Division, Armstrong Laboratory, Brooks AFB and KRUG Life Sciences, San Antonio, TX 78235-5000.

INTRODUCTION. While it is generally accepted that +Gz-duration tolerance is primarily an anaerobic activity, the degree of aerobic involvement has not been successfully quantified. On the other hand, the Wingate Anaerobic Test (WATS), an exercise task directly related to a simulated aerial combat maneuver (SACM) centrifuge profile, has been shown to use approximately 85% anaerobic and 15% aerobic resources. The purpose of this study was to compare the physiologic response to WATS with that of the SACM during hyperoxia, normoxia, and hypoxia. **METHODS.** Following WATS and SACM training, subjects (N=7) performed either WATS or SACM while exposed, in random order and with 48h between tests, to either hyperoxia (60% inspired oxygen (FiO2)), normoxia (20% O2) or hypoxia (18,16,14,12% O2). Heart rate and blood oxygen saturation (SaO2) were recorded continuously. Blood was sampled via fingerprick for lactate determination pre- and post-gas (i.e., controls), post warm-up, and at 3 intervals following WATS and SACM. **RESULTS.** The level of inspired oxygen was directly related to maximum heart rate during SACM, but showed no relationship with maximum heart rate during WATS. While blood lactate level at 3-min post-SACM was related to FiO2, post-WATS blood lactate level did not appear to be influenced by inspired oxygen. SACM duration was significantly affected by FiO2. A significant FiO2 effect (p<.05) was also indicated for WATS power values; however, post-hoc comparison of means revealed that the effect on mean power was due to the 14% O2 exposure (14,16,18,20,60%). Five of 7 subjects were unable to initiate the WATS at 12% O2 due to an SaO2 ≤ 60 during warm-up (limitation of protocol). Blood oxygen saturation was significantly altered (p<.05) as a result of FiO2 during both WATS and SACM. **CONCLUSION.** Exposure to SACM may present a stressor which includes an aerobic component that may be greater than that previously reported for the WATS.

PHYSIOLOGICAL COMPARISONS BETWEEN SUBJECTS IN THE FORWARD LEANING AND UPRIGHT POSTURES DURING HIGH Gz CENTRIFUGE TESTS. Wei Li, J.W. Frazier, C. B. Monson, J. 1. Aerospace Medicine, Wright State University, Dayton, OH 45401-0927; 2. Armstrong Laboratory, WPAFB, Dayton, OH 45433; 3. Rockwell International Corporation, Los Angeles, CA 90009

INTRODUCTION. Leaning forward in an aircraft seat changes the vectors of accelerative force such that the hydrostatic heart-eye column may be less affected. The force vector changes from one vector primarily along the head-to-foot axis (+Gz) to one with a significant component in the back-to-chest axis (-Gx), a direction more tolerable to humans. This paper compared physiological data from subjects leaning forward or upright during high G exposures on a centrifuge. **METHODS.** Seven subjects between the ages of 27 and 40 (mean age 30.7 years) underwent a +5Gz to 9Gz Simulated Aerial Combat Maneuver (SACM) with 10 second plateaus at 5G and 9G and a 0.5 Gz/sec onset rate. Data recorded included ECG, SAO2, and endurance time-at-G. Each subject ran the SACM profile twice, once while leaning forward approximately 24 degree and once while upright. Each profile was run on separate days. **RESULTS.** For all subjects, while forward leaning and upright, HR averaged 144 and 171, respectively, during the exposures to 9Gz; SAO2 averaged 89.6% and 91.0% and G-tolerance time were 138.0 seconds and 74.7 seconds, approximately 85% higher in the forward-leaning posture. These values were significantly different (P<0.001). **CONCLUSION.** The increased SACM endurance time and the lower HR in the forward lean position demonstrate that subjects using forward leaning have greater Gz tolerance than when in the full upright posture.

DEVELOPMENTAL TEST AND EVALUATION OF THE CIVIL RESERVE AIRFLEET AEROMEDICAL EVACUATION SHIPSET (CRAF-AESS). L. Brickley*. Human Systems Program Office, Brooks AFB, TX 78235.

INTRODUCTION. The CRAF-AESS concept is to design a reconfiguration kit to convert commercial Boeing 767 and McDonald Douglas 80-series aircraft for aeromedical evacuation. The 767 will augment strategic evacuation of casualties, thus freeing C-141's to carry war fighting supplies. In response to an urgent HQMAC requirement, the CRAF-AESS development program was accelerated to produce 10 kits in support of Operation Desert Storm. An aggressive agenda was executed to manage/perform development test and production at three times the normal timetable. **METHODS.** Human Systems Program Office personnel were deployed to subcontractors and to the contractor to expedite engineering changes and witness/approve testing. Contracting and funding issues were fine tuned. Component qualification testing on each of the three major subsystems was performed, followed by hangar floor testing of the integrated subsystems. The kit was installed on an aircraft, and two flight tests were flown. **RESULTS.** The 767 CRAF-AESS was demonstrated to be safe and effective. The FAA issued a flying certificate, which then allowed HQMAC to fly an Operational Test and Evaluation flight. **CONCLUSION.** CRAF-AESS is capable of providing casualties excellent medical care if the need arises in the future.

OPERATIONAL TEST AND EVALUATION OF THE CIVIL RESERVE AIRFLEET AEROMEDICAL EVACUATION SHIPSET (CRAF-AESS) AND AEROMEDICAL EVACUATION CREWMEMBER (AECM) TRAINING REQUIREMENTS. C. TUPPER*. Headquarters, Military Airlift Command (MAC), Aeromedical Evacuation Systems and Equipment Branch, Scott AFB, IL 62225-5001.

INTRODUCTION. CRAF-AESS utilizes civilian airframes to transport DoD patients in contingencies when military airlift assets are required for other operations. In March 1991, a commercial Boeing 767-300 was configured with 111 litter positions and 28 ambulatory seats and flew test flights with 96 simulated patients and test personnel onboard. This operational test was conducted to determine the effectiveness and suitability of the system and to collect the data necessary to make the final production decisions.

METHODS. Development of CRAF-AESS was a five year project. Two flight tests were performed using AECMs from operational active duty and Air Reserve Component (ARC) units to test nine critical operational issues identified by the USAF Airlift Center (USAFALCENT). **RESULTS.** The test demonstrated that AECMs can use the B-767 CRAF-AESS successfully and provide safe in-flight care to a large number of patients. However, AECMs expressed concern that training prior to the flight would have increased their confidence and ability to perform with greater efficiency on the B-767.

CONCLUSION. The Boeing 767 CRAF-AESS provides the capability to reduce dependence on the C-17A, C-141B and other USAF cargo aircraft. CRAF-AESS provides safe and expeditious movement of patients in a contingency operation. Proper training of AECMs will assure minimal transition time from military to civilian airframes.

DEVELOPMENT AND EVALUATION OF AEROMEDICAL EVACUATION EQUIPMENT SECURING DEVICES. T.E. Philbeck, Jr., T.W. Waters, and R.J. Knecht*, Armstrong Laboratory, Brooks AFB, TX 78235-5000.

INTRODUCTION. The USAF aeromedical evacuation system has a large inventory of medical equipment items for use on aeromedical aircraft. The items are designed to be secured to the NATO litter pole, but will not readily secure to anything else on the aircraft. Aeromedical Research personnel have designed four separate devices to safely secure some of the medical equipment items within the aircraft. **METHODS.** The devices were conceived by aeromedical personnel, and constructed by the Brooks AFB Fabrication Shop. Test procedures were developed that covered safety, function, and human factors. Function was verified by vibration testing, form and fit on aeromedical aircraft mockups, and airborne feasibility evaluations. **RESULTS.** The Aeromedical Equipment Pole and the Waters Bracket were effective and safe devices for securing several aeromedical equipment items, including the Biochem 1040A pulse oximeter, MTP 1001a infusion pump, and the MiniOX III oxygen monitor. The Waters Shelf was effective for securing the same items; also the Impact 308M portable aspirator, the Propaq 106 vital signs monitor, and Nellcor N-100 pulse oximeter. The Horton Bracket was effective for securing the IMED 928 infusion pump, the MiniOX III oxygen monitor, and the Baby Bird infant ventilator. **CONCLUSIONS.** All four devices, which at present require local production, are safe effective devices for securing aeromedical evacuation equipment aboard the C-9, C-130, and C-141 aircraft.

THE DEVELOPMENT, LABORATORY TESTING AND FIELD TESTING OF A HEAD COOLING DEVICE FOR THE RELIEF OF HEAT STRESS IN THE WORKING ENVIRONMENT. *M.F. Foley, **M.J. Antunano and *M.A. Orzech. *Armstrong Laboratory, Wright-Patterson AFB OH 45433 and **Wright State University, Dayton OH 45435.

INTRODUCTION. The human head is an excellent site for removing heat from the body. It is an alternative for protecting people against heat exposure. **METHODS.** A new, moderately priced, totally self-contained, portable, reusable head cooling device with no power packs or other encumbrances was developed for this purpose. Ten males, aged 27-37, participated in the laboratory portion of this study. Each subject performed two tests of one hour duration in a climatic chamber. One test was performed with head cooling, the other test without head cooling. The field test portion of the study utilized subjects working in hot environments, including flight line personnel, steam fitters, fire fighters, and foundry workers. **RESULTS.** Head cooling reduced core temperature, heart rate, mean upper body temperature, and heart workload in the laboratory subjects and increased heat tolerance and subjective comfort in the field test subjects. **CONCLUSION.** Head cooling is a useful, safe, inexpensive alternative for reducing strain during physical work in the heat.

PROBLEMS ENCOUNTERED IN TRANSPORTING "DO NOT RESUSCITATE" (DNR) PATIENTS. N.M. BOSS.* 57th AES Scott AFB, IL 62225-5436.

INTRODUCTION. The routine airevac (A/E) of DNR patients poses numerous legal questions. The 57th AES has seen an increase in the number of these patients. The closure of many military installations will no doubt exacerbate an already troubling situation, due at least in part to a higher reliance on the A/E system from civilian health agencies. This presentation will review current regulations and focus on several major problems, including living wills, encountered in assuring all legal documentation is being completed prior to transport of DNR patients. In addition, several solutions will be explored, including a proposed draft of a standardized DNR form. **METHODS.** A slide presentation showing: 1) references of current policies, 2) identification of problems encountered, 3) statistical analysis of QA indicators used with DNR patients, 4) solution options, 5) proposed DNR form. **RESULTS.** Identification of inconsistencies in legal documentation, together with confusion of the part of patients and family members has led to the attempted development of standardized policies and procedures for the treatment of DNR patients in the A/E system. **CONCLUSION.** This presentation will discuss the many problems faced in the transport and treatment of the DNR patient, particularly while in the A/E system. An increased awareness on the part of caregivers will facilitate the upholding of legal standards and promote continued quality patient care.

TITLE: CLINICAL STRESSORS AND THEIR EFFECT ON NURSES IN THE EMERGENCY CARE ENVIRONMENT. Major S.A. Wright*, 5th Medical Group Hospital, Minot AFB ND 58705-5024.

INTRODUCTION: Clinical events, such as the death of a co-worker, death after prolonged resuscitation, major trauma incidents, multiple casualties, and caring for badly burned patients are clinical realities in the emergency care environment. These events represent clinical situations that expose nurses to the tragedy of human suffering and death. A nationwide study was conducted to 1) determine the stress responses nurses in the emergency setting experienced when exposed to these clinical events, 2) determine the intensity of stress experienced, and 3) identify commonly used coping strategies. **METHOD:** A questionnaire, "Critical Incident Stress and the Emergency Nurse" was sent to 500 members of the Emergency Nurses Association. **RESULTS:** Every event studied caused stress in emergency nurses. Greater than 90 percent of the subjects reported stress responses to these events. Coping strategies used represented methods with long term benefits of stress reduction. **CONCLUSION:** The results of this study will be applied to the military nurse working within the battlefield environment. Recognition of stress related to clinical events commonly seen in the emergency care area such as the battlefield setting is the first step toward the effective management of this occupational hazard. Identification of common responses, intensity of stress experienced, and common coping strategies is useful information to be used for the promotion of health and wellness of the military nurse.

Laboratory Electromyographic Study of Recovery From Simulated Straining Maneuvers L. P. Krock* and M. W. Cornwall*. Crew Technology Division, Armstrong Laboratory, Brooks AFB, Texas, and *Department of Physical Therapy, Northern Arizona University, Flagstaff, Arizona.

Introduction: The purpose of this study was to investigate the recovery response of the thigh muscle to laboratory simulation of two successive aerial combat maneuvers. **Methods:** Twenty male volunteers performed 10 s alternating isometric leg contractions at 20% and 50% of pre-determined maximum voluntary contraction, until exhausted. Following the first work bout, subjects were assigned (counterbalanced) to one of six recovery intervals (10, 20, 40, 60, 120 and 240 mins). Immediately after the rest interval, subjects repeated the exhaustive work task. Surface electromyography was recorded from the quadriceps femoris muscle of the subject's dominant side. Normalized root mean squares (RMS) were calculated for each contraction level during the work bout and analyzed for differences within and between work bouts and among recovery intervals. **Results:** Post-recovery endurance times (ET) did not achieve pre-recovery levels, although, exercise ET was 91% recovered after 60 min. Mean normalized RMS increased (15.04 to 31.45 %) from beginning to end of the work bout. Differences were also observed in the myoelectric signal for amplitude at the two tension levels. **Conclusion:** This laboratory simulation suggests high performance jet pilots will have reduced capability performing anti-G straining maneuvers during multiple air-to-air engagements.

CARDIO-VASCULAR COMPENSATION IN A COMPLEX +Gz ENVIRONMENT. N. Neblett, J.P. Cammarota*, & J.E. Whinnery*. USNA, Annapolis, MD, ACME LABS, Naval Air Development Center, Warminster, & National Guard Bureau, Andrews AFB, MD..

INTRODUCTION. The body of knowledge that is available to evaluate human tolerance to +Gz was developed through experiments on human centrifuges using simple acceleration profiles. These data are not sufficient to predict the effects of complex +Gz time histories such as those encountered during aerial combat maneuvering (ACM). In order to gain some insight into the physiologic effects of the more dynamic acceleration environment, complex centrifuge open-loop testing profiles were developed. **METHODS.** Three compound acceleration profiles were developed that included combinations of rapid (ROR) and gradual (GOR) onset rate profiles. These profiles were designed to give the subject a "G preload" immediately prior to the more traditional GOR or ROR centrifuge exposures. Plateau levels were changeable in increments of 0.25Gz. The endpoint for the acceleration exposure was 60° or greater peripheral light loss sustained for three seconds, or 100% central light loss (Blackout). The subjects were in an upright seat, did not wear an anti-G suit, and did not perform an anti-G straining maneuver. The study involved 21 volunteer subjects who completed over 900 exposures (most exposures went to a light loss endpoint). **RESULTS.** The ROR preload had little effect on the G level tolerance to the GOR. The time to lightloss on the ROR to plateau segment was dependent on the level of the GOR preload segment. A moderate preload (with respect to the ROR plateau level) increased the time to lightloss as compared to low and high preload levels. Preload +Gz levels that varied by as little as 0.25Gz had different effects on the human response to the ROR segment. **CONCLUSIONS.** The profiles developed, while not nearly as dynamic as an ACM environment, reveal the dynamic complexities of the physiologic response to acceleration stress in a way not possible with simple ROR or GOR profiles.

INDICATIONS OF DIFFERENCES IN NEUROLOGIC TOLERANCE IN A COMPLEX +Gz ENVIRONMENT. J.P. Cammarota*, N. Neblett, & J.E. Whinnery*. ACME LABS, NADC, Warminster PA, USNA, Annapolis, MD & National Guard Bureau, Andrews AFB.

INTRODUCTION. The body of knowledge that is available to evaluate human tolerance to +Gz was developed through experiments on human centrifuges using simple acceleration profiles. These data are not sufficient to predict the effects of complex +Gz time histories such as those encountered during aerial combat maneuvering (ACM). In order to gain some insight into the physiologic effects of the more dynamic acceleration environment, complex centrifuge open-loop testing profiles were developed. **METHODS.** Three compound +Gz profiles were developed that included combinations of rapid (ROR) and gradual (GOR) onset rate profiles. These profiles were designed to give the subject a "G preload" immediately prior to the more traditional GOR or ROR centrifuge exposures. Plateau levels were changeable in increments of 0.25Gz. The endpoint for the acceleration exposure was 60° or greater peripheral light loss (PLL) sustained for three seconds, or 100% central light loss (Blackout). The subjects were in an upright seat, did not wear an anti-G suit, and did not perform an anti-G straining maneuver. The study involved 21 volunteer subjects who completed over 900 exposures (most exposures went to a light loss endpoint). **RESULTS.** The compound profiles that were used brought out marked differences in the subjects' ability to tolerate the +Gz stress. Some subjects had sub-60° sustained PLL for long periods of time, while others rapidly progressed to blackout as soon as there was any indication of PLL. In subjects exhibiting steady-state light loss, we were able to consistently effect the quality of light loss at the endpoint. By manipulation of the preload plateau levels, light loss could be changed from strictly peripheral to an overall greyout. **CONCLUSIONS.** By using more complex profiles on the human centrifuge, greater insight is gained into the spectrum of effects of acceleration on the central nervous system.

EVALUATION OF ADVANCED LIFE SUPPORT SUIT CONCEPTS FOR G PROTECTION. P. E. Whitley. Aerial Combat Maneuvering Enhancement Laboratory, NAVAIRDEVCEEN, Warminster, PA 18974-5000.

INTRODUCTION. As part of the Advanced Integrated Life Support System Program, thirteen advanced concepts for life support were evaluated on the centrifuge for G protection. All systems incorporated pressure breathing for G (PBG) and varying degrees of body coverage. **METHODS.** Seven experienced subjects were exposed to a Gradual Onset Rate (GOR) and Rapid Onset Rate (ROR) runs with and without an anti-G straining maneuver. The ROR duration was 30 seconds and maximum G for both runs was 10 Gz. The endpoint was 60° of peripheral vision loss plus an ROR time duration less than 15 seconds. **RESULTS.** The largest single factor for increased G tolerance was the increase in lower body coverage. The lowest mean non-straining tolerance with current anti-G suits was 5.7 G while increasing to total coverage asymptotically approached 8.0 G. Straining tolerance values were truncated by the 10 Gz limit. A utility curve for increased lower body coverage was achieved. Many runs were prematurely stopped for arm pain in concepts without arm coverage. Coverage of the arms, hands, and feet did not significantly increase visual tolerance but enhanced tolerance to pain during G while decreasing subjective mobility and comfort. Two subjects suffered lower rib injuries attributed to increased abdominal bladder coverage. **CONCLUSIONS.** Coverage approaching the full pressure suit is not required for maximum non-straining G tolerance. The ideal lower body coverage has been determined. Compatible arm pain relief is required and is being pursued. Rib injury is possible with expanded abdominal bladder coverage.

ARM PAIN ASSOCIATED WITH POSITIVE PRESSURE BREATHING FOR +Gz ACCELERATION PROTECTION. ARJ Prior* and A Tozer. Royal Air Force, Institute of Aviation Medicine, Farnborough, Hampshire. GU14 6SZ. UK.

INTRODUCTION. Pain in the arms, whilst positive pressure breathing under high G (PBG), has been noted in several recent studies. The pain is particularly severe in subjects exposed to +Gz acceleration in a human centrifuge and whose arms are positioned below heart level, but it is not restricted to these conditions. It has also been noted in the centrifuge with the arms supported as in the F16 cockpit, and during air combat in the Hawk aircraft where, in some aircrew, the pain was sufficiently severe to prevent further high G excursions. Studies have been carried out to investigate the cause of the arm pain. **METHODS.** Subjects were each exposed to +Gz accelerations in the range 2.8 - 9.0 Gz, at a 1 G/s onset rate for 15 s at peak G, seated in the RAF IAM human centrifuge, with the forearms 23cm below heart level, under the following conditions: (1) unprotected, (2) anti-G trousers, RAF Mk IV (AGT), (3) AGT+PBG, (4) AGT+PBG plus chest counterpressure waistcoat (CCP), (5) full coverage anti-G trousers (FAGT), (6) FAGT+PBG, (7) FAGT+PBG+CCP. A PBG schedule of 13 mmHg/G, with a 2Gz cut-in, was used. In addition, for condition (7), schedules of 8 mmHg/G and 10.5 mmHg/G were also used. Forearm venous pressure, forearm blood volume, mask pressure, anti-G trouser pressure and subjective rating of arm pain were recorded. **RESULTS.** The subjective appreciation of arm pain correlated with forearm venous pressure ($r=0.86$), at pressures in excess of approximately 150 mmHg at which the pain was first noticed. For any given condition, the venous pressure was linearly related to +Gz acceleration and, during PBG conditions, to the level of applied mask pressure. The venous pressure was not influenced by the presence of chest counterpressure or by the extent of anti-G trouser coverage. **CONCLUSIONS.** In aircraft cockpits configured with stick and throttle such that the pilot's arms are normally placed below heart level, a reduction in the severity of arm pain might be achieved by a PBG schedule resulting in the lowest possible mask pressure compatible with adequate enhanced G protection. Full, or extended coverage anti-G trousers should be retained.

THE RELATIONSHIP BETWEEN MUSCLE STRENGTH COORDINATION TRAINING UNDER THE WEIGHT-LIFTING EXERCISES AND THE G-TOLERANCE

X.Wang Z.H. Yao F.M. Peng H.C. Zhang L. Ma S.W. Wang J.P. Gao
Institute of Aviation Medicine AF, China

INTRODUCTION. The G-tolerance augmenting effect of weight-lifting training (WLT) has been well documented. This study is to demonstrate muscle strength coordination training (MSCT) can still enhance its effect. **METHODS.** 146 pilots were divided into 3 groups: Exp. group 1 (37 pilots underwent WLT and MSCT), Exp. group 2 (17 pilots, MSCT only) and control group (42 pilots, WLT only). MSCT was completed on a special MSCT device. The pressure of cuff bladders wrapped on shank, thigh and abdomen and the Blood pressure as test indicators were measured during WLT and MSCT. The training period was consisted of 3 months for each group. The final effect was examined on the Human Centrifuge. **RESULTS.** 1. The value of b.p. during making muscle strength alone between three groups, as compared with of quiet condition is increased on 71.0 ± 7.6 , 54.2 ± 5.0 , 30.0 ± 7.1 mmHg respectively ($P < 0.01$); 2. The value of b.p. during making anti-G maneuver, as compared with of quiet condition is increased on 94.1 ± 9.2 , 72.1 ± 9.9 , 51.0 ± 13.4 mmHg ($P < 0.001$) respectively; 3. The pressure of cuff bladders on the shank, thigh and abdomen of the pilots (16) before MSCT was measured as 57.0 ± 4.2 , 66.7 ± 14.1 , 100.0 ± 22.5 mmHg respectively, through MSCT (10 Pilots), as 83.0 ± 4.8 , 110.0 ± 11.1 , 140.0 ± 10.9 mmHg respectively, the T-test shows, there is significant difference between them ($P < 0.001$); 4. These results were confirmed by centrifuge runs; the G-tolerance with support of anti-G maneuver, but without a G-suit the pilots of Exp. group 1 passed on 8-8.5 G, with support of anti-G maneuver and G-suit passed 9.0 G, 10 sec, without visual disturbance. **CONCLUSION.** The MSCT can bring a 2-3 G gain in G-tolerance over that by WLT alone, the MSCT must be taken for enhancing the G-tolerance of pilots, special on high performance aircraft.

PREVALENCE OF OVER EXERTION DURING SUBMAXIMAL EXERCISE TESTS USING 85% OF AGE-PREDICTED MAXIMAL HEART RATE. L. Naftzger*, LA Kaminsky, MH Whaley, GB Dwyer, SC Glass, & LH Getchell. Ball State University, Muncie, IN 47306

INTRODUCTION. The 4th edition of the *Guidelines for Exercise Testing and Prescription* supports increased use of submaximal exercise testing "to assess physical fitness (and) to provide the basis for exercise prescription" (p. 4). Many of these tests are performed with minimal monitoring and use 85% of age-predicted maximal heart rate ($\text{pHR}_{\text{max}} = 220 - \text{age}$) as an endpoint. Due to the large standard error (± 15 bpm) associated with pHR_{max} , this endpoint may represent a wide range of actual relative efforts. The purpose of this investigation was to assess the likelihood of near maximal exertion ($\text{HR} \geq 90\%$ and $\geq 95\%$ of actual HR_{max}) using 85% pHR_{max} as termination criteria for exercise testing. **METHODS.** Data were analyzed from graded treadmill exercise tests (to volitional fatigue) in 1207 men (41.6 \pm 10 yrs) and 736 women (41.4 \pm 11 yrs) who participated in an adult exercise program. All subjects: 1) were not taking medications known to attenuate the heart rate response to exercise, 2) achieved $\text{RER} > 1.10$, and 3) did not exhibit an abnormal response resulting in a premature endpoint for the test. Actual maximal HR (MHR) was determined from an ECG tracing. **RESULTS.** Using 85% of pHR_{max} , the prevalence rates of over exertion for younger and older age groups (ACSM Guidelines classification) were as follows:

	$\geq 90\%$	MHR (n, %)	$\geq 95\%$	MHR (n, %)
Men (≤ 40 yr) n=584	80	13.7%	12	2.1%
Men (> 40 yr) n=623	83	13.3%	23	3.7%
Women (≤ 50 yr) n=579	102	17.6%	29	5.0%
Women (> 50 yr) n=157	26	16.6%	9	5.7%

CONCLUSION. These data reveal that between 2.1-17.6% of exercise tests using the 85% pHR_{max} criteria may actually be near maximal efforts. This implies a safety concern due to limited monitoring. This suggests the need for identification of factors predictive of those whose true HR_{max} is significantly less than pHR_{max} .

STATE OF THE COMMAND. P.M. Moss *. 63rd AES, O'Hare, ARFF, IL. 60666

Within the past year changes have occurred in the Air Force at all levels which will impact the future of nursing. Desert Storm focused attention on the abilities of military nurses; and serves as a model for future military conflicts. It highlighted the accomplishments and shortcomings of Air Force nursing in all patient care arenas. Using Desert Storm as a live laboratory, this panel will discuss the changes required to meet future needs and conflicts and how these changes will affect Air Force Nursing. This panel is comprised of Command Nurses from Tactical Air, Strategic Air, Air Force Logistics, Air Force Systems and Military Airlift. These Nursing Leaders will deliver a short presentation on the changes occurring in their command and its impact on the future on nursing in the Air Force.

INTELLIGENCE EFFICIENCY TEST FOR PILOT CANDIDATES SELECTION

G. X. Li, Y. Guo, J. J. Zhou, Li, Y. X. M. Meng, Q. Li
Institute of Aviation Medicine AF, Beijing, China

INTRODUCTION. In the investigations in the flight training of the Air Force of China, we found that intelligence efficiency (incorporating psychomotor performance and information processing capability), behavior controlling ability (mainly emotion controlling) and suitable personality were essential in successful accomplishment of flight training. This research was to develop and validate a computerized battery of cognitive and psychomotor test named Intelligence Efficiency Test (IET). **METHODS.** A computerized dual-task battery, to be performed simultaneously, 7 min for exercising, 15 min for testing, was administered to 388 male student pilots (aged 18-22 yr.). One task was a two-dimensional compensatory tracking and the other, digit cancelling task. The degree of difficulty could be automatically adjusted to adapt the dexterity of the examinee and his score and limit of performance displayed in real time. The scoring was based on 6 criteria selected from 22 obtained from cluster analysis. Its validity was evaluated by correlating the score with flying score from flight instructor. **RESULTS.** Concurrent validity coefficient (VC) was 0.36 and predictive VC, 0.34. Total coincidence rate was 83%. The cutoff point was determined at an elimination rate 30%, then 52% of the washouts and 18% of those passing the flying training would have been rejected. The test has been already spread and applied in student pilot screening of 9144 candidates. **CONCLUSION.** IET is quite satisfactory for psychological screening of pilot cadet.

PILOTS SELECTION: BEHAVIORAL MEASURES AS PREDICTIVE OF FLIGHT TRAININGS OUTCOME. VALIDATION STUDY ON 136 APPLICANTS.

G. Arduino, N. Cresci, S. Izzo, R. Mosticoni. Comando Generale Scuole A.M., Guidonia A.F.B., I-00012 ITALY

INTRODUCTION. Due to safety and costs, training outcome prediction is a relevant factor in pilots selection. Behavioral assessment is found as forecasting in predict the training outcome. A double-blind experiment was conducted to evaluate the predictive validity of behavior observations by means of a computerized setting (CASSIOPEA) based on the experimental behavior analysis. **METHOD.** CASSIOPEA is a Computer Aided Setting Screening Ideal v Observed Performance in Entry Assessment. Construct validation showed individual differences correlated with aviator skills. Before their trainings start, 136 I.A.F. pilot applicants performed in four CASSIOPEA settings producing behavioral measures about Problem Solving, S-R stability, Discriminative Learning, Distributed and Selective Attention. An ideal pilot behavior pattern was automatically detected and stored by the System for any applicant. After basic flight training, that pattern occurrence was cross validated with the effective outcome. **RESULTS.** Validity coefficients: Criterial correlation $\phi = .296$ ($p < .001$); Success occurrence agreement was 82.3% ($\kappa = .508$ and $p < .001$). **CONCLUSIONS.** Pilot applicants performing an high efficiency (80 pct) in problem solving, a reliable S-R correlation ($\phi = .222$) in discriminative tasks, and an effective sensitivity (ROC's $d' = 1.65$) in visual attention tasks, have a significative probability of success achievement in I.A.F. flight trainings.

PERFORMANCE OF COLOR-DEPENDENT TASKS OF AIR TRAFFIC CONTROL SPECIALISTS AS A FUNCTION OF TYPE AND DEGREE OF COLOR VISION DEFICIENCY. H.W. Mertens* and N.J. Milburn. FAA Civil Aeromedical Institute, P.O. Box 25082, Oklahoma City, OK, 73125.

INTRODUCTION: This study was designed to expand initial efforts to validate requirements for normal color vision in air traffic control (ATC) personnel. **METHOD:** An enlarged data base was developed involving 121 individuals with normal color vision, 31 simple and 44 extreme anomalous trichromats, and 48 dichromats; both protans and deuterans were included. Performance of subjects with normal color vision on a battery of ATC tasks that require color vision was compared with the performance of individuals in various classifications of color vision deficiency. Simulations of ATC color tasks concerned color coding in flight progress strips (at enroute centers), aircraft lights and Aviation Signal Light indicator (in tower operations), and color weather radar (at flight service stations and en route centers). **RESULTS:** Mean errors were significantly higher at every level (degree) of color vision deficiency than in normals. Approximately 6 percent of color deficient subjects were able to perform ATC color tasks without error. The six percent were all from the simple anomalous trichromat category; all extreme anomalous trichromats and dichromats were prone to error on ATC tasks. **CONCLUSION:** These findings provide support for the requirement of normal color vision in initial screening. Recommendations are discussed concerning secondary color vision screening that might be used to identify the few deficient who are able to perform ATC color-dependent tasks without error.

AN EVALUATION OF FIGHTER PILOT WORKLOAD(2)

Y. Kakimoto, * F. Tajima, S. Maruyama, S. Nishi, H. Tarui, * T. Kwaragi, A. Nakamura, * and Y. Nagasawa*
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INTRODUCTION. Following the presentation of 60th AsMA meeting, fighter pilot workload study has been carried out to add another type of aircraft, F4E and F1 and missions to F15 in the previous study through actual training flights. Based on the change of HR (beats/min), we compared with the change of NE/E (Norepinephrine/Epinephrine) ratio, cognitive demands, subjective fatigue and saliva cortisol level. **METHODS.** HR was recorded from F4E pilots (N=6) and F1 pilots (N=6) during flights continuously. Urine and saliva samples, CFF and subjective fatigue were collected before and post each flight. **RESULTS.** The order of efforts, cognitive demands and task difficulty was ACM, gunnery and GCI mission by questionnaires. HR changed accordance with these orders in average HR, 177.7% in ACM, 175.2% in gunnery and 162.4% in GCI mission. NE/E ratio was 2.6 in ACM, 2.9 in gunnery and 4.3 in GCI mission in post flight values. **CONCLUSION.** NE/E ratio was shown in the range 2.0- 4.0 which Fibiger, W (1986) explained the range correlated significantly with mental efforts. The indexes used in this study showed that high mental efforts were required in ACM and gunnery maneuvering corresponded with subjective rating. Further study is requested because the number of subjects and missions were limited in this study.

VALIDITY OF CLINICAL COLOR VISION TESTS FOR AIR TRAFFIC CONTROL SPECIALISTS. N.J. Milburn, and H.W. Mertens*. FAA Civil Aeromedical Institute, P.O. Box 25082, Oklahoma City, OK, 73125.

INTRODUCTION: An experiment on the relationship between clinical color vision screening test performance and performance on color-dependent tasks of Air Traffic Control Specialists (ATCSs) was replicated to expand the data base supporting the job-related validity of the screening tests. **METHOD:** The original experiment (n=108), and the replication (n=136) involved a total of 121 normal trichromats and 123 with varying degrees and types of color vision deficiency (anomaloscope classification). All 13 of the FAA-accepted color vision tests that are known to be in use were validated. The simulations of ATCS color tasks that served as validation criteria were flight progress strips (at en route centers), aircraft lights and the Aviation Signal Light indicator (ATC terminal operations), and color weather radar (flight service station and enroute center facilities). **RESULTS:** The validities (Kappa) of aeromedical screening tests ranged from 0.44 to 0.91 for prediction of error-free performance on all color dependent tasks. The aeromedical screening tests were generally acceptable in terms of selecting individuals who did not make errors, but several tests had undesirably high false alarm rates. **CONCLUSION:** The high job-related validity of several aeromedical screening tests was confirmed. Recommendations for improvement of color vision screening of ATCSs are discussed.

COMPARISON OF PERFORMANCE ON THE SHIPLEY INSTITUTE OF LIVING SCALE, AIR TRAFFIC CONTROL SPECIALIST SELECTION TEST AND FAA ACADEMY SCREEN. P.S. Della Rocca, N. Milburn, and H. Mertens*. Human Resources Research Division, FAA Civil Aeromedical Institute, Oklahoma City, OK 73125.

INTRODUCTION. This study was conducted to establish norms for ATCS personnel on a group test of intellectual functioning, the Shipley Institute of Living Scale (SILS), to screen subjects for future research on the effects of Air Traffic Control Specialist (ATCS) related stressors on complex task performance. The SILS provides both verbal (Vocabulary) and cognitive performance (Abstraction) measures of general intellectual functioning. The relationship between the SILS and performance of ATCSs in the FAA Academy Nonradar Screen Program (NSP) was also assessed. **METHODS.** ATCSs undergo a two-stage selection process: (a) the Office of Personnel Management (OPM) Air Traffic Control Specialist Battery and (b) the NSP, a nine-week performance-based screening course at the FAA Academy. The Shipley was administered to three entering groups of new hires (N=563) upon their arrival at the FAA Academy. SILS scores were converted to estimated WAIS-R Full Scale intelligence scores. The SILS measures were compared to scores (a) on the OPM selection battery and (b) in the NSP. **RESULTS.** SILS Total, Abstraction, and estimated WAIS-R scores were better predictors of NPS performance than were the SILS Vocabulary Subtest scores and OPM ratings. Moderate correlations were found between the SILS measures and final Academy score. ATCS applicants scored higher on the Abstraction Subtest than the Vocabulary Subtest. **CONCLUSIONS.** ATCSs tend to be above average in intelligence, and tests of cognitive performance tend to be better predictors of overall NPS performance than verbal measures. The normative data can serve as an effective screen for subjects involved in ATCS-related research.

CONTRIBUTIONS OF PERSONALITY MEASURES TO PREDICTING SUCCESS OF TRAINEES IN THE AIR TRAFFIC CONTROL NONRADAR SCREEN PROGRAM. D.J. Schroeder*, D. Broach, and W. Young. Human Resources Research Division, FAA Civil Aeromedical Institute, P.O. Box 25082, Oklahoma City, OK 73125.

INTRODUCTION. Reviews have consistently concluded that the validity of personality as a predictor of performance on the job or in training is low. However, Barrick and Mount's (1991) meta-analysis of personality and job performance studies based on the presence of the "big five" personality dimensions demonstrated the utility of that model in personnel selection and training. This study was designed to evaluate the utility of personality in predicting student success in the FAA's Air Traffic Control Nonradar Screen Program (NRSP), using a personality measure (NEO) that is based on the "big five" personality theory. **METHODS.** The NEO Personality Inventory and a Biographical Inventory were administered to 1,091 students at the time of their entry into the 9 week FAA Academy NRSP. Scores on the NEO scales and aptitude measures from the Office of Personnel selection battery were used to predict student success (NLCOMP). **RESULTS.** Students exhibited lower average scores in Neuroticism, higher average scores in Extroversion, Openness to Experience and Conscientiousness, and no difference in Agreeableness when compared to the normative sample. Correlations between the personality measures and NLCOMP were low, ranging from .007 for Anxiety to .092 for Fantasy. Despite the relatively low overall correlations, when used in a regression equation along with the aptitude measures, several of the personality measures proved to be useful predictors. This included excitement-seeking, fantasy, actions, and positive emotions. **CONCLUSIONS.** While the overall results were not entirely consistent with the predictions of Barrick and Mount (1991), they do offer some support for the role of personality variables in predicting initial success in the ATCS NRSP. Continued research is needed to determine if the same measures are predictive of success on the job.

Effects of Atropine and Sleep Deprivation on Human Performance. H.L. Williams & G.A. McLean*, Oklahoma Center for Alcohol and Drug-Related Studies, University of Oklahoma Health Sciences Center.

Introduction. Studies of human performance were conducted to determine the independent and combined effects of a 2mg Atropine dose and a night of Sleep Deprivation on information processing functions. **Methods.** The performance tasks included visual target identification and an auditory vigilance paradigm designed to examine signal detection abilities; a serially-staged oddity matching task compared effects on input/decision/output processing. **Results.** Atropine and sleep loss produced independent decrements in both visual and auditory signal detection efficiency, without effects on responsiveness. These effects were synergistic when they were combined. Similar decrements in input processing, without effects on decision and output processing, were also found in the oddity matching task after atropine and sleep deprivation. **Conclusion.** These treatments produce discrete, hyperadditive effects on information acquisition, leaving decision and response processes intact. Exposure of humans to either or (especially) both conditions should be avoided when human performance is heavily dependent on information acquisition.

POSTURAL EQUILIBRIUM TESTING OF AVIATORS: EVALUATION OF THE NEUROCOM® EQUITEST® SYSTEM FOR MODERATE POSTURAL DESEQUILIBRIUM. M-F. Laliberté¹, B.J. McGrath², K.A. Baylor², A.H. Rupert², F.E. Guedry³. ¹ Defence and Civil Institute of Environmental Medicine, North York, Ontario, Canada; ² M3M 3B9, ³ Naval Aerospace Research Laboratory, Pensacola, Florida, 32508-5700; ³ University of West Florida, Pensacola, Florida.

INTRODUCTION. Approximately 29% of aircrew report symptoms of Simulator Sickness (SS) following prolonged exposure to abnormal sensory cues found in modern flight simulators. Symptoms of SS can be classified into four main categories; general malaise, fatigue related, visual disturbances and postural disequilibrium. The purpose of this study was to evaluate the sensitivity of the NEUROCOM® EQUITEST® SYSTEM for assessing moderate levels of postural disequilibrium resulting from exposure to abnormal sensory information. The Equitest System is a device used for clinical assessment and examines the interaction of vestibular, visual and proprioceptive inputs on postural control. **METHODS.** Fifteen male Navy and Marine Corps pilot candidates were tested in two conditions (control and experimental) which were conducted on separate consecutive days (24 hrs interval minimum). The order of condition was randomized across days, and postural disequilibrium was induced using 50% ethyl alcohol at a dose of 1cc/lb of body weight. Subjects were assessed on the Equitest System using a modified testing protocol involving Sensory Organization Tests (SOT) and Motor Coordination Tests (MCT) with random order trials. **RESULTS.** All SOT scores showed significant differences between the control and experimental conditions. However, MCT latency scores showed significant increases with alcohol only in two of the six tests. **CONCLUSION.** For an aviator population, SOT evaluation provided by the Equitest appear to be effective in discriminating moderate postural disequilibrium. These results justify continued investigation to assess the applicability of the NEUROCOM® EQUITEST® SYSTEM as an operational device in the evaluation of SS.

CROSS-VALIDATION OF A DOSE EQUIVALENCY ALGORITHM: PREDICTING ALCOHOL CONCENTRATION FROM PERFORMANCE. Robert S. Kennedy*, Essex Corporation; William P. Dunlap, Tulane University; Robert L. Wilkes, Casper College; Gene G. Rugotzke, Wyoming Public Health Service.

INTRODUCTION. Toxic and controlled substances ingested before entering the workplace can render an individual unfit for duty. Bioassays of body fluids or hair clippings can establish the presence of these substances, but beg the question of whether operational performance will be degraded. A performance-based method would permit more direct assessment of fitness for duty, but performance test batteries need a context or standard for comparison of performance loss. Alcohol was examined for feasibility as this standard. **METHOD.** A series of metrically sound microcomputer-based tests were administered before, during, and after graded dosages of alcohol were applied in 24 subjects. The ascending and descending limbs of the alcohol concentration curves were followed and multiple regression analyses were calculated. **RESULTS.** Data collected in a previous experiment using only the descending limb were used to create a multivariate predictor equation of performance deficit. The algorithm was cross-validated to predict both ascending and descending limbs in the second sample ($p < .01$). **CONCLUSION.** Since this algorithm translates performance deficit directly into blood alcohol concentration and vice versa, a software program was written to permit selection of alcohol dose equivalency limitations. Such an algorithm will permit performance deficits on these tasks to be indexed to alcohol dosage and could be useful as a context for evaluating other agents and conditions.

THE EFFECTS OF HYPOXIA ON AUDITORY REACTION TIME AND P300 LATENCY. A.E. Lindeis* & B. Fowler. York University/ DCIEM, Toronto, Canada.

INTRODUCTION. The literature provides strong evidence that visual processing is slowed by hypoxia, but evidence regarding the effects of hypoxia on auditory processing is lacking. Therefore, the two purposes of this study were to evaluate the effects of hypoxia on auditory reaction time (RT) as a function of stimulus frequency, and to determine whether the event-related potential, P300, responds to hypoxia in a similar manner to RT. **METHODS.** Twelve well-trained subjects performed an auditory RT task in an oddball paradigm while EEG data were collected from three electrodes (Fz, Cz, Pz). In each condition, subjects were presented with 150 trials of a 50 ms tone burst that was either of high or low intensity. Subjects were tested at three different frequencies (500 Hz, 1000 Hz, 4000 Hz) and breathed two different gas mixtures (either air or a low oxygen gas mixture producing an SAO_2 of 65%). A prescribed level of accuracy was maintained throughout all conditions. P300 data were analyzed on a single trial basis. **RESULTS.** Auditory RT and P300 latency were slowed by hypoxia in a parallel manner at all three frequencies (overall slowing of RT, 32 ms $p \leq .01$; P300 latency (Cz & Pz), 32 ms $p \leq .0001$). P300 amplitude was not affected by hypoxia. **CONCLUSIONS.** Since P300 is thought to index only the time to evaluate a stimulus, these results suggest that hypoxia affects the stimulus evaluation stage of auditory processing, and they raise questions concerning the traditional view that audition is relatively resistant to hypoxia. Furthermore, the frequency dependent effects of hypoxia on auditory thresholds reported in the literature appear not to influence the processing of above-threshold stimuli.

A PROGRAM TO ADDRESS HUMAN FACTOR ISSUES RESULTING FROM A LABOUR DISPUTE. A. B. Zentner*, B. Hayward, N. Alston. Australian Airlines, Melbourne, Australia

INTRODUCTION. In recent years it has become clear that corporate factors contribute significantly to human factor incidents and accidents. Further research indicates that stresses induced in pilots during a labour dispute can significantly affect pilot performance. This paper reports on a Human Factors training program for pilots introduced by Australian Airlines to address the corporate Human Factors arising from a protracted labour dispute. **RESULTS.** Following a major industrial dispute in which almost all the 547 pilots resigned from the airline, Australian rebuilt its pilot workforce with a combination of re-hires and new hires from overseas, the military and General Aviation. A course for pilots and their spouses was built using models of decision making and communication styles together with group discussions of the labour dispute and its potential flight-safety impact. **CONCLUSION.** This variant of CRM training built a cohesive group from pilots of disparate backgrounds in a successful attempt to pre-empt human performance problems stemming from a stressful corporate environment.

THE NIGHT VISION GOGGLE EMERGENCY DETACHMENT SYSTEM

D.J. Schmidt
NAVAL AIR DEVELOPMENT CENTER

Aircrewman flying ejection seat aircraft with night vision goggles are subjected to a high risk of serious injury during ejection due to the additional torque on the neck produced by the offset center of gravity and acceleration forces during an ejection. The Naval Air Development Center has developed a method to separate the night vision goggles from the helmet during ejection. During the first quarter inch of seat movement, a switch mounted to the rear of the seat is closed allowing current to flow to an electro-ballistic actuator or the helmet. This actuator, during its one inch of travel, drives a plastic wedge down a track underneath the locking pin of the night vision goggles, releasing them from the helmet. Tests show that the night vision goggles are separated from the helmet within 25 milliseconds of the seat's first motion. Load cells mounted in the head and neck of Hybrid III dummies show that separation occurs before injurious loads are transmitted to the head and neck. THE NIGHT VISION GOGGLES EMERGENCY DETACHMENT SYSTEM has been through HERO testing as well as reliability testing. The system will be operational by the end of Fiscal Year 93.

CORRELATION BETWEEN SOCIOGRAM AND PSYCHOLOGICAL, LINGUISTIC AND OPERATIONAL VARIABLES IN EXPERIMENTAL CRM. H.O. Leimann-Patt(*), A. Campos Palacios. National Institute of Aerospace Medicine, Belisario Roldán N° 4651. (1425) Buenos Aires, Argentina.

INTRODUCTION. "CRM" continues to be a superb training context as well as a fruitful research one. Old Moreno's "Sociogram", now computerized and adapted to cockpit population, allows Human Factor researchers to detect successful as well as "broken" pilots couples, before they enter the flight deck, so appointing a more suited and safer cockpit crew schedule. **METHODS.** Authors were committed to solve serious substandard behaviors in a domestic airline. Computerized sociogram results were correlated with performance, in simulator "LOFT" scenarios, set up by means of transactional linguistic analysis from videos, and air checkman evaluation of each flight session; and with also computerized "16PF" and "EPPS" personality inventories in order to establish if dyadic performance could be forecasted by the cross analysis of involved pilots' personality profiles. **RESULTS.** No statistical analysis could be made due to the reduced amount of pilots (n=23) and the huge quantity of variables, but sociogram proved to be an excellent predicting tool for cockpit dyadic behavior. **CONCLUSION.** Reliability of an instrument doesn't mean necessarily adequacy. Sociogram was applicable just when pilots themselves were aware of its usefulness.

CALCULATING AIR CREW REST INTERVALS J. Whitmore, J. French*, L. Olenick, J. Hall. Armstrong Laboratory, Brooks AFB, TX 78235.

INTRODUCTION. It is common for commercial and military air crews to fly across several time zones, for long periods of time, at any time of their subjective day, often with the departure time known only a couple of hours prior to takeoff, and often with little sleep. An equation is described which is specifically designed for predicting effective rest periods for long haul air crew. **Method.** Eight C-141 pilots involved in Operation Desert Storm maintained logs recording their activities, temperature and fatigue ratings at various times of the day over a 30 day exercise. Rest periods calculated were correlated with the pilot's subjective fatigue and mood scores. **Results.** An equation was developed which better predicted the recorded fatigue scores than existing crew rest models. As well, fatigue rating and mood scores were found to correlate highly for each flight ($r = .87$). **Discussion.** The development of the equation illuminated those factors which most affect the level of fatigue experienced by the pilots. The rest gauge that resulted stresses recent flight history as a fatigue index for continuous operations rather than 30 day flight history. Finally, the utility of the rest gauge in calculating the amount of rest needed by pilots involved in commercial flying should be determined.

SCANNING AND MONITORING PERFORMANCE IS AFFECTED BY THE REINFORCEMENT VALUE OF THE TARGETS. A.M. Revzin* and P.G. Rasmussen. Civil Aeromedical Institute, Federal Aviation Administration, Oklahoma City, OK 73125.

INTRODUCTION. We tested an hypothesis, based on anecdotal and introspective evidence, suggesting that Air Traffic Control Specialists (ATCSs) may make scanning and monitoring errors because they tend to concentrate on a "high-value" display sub-area (e.g., one containing large commercial aircraft) while ignoring lower-value problems elsewhere on the display. **METHODS.** Our test system required subjects (Ss) to monitor two workareas of varying spacing and task difficulty. In the first experiment the Ss were rewarded for "good" (above median) performance with differing task difficulties in each workarea. The second experiment also rewarded good test performance. However, both workareas had identical task difficulty and, in one clearly marked workarea, designated as "high error value", each error cost the Ss 4 times as much as in the other. The second experiment was later repeated, using a "high error value" of 10. **RESULTS.** In the first experiment, the error rates in the two workareas were identical, and there was no tendency for the Ss to concentrate on the "easier" task. In the second experiment, though the overall error rates in the two workareas were similar, 60% of the Ss tended to concentrate on the high error value workarea, while ignoring the other. **CONCLUSIONS.** About 60% of our Ss tended to concentrate on a display sub-area containing high value events, while ignoring events elsewhere on the display. This type of testing approach may have future utility for screening of ATCS candidates.

PATS: Psychophysiological Assessment Test System, Goals and Description. G. F. Wilson*, AL/CFHP and C. Oliver, LTSI, W-P AFB, OH

INTRODUCTION. With the increased use of psychophysiological measures in aviation related research, the need for a multi-function data collection and analysis device has become apparent. The areas requiring such a device include laboratory testing, design testing, simulation and flight; this requires a device which has the capability to provide appropriate functionality in all of these environments. Operator workload, fatigue, various stress environments and operator state assessment are a few of the topics that can be investigated with the PATS. We have developed a device which meets many of these needs. **METHODS.** The PATS is hosted on the Macintosh IIX computer with the user interface written in Hypercard. The PATS has the capability to present auditory and visual stimuli in several cognitive and sensory paradigms, collect and store 16 channels of analog data and 32 channels of digital I/O data, provide for editing and other manipulations of this data, reduce the data and perform statistical analysis on the reduced data. The system is designed to be user friendly so that operators not familiar with psychophysiological methods can easily use the device. **CONCLUSIONS.** The design and functionality of PATS will be presented and examples of each function will be shown. Distribution arrangements and hardware requirements will also be discussed.

RADIAL KERATOTOMY IN THE SOLDIER-AVIATOR. R.W. Enzenauer,*
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Radial keratotomy (RK) is an ophthalmological procedure that alters the shape of the cornea making it "flatter," causing the desired shift to far-sightedness. Complications can be minor and "normal" in the immediate post-operative period, or can include problems that occur in many eyes, that persist but do not decrease best corrected visual acuity, or may include events that potentially or actually threaten vision and may produce blindness. At best, only 50% of patients can expect to have 20/20 uncorrected vision 2-3 years after surgery. The refractive error can change by as much as 1.00 diopter in 12% of patients. Diurnal fluctuations in vision (2-5 Snellen lines) can persist years after RK. Perhaps 1% of patients may have a 2-3 Snellen line loss of best corrected vision, and a significant number may not be correctable to 20/20. Irregular astigmatism may produce double vision or ghost images that interfere with clear vision. Disabling glare can disrupt daily activities. Eyes that have undergone RK are at increased risk of corneal rupture after blunt eye trauma.

The visual demands of the active duty military, and more dramatically the military aviator, are incompatible with RK. Therefore, RK should not be performed on active duty soldiers nor should enlistees be accepted if they have undergone the procedure.

EXCIMER LASER PILOT PRK, Threat or Millennium? A. S. Markovits*
Naval Aerospace Medical Institute, Pensacola, FL 32508-5600.

INTRODUCTION. The development of the excimer laser that is capable of correcting myopia, without leaving obvious scars as does radial keratotomy, makes it almost certain that this promising, but very new modality will be something the military aviation community will be facing in the immediate future. Methods of detection are available, but are expensive and time consuming. Should military aviation proactively permit or even sponsor a group of PRK student pilots in order to observe them closely, and then perhaps utilize this new modality vice, for example, contacts? **METHODS.** Questionnaires being historically essentially useless, purchase of corneal topographic modeling systems (essentially a highly sophisticated keratometer) would probably detect the vast majority of PRK eyes. Testing would require an expensive, time consuming, additional step. If it is found impractical, then perhaps the best method would be to provide a test group, perhaps of already winged pilots, who for operational reasons are wearing contact lenses vice glasses. **RESULTS.** Obviously none yet available; a proactive proposal. **CONCLUSION.** Since even PRK'd candidates may be reluctant to proffer this information, a sponsored "pilot" group of PRK patients might be an ideal method to observe such cadre; probably this would result in the "coming out" of any already in the program or just coming in. The alternatives are to not have the knowledge of the PRK'd candidate (probably by now, several are in training), or to institute cumbersome and expensive detection techniques.

A SUBJECTIVE ASSESSMENT OF CONTACT LENS USE BY ARMY
AIRCREW M.R. Lattimore, R.L.S. Cornum
U.S. Army Aeromedical Research Laboratory (USAARL)

INTRODUCTION. While electro-optic/visionic systems have extended the aviator's visual range, these devices are becoming increasingly incompatible with spectacle wear. Since nearly 23 percent of Army aviators are ametropic, contact lenses have drawn increasing attention as a spectacle substitute. **METHODS.** From November 1988 until October 1991, USAARL conducted a series of contact lens research protocols in order to develop a comprehensive database on contact lens wear in a variety of environments. Questionnaires were used as a means of assessing suitability and acceptability of contact lens use by Army aircrew. Responses from 202 subjects were obtained over the latter portion of the studies from June 1990 through September 1991. The questions delved into operational and safety of flight issues of contact lens wear. **RESULTS.** Subjects overwhelmingly approved of contact lens use in all settings (garrison, field training, and combat); 95% expressed greater combat readiness and effectiveness with contact lenses; 98% felt contact lens use (and maintenance) in the cockpit had no adverse impact on safety of flight; and 98% endorsed the routine use of contact lenses. **CONCLUSION.** Questionnaire data high-light Army aircrew acceptance of contact lens use.

CONTACT LENS AND SPECTACLE USE IN NAVAL AVIATION: SURVEY
RESULTS. D. L. Still¹, M. H. Mittelman² and L. A. Temme¹. ¹Naval Aerospace
Medical Research Laboratory and ²Naval Aerospace Medical Institute, Pensacola, FL
32508.

INTRODUCTION. Current technological advances in many aircraft are resulting in flight equipment not compatible with spectacles. This situation is creating a problem that contact lens use may solve. Since an estimated 18% of the Navy and Marine Corps aviators wear spectacles, we assessed the operational experiences of aviation personnel who use spectacles and contact lenses. **METHODS.** We developed a survey of 74 multiple-choice questions concerning aspects of user experience with spectacles and contact lenses in the aviation environment. Ten thousand questionnaires were sent out to naval aviators, naval flight officers and selected aircrewmembers while they underwent periodic aviation physiology refresher training or while deployed during Operation Desert Shield. **RESULTS.** Of the 1231 respondents, 305 reported flying only with spectacles whereas 162 aviation personnel reported at least some flying with contact lenses. Of the 162, about 86% reported that their overall flight performance was better with contact lenses than with spectacles, whereas about 13% felt that there was no difference, and less than 1% felt that performance was worse. Few problems related to contact lens use were noted whereas spectacle wear was noted to present problems in a wide variety of situations. Examples are discussed. **CONCLUSIONS.** User-reported experiences with contact lenses were highly favorable and suggest a broad acceptance in the operational communities.

EYEGLASS USE BY U.S. NAVY JET PILOTS: EFFECTS ON NIGHT CARRIER
LANDING PERFORMANCE. L. A. Temme¹, D. L. Still¹, and M. H. Mittelman².

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INTRODUCTION. Current vision standards for student naval aviators, effective 1 July 1990, lowered the uncorrected visual acuity requirements from 20/20 to 20/30 (correctable to 20/20) for each eye. We conducted a study to compare the night carrier landing (NCL) performance of pilots required to fly with prescriptive eyeglass correction to that of pilots who do not need an eyeglass correction to fly. **METHODS.** Night carrier landing scores, age, career jet flight hours, and total career flight hours were obtained for 122 U.S. Navy fighter pilots participating in air combat maneuver training at NAS, Oceana, Virginia. Of these, 16 pilots required prescription eyeglass correction to fly, 106 did not. We did not perform refractions to assess whether eyeglass corrections used were accurate or current; in other words, pilots used the glasses they normally used while flying. Standard statistical tests for significance were performed to determine if the NCL scores of the two groups of pilots were significantly different. **RESULTS.** We found no significant difference in NCL scores between the two groups of pilots—even when the pilots were matched on the basis of age and flight experience. **CONCLUSION.** Pilots who have a refractive error and wear an eyeglass correction while flying perform night carrier landings as well as the pilots who have no refractive error and fly with no eye glass correction.

OCULAR MOTILITY DISORDERS IN MILITARY AVIATORS; THE USAFSAM
EXPERIENCE, 1975-1989. J.R. Knowles* and T.J. Tredici. USAF
School of Aerospace Medicine, Brooks Air Force Base, TX 78235-
5301.

INTRODUCTION. It is generally thought that all aviators must have "straight" eyes to fly. Accordingly, muscle imbalance was one of the greatest sources of exclusion from the air service in WWI. Screening for ocular motility disorders (OMDs) continues to the present day. Some aviators whose eyes are not straight do, however, fly. Whether missed on the original screening or developing later, OMDs do exist. The literature on ocular motility disorders in aviators is sparse. This study categorizes the full spectrum of ocular motility disorders seen at USAFSAM during a 15-year period. **METHODS.** This was a descriptive study using the clinical records of the Consultation Service at Brooks AFB, TX. Thus, this study looks at personnel who had already been screened and accepted into flying training. **RESULTS.** 140 aviators were found to have disqualifying OMDs at USAFSAM from 1/1/75 through 12/31/89. This represented 2.7% of the 5,243 aviators seen in the Ophthalmology Branch during this time. They were divided among four major categories (1) excessive heterophoria 14%, (2) microtropia 48%, (3) comitant heterotropia 16%, and (4) incomitant heterotropia 22%. **CONCLUSION.** OMDs are found in aviators despite strict screening standards. Microtropia was by far the most common OMD seen in this group of aviators. Issues regarding selection, screening, and retention were discussed. Areas for further investigation were identified.

PREVIOUS EXPOSURE TO NEGATIVE Gz REDUCES RELAXED +Gz TOLERANCE.

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INTRODUCTION. Brief negative Gz exposure during high +Gz manoeuvring has been implicated as a potent cause of G-LOC in aerobatic and fighter aircraft. The manoeuvres involved periods of -Gz acceleration immediately followed by positive Gz exposure. When questioned, aerobatic and fighter pilots all described a lowered Gz tolerance when changing rapidly from -Gz to +Gz. This study was designed to investigate how relaxed G tolerance (RGT) is influenced by different durations and levels of preceding -Gz exposure. **METHODS.** RGT (60 % loss of peripheral vision) was measured in a human centrifuge (1 G/s onset rate) with repeated 15s +Gz exposures from a +1.1 Gz baseline. Subjects then underwent -Gz exposures immediately followed by 15s +Gz exposures until 60 % loss of peripheral vision occurred. Negative Gz levels were -1.0, -1.4 and -1.8 Gz; duration of -Gz exposure was 30s (7 subjects), 16s (8 subjects) and 2s (8 subjects). **RESULTS.**

	30s	16s	2s
RGT (+1.1)	4.11 (+/- 0.43 SD)	4.23 (+/- 0.33 SD)	4.13 (+/- 0.30 SD)
RGT (-1.0)	2.66 (+/- 0.44 SD)	3.00 (+/- 0.39 SD)	3.36 (+/- 0.27 SD)
RGT (-1.4)	2.49 (+/- 0.51 SD)	2.80 (+/- 0.26 SD)	3.30 (+/- 0.21 SD)
RGT (-1.8)	2.47 (+/- 0.21 SD)	2.67 (+/- 0.24 SD)	3.19 (+/- 0.23 SD)

A significant reduction in RGT was seen after previous exposure to negative Gz. Longer durations of -Gz exposure cause a greater reduction in RGT, whereas the influence of the -Gz level is small. **CONCLUSION.** Exposure to -Gz immediately followed by +Gz acceleration decreases individual G tolerance. The reduction is significant after a 2s exposure to -Gz, which is comparable to inflight conditions. Pilots should be aware that even a short exposure to -Gz will significantly reduce their normal Gz tolerance.

LOSS OF CONSCIOUSNESS INDUCED BY STRANGULATION OR +Gz: A COMPARISON. J.E. Whinnery* and E.M. Forster*. Aerial Combat Maneuver Enhancement Laboratory, NAVAIRDEVCON, Warminster, PA 18974.

INTRODUCTION. In 1943, Rossen *et al* (RKA), published their investigations on arrest of the cerebral circulation leading to loss of consciousness (LOC) in man. An accurate quantitative kinetic comparison of the RKA data and data from G-LOC research could provide information concerning the similarities and/or differences in the mechanisms of the two phenomena. **METHOD.** To accomplish this comparison, given the limitations of the available data, the following variables were considered: time to unconsciousness (TLOC) and for recovery (TREC); time at maximum +Gz (TAG); onset/offset rate, and approximate duration of the insult. **RESULTS.** RKA_TLOC was 6.4 to 6.9s (S.D.= 1.4s, N= 74) and found to be similar to the predicted G-LOC_TLOC of 7.2s, and TAG of 7.5s (S.D.= 1.5s, N= 935). RKA_TREC was 5.9 to 6.4s (S.D.= 2.51s, N= 28) and shorter than the equivalent G-LOC parameter of 23.7s (S.D.= 9, N= 103). However, the predicted minimum G-LOC_TREC is 6.8s. Further, the LOC syndrome encompassing numerous psychophysiological symptoms are essentially equivalent for both types of insults. **CONCLUSION.** The results suggest an analogous ischemic mechanism for LOC induction and recovery caused by strangulation and +Gz. A protective mechanism seems to be activated when a threshold is reached. This threshold is based on O₂ (and/or other energy substrates) availability/consumption. It seems reasonable to assert that the human body will protect itself (lose consciousness and skeletal muscle tone; reduce neuronal activity) when this threshold is reached rather than continuing to function until either complete cerebral anemia occurs or all the available O₂ is consumed.

G-LOC RECOVERY WITH AND WITHOUT G-SUIT INFLATION. E.M. Forster* J.P. Cammarota* J.E. Whinnery* ACME Labs, NAVAIRDEVCON, Warminster, PA 18974.

INTRODUCTION. The anti-g suit (AGS) aids the pilot in tolerating acceleration (+Gz) stress. Usually, the AGS is deflated as acceleration decreases post-run regardless of the reason for termination including G-LOC which is when the subject (S) most needs the support provided by the AGS. **METHOD.** The standard CSU15-P suit worn by 30 aircrew (32 runs) while undergoing +Gz tolerance training was inflated to 10 psi immediately upon G-LOC (GS). Deflation of the suit was complete in 15s. Incapacitation periods were compared with 51 aircrew (75 runs) whose AGS was not abruptly inflated upon G-LOC (NGS). The incapacitation parameters included absolute (ABSINCAP) when the S is obviously unconscious, relative (RELINCAP) when the S is awake but disoriented, and total (TOTINCAP). **RESULTS.** ABSINCAP was different between both groups: GS=5+2s; NGS=7+3s (p=.009, N=90 runs; p=.02, N=71S). The GS group exhibited flailing behavior for a longer period of time (1.5s) than the NGS group (p=.0001, N=85runs; p=.0003, N=66s). While the GS group essentially awakened faster, their muscular control was not fully recovered. A brief period of confusion occasionally accompanied by mimic or myoclonic convulsions (versus G-LOC *per se*) was observed more often on the GS group (GS=15%; NGS=7%). Those S's who reported experiencing dreams during unconsciousness exhibited a longer ABSINCAP (5s) and TOTINAP (7s) than those S's who did not experience dreams (p<.01). **CONCLUSION.** The unconsciousness and convulsion period of ABSINCAP has been further defined. Mental and motor function are not concurrently activated when the S awakens from G-LOC. Inflation of the AGS upon G-LOC reduces ABSINCAP by approximately 2s, causing the S to be aware of his environment more quickly but without full motor function.

G-LOC IN FIGHTER AIRCREW DURING TRAINING. M.H. Harmon, J.E. Whinnery* and E.M. Forster*. Aerial Combat Maneuver Enhancement Laboratory, NAVAIRDEVCON, Warminster, PA 18974-5000.

INTRODUCTION. Characteristics of fighter aircrew were studied in relation to whether or not the aviators experienced G-LOC while undergoing Gz-tolerance enhancement training on the Naval Air Development Center centrifuge. **METHODS.** Five hundred twenty aviators, including members of the Air National Guard and the Navy, were exposed to a series of centrifuge training profiles, comprising a gradual onset run (GOR) and 5 different rapid onset runs (ROR). Information on subject characteristics (height, weight, total flying hours, etc.) was compiled along with performance data relating to the centrifuge runs. To uncover significant relationships between G-LOC and characteristics of the aviators, correlational and t-test analyses were employed. Logistic regression was then carried out relating G-LOC simultaneously with the variables which showed significance at the .05 level. **RESULTS.** Logistic regression analysis showed number of tactical flying hours to be the best predictor of presence or absence of G-LOC, with no other variable adding significantly after it was considered. Most of the 5 individual variables significantly related to G-LOC were moderately or highly intercorrelated. **CONCLUSIONS.** Greater experience in tactical flying, which tends to rise along with age in fighter aircrew, was shown to improve the likelihood of avoiding G-LOC during centrifuge training.

INCIDENCE OF CARDIAC DYSRHYTHMIAS OCCURRING DURING CENTRIFUGE TRAINING. I. McKenzie* and K.K. Gillingham*. Armstrong Laboratory, Brooks AFB TX 78235-5000.

INTRODUCTION. Students attending aeromedical professional courses at the USAF School of Aerospace Medicine are offered the opportunity to undertake high-G centrifuge training, during which ECG monitoring is routinely performed. The aim of this study was to document the incidence of cardiac dysrhythmias occurring during high-G training on the Armstrong Laboratory centrifuge. **METHODS.** Medical monitors' records of 1180 students' centrifuge training sessions from 1984 through 1991 were reviewed, and the salient information concerning occurrence and type of dysrhythmia were transcribed to an electronic database. **RESULTS.** Dysrhythmias were recorded in 552 (47%) of the training sessions. Ventricular ectopy occurred in 480 (41%) of the sessions, and supraventricular dysrhythmias appeared in 127 (11%). In 53 (4.4%) of the sessions, training either was or would have been terminated because of the dysrhythmia. Session-terminating dysrhythmias included: 27 ventricular tachycardias (2.3%), including 13 triplets (1.1%); 8 ventricular couplets (0.7%); 12 episodes of too-frequent ventricular premature beats (1.0%); 2 of supraventricular tachycardia (0.2%); and 4 of anomalous bradycardia (0.3%). **CONCLUSION.** Centrifuge training can provoke serious dysrhythmias in ostensibly healthy individuals, and ECG monitoring of aircrew undergoing such training is recommended for their safety. Because some of these dysrhythmias are disqualifying for aircrew duties, the need for a more lenient aeromedical disposition policy must be considered.

CASE REPORT: SERIOUS ARRHYTHMIA ASSOCIATED WITH HIGH Gz LOAD.

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INTRODUCTION: Since 1981, more than 5,500 pilots have been trained by Japanese Self Defense Force human centrifuge and ECG monitoring during G-load was done on all trainees. A large number of high-G related dysrhythmia has been found. PVCs were the most frequent dysrhythmia (40% of all trainees). SVPCs were found in 20% of trainees. Recently we have experienced 4 cases of G-induced serious arrhythmia which may threaten the flying duty.

CASE REPORT: Four fighter pilots who were all apparently healthy males developed marked sino-atrial block with sinus arrest (4-7 sec) associated with blurred consciousness during the G-training. Further cardiovascular examinations of these cases (electro-physiological test) revealed no abnormality. They were all disqualified from flying duty in high performance aircraft. The last case (F-15 pilot) was evaluated by the human centrifuge because of frequent episodes of LOC during ACM flight. He was found to develop ventricular tachycardia with LOC upon the Gz load (6G), which confirmed the concomitant occurrence of the in-flight G-LOC and the dysrhythmia. **CONCLUSION:** Results indicated that serious arrhythmia which threaten the flying safety may develop in an otherwise healthy active pilots. And in-flight occurrence of G-induced arrhythmia with LOC in actual ACM flight was confirmed. The importance of the G-training with ECG monitoring for fighter pilots is re-emphasized and a centrifuge evaluation of pilots with G-related problems is recommended.

DESERT STORM: AN AEROMEDICAL TECHNICIANS PERSPECTIVE.
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INTRODUCTION: The deployment of the 356th Squadron Medical Element (SME) to the Persian Gulf provided the unit with medical care from a staff that already had a pre-established relationship with the aircrew members which was vital throughout the Desert Storm deployment. **METHODS:** On 26 Jan 91, the 356th TAS deployed to a classified site (site 1). Upon arrival in the AOR the SME combined resources with a prepositioned SME and established a Flight Medicine Clinic. This was also true for a redeployment on 25 Apr 91 to site 2 when 4 SME's were combined into a single clinic. **RESULTS:** Aircrew were relatively healthy and the patient count at site 1 totaled 249 in a 3 month period. The most commonly seen medical complaint was upper respiratory infections (URI's) and dermatological conditions which accounted for 32% of the patients seen. At site 2, a total of 746 patients were seen in a two month period. Again, URI's and Dermatological conditions were the most predominant problems totaling 22% and 19% respectively. **CONCLUSIONS:** The medical conditions, experiences, and lessons learn in this 4.5 month deployment may be of value to the Aeromedical community in planning for future desert deployments.

A NEW CONCEPT FOR A MOBILE, RAPIDLY RESPONDING AND VERSATILE AEROMEDICAL UNIT. T. E. Martin*, 4626 Aeromedical Evacuation Squadron, Royal Auxiliary Air Force, RAF Hurlingham, Wilts, SN14 6BT, UK.

INTRODUCTION. Of the many lessons learned in the deployment of aeromedical assets by the RAF during Operation Granby/Desert Storm, perhaps the most vital was the recognition of a need for total flexibility with respect to resourcing casualty evacuation. **METHODS.** The RAF established a number of aeromedical deployments in support of the allied campaign. One in particular, at Al Jubail, expanded to become a major resuscitation facility. This Unit evolved rapidly from its pre-planned role as an airfield reception detachment to one having the capability of a fully independent Aeromedical Staging Facility (ASF) with a substructure of integrated teams which were capable of working as a single, large unit, and yet which were also capable of complete autonomy in their own specialised roles. **RESULTS.** Over 700 patients were treated and transported through the ASF at Al Jubail though, fortuitously, less than 50 were battle casualties. Most were the victims of road traffic accidents, pre-war manoeuvres and simple carelessness in a demanding environment. There were also the same cross-section of medical and surgical conditions that would have been expected in any population of 45,000. **CONCLUSIONS.** For the first time in its history, the RAF was required to operate a number of resuscitation equipped aeromedical facilities within a war zone. It is the author's opinion (and not necessarily that of the UK Ministry of Defence) that such a Unit might form the basis of a highly mobile Aeromedical Squadron which is flexible enough to provide the manpower and resources for any one of a number (or combination) of medical needs. These might include: an Airfield Reception/Holding team, In-Flight Medical teams (Primary Transfer Trauma personnel and/or Secondary Transfer escorts), Road Ambulance teams, Evacuation Cell of a Field Hospital, Major Resuscitation Centre, Critical Care Facility, Battlefield Surgical team or, as an integrated unit, forming a complete Aeromedical Staging Facility or Airfield Surgical Hospital. Such a versatile squadron would respond rapidly to any scale of skirmish, conflict or catastrophe and start work immediately, pending the arrival of suitable medical reinforcements.

THE USE OF AEROMEDICAL EVACUATION FLIGHT SURGEONS (AEFS) IN WAR: RECOMMENDATIONS FROM THE USAF AEFS CONFERENCE, MAY 16-17, 1991.
 R.A. Munson*, R.C. Whitton*, L.A. Richardson*, Aeromedical Consultation Service, Brooks AFB, TX 78235.

INTRODUCTION. Desert Storm saw the first preplanned use of physicians as integral crewmembers in Aeromedical Evacuation. Drawing from that experience, as well as the experience of Operation Just Cause and the transport of wounded Marines from Beirut, an ad hoc conference was held on May 16-17, 1991, and made recommendations in three areas: mission and duties, training, and equipment. **RECOMMENDATIONS.** The AEFS Conference recommended that "The Aeromedical Evacuation Flight Surgeon provides clinical support in the aeromedical evacuation system. These physicians will augment the basic aeromedical evacuation crew on selected tactical and strategic evacuation missions. Designated Flight Surgeons will be capable of providing critical care support within the aeromedical system and must be qualified in Advanced Cardiac Life Support (ACLS) and Advanced Trauma Life Support (ATLS)." The duties of AEFSs would include: proactive and reactive care on flights, consultant/advisor to the Medical Crew Director, "Senior Medical Authority" on flights, advisor to all elements within the Airvac system, teaching, liaison, and consultation to referring medical units, and Flight Surgeon to the attached unit. A senior AEFS should be assigned to each Aeromedical Evacuation Control Center; in contingencies mobility AEFSs are assigned as needed and report to the senior AEFS. In addition to ACLS and ATLS they should receive instruction in aeromedical evacuation. Standardized emergency response kits should be issued as part of mobility equipment and the Table of Allowances for Airvac units should be expanded to allow for resupply of these kits. Trained AEFSs should be identified by AFSC suffix.

DESERT DEPLOYMENT AND COCCIDIOIDOMYCOSIS INFECTION.
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Flight surgeons provide primary care to a mobile patient population, aircrew members. During deployments and while serving as medical duty officers that population expands to include non-aircrew members. The mobility of the military patient population is a particular problem for infectious diseases that pursue an indolent clinical course initially. We present two cases of systemic coccidioidomycosis that manifested outside the endemic area and caused the patients' deaths. Epidemiologic, diagnostic, therapeutic and preventive measures are discussed.

THE USE OF THE TXP PRESSURE VENTILATOR BY FLIGHT SURGEONS DURING AEROMEDICAL EVACUATION MISSIONS DURING OPERATION DESERT STORM AT KING KHALID MILITARY CITY, SAUDI ARABIA L.A. Richardson and R. A. Munson*, Aeromedical Consultation Service, Brooks AFB, San Antonio TX 78235.

INTRODUCTION. The TXP pressure ventilator made possible the successful aeromedical evacuation (AE) of ventilator dependent (VD) patients (PATs) during Operation Desert Storm. **METHODS.** All PATs were selected by their referring physicians. All PATs received a preflight aeromedical evaluation by a flight surgeon (FS) which included chart review and a physical. All PATs were given a trial on the TXP with measurement of tidal volumes using a Wright spirometer (WS) and oxygen saturations using a pulse oximeter (POX). If the FS determined the PAT was stable and demonstrated adequate ventilation on the TXP, he or she was accepted for AE. Unstable PATs or those failing a TXP trial were not accepted. Inflatable cuffs on the intubation tubes and Foley catheters were filled with saline. All PATs were placed on the TXP during the preflight PAT preparation and were transported to and from the flight line accompanied by a physician. The TXP was interfaced with the portable liquid oxygen delivery system (LOX) in the C-130 and with passenger oxygen in the C-141 aircraft. The AE FS who accompanied the PAT assumed responsibility for the inflight management of the TXP. The AE FS used a WS and a POX to monitor the PAT in flight and to optimize ventilatory management during changes in altitude. Local physicians or respiratory therapists were not obligated to accompany the PATs. **RESULTS.** A total of six VD PATs were transported during intra-theater flights in C-130 or inter-theater flights in C-141 aircraft. **CONCLUSIONS.** All VD PAT movements with a AE FS in attendance were successful and resulted in PATs receiving definitive care not available at the point of origin at an earlier time than would otherwise have been possible.

RESERVIST OBSERVATIONS ON RETENTION DURING DESERT STORM

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INTRODUCTION During Desert Storm, approximately 1000 AF reservists were mobilized to duty at Wilford Hall, including 90 non-deployed physicians and dentists. **METHODS** An anonymous questionnaire was distributed to this group with responses from 29 physicians and 6 dentists. **RESULTS** This study evaluates the physician responders. None were mismatched in their AFSC. Ave. prior active duty time was 6.6 yrs, with 6 yrs inactive time and 7.9 yrs of "good" reserve time. The ave. civilian salary they left was \$196,000 and ave. continued office overhead expenses while on active duty was \$91,425/yr. Two doctors declared bankruptcy and an ave. of 3 personnel were released from each civilian office staff. 1070 miles was the ave. distance traveled from home to WHMC. One-half definitely planned to stay in the reserves with surgical specialists (94XX) earning higher civilian salaries tending to plan to stay in the reserves. **CONCLUSIONS** Although disruptive to civilian practice and family, a large percentage of mobilized reservists plan to continue beyond obligation in their AF reserve careers.

THE FREQUENCY OF SELF-MEDICATION AMONG U.S. NAVY AIRCREWS AND ITS ROLE IN AIRCRAFT MISHAPS. J.R. Brinker*, G.L. Dowell*, and D.F. Neri*. Naval Aerospace Medical Institute and Naval Aerospace Medical Research Laboratory, Pensacola, FL 32508.

INTRODUCTION. The Navy prohibits the practice of self-medication in its aircrews. Self-medication is defined as the act of taking medication without the consent of a flight surgeon. Nevertheless, reports continue to reveal the unauthorized use of medications in aircrew involved in aircraft mishaps. Although self-medication is rarely listed as a causal factor in these mishaps, the anecdotal frequency of its appearance in these reports suggest the possibility of an unrecognized role. Further, the fact that highly disciplined aircrew are violating a well known regulation with some frequency speaks to the need to identify the factors pertaining to this abuse. **METHOD.** Naval aviators, naval flight officers, and enlisted aircrew from six training and fleet squadrons are being surveyed to identify the frequency of self-medication, the medications being used, and the conditions prompting such use. The survey is confidential in that individual anonymity is maintained during the collection process. The survey instrument elicits data on personal use of both over-the-counter and previously prescribed medications taken without medical consultation. Solicited data include: time since aircrew designation, incidence and frequency of self-medication, basis for self-medication (colds, headaches, etc.) and identification of medications used. Additionally, Naval Safety Center (NSC) and Armed Forces Institute of Pathology (AFIP) data on mishap aircrews and medication use will be reviewed for a comparison analysis. **COMMENTS.** The brief will review the results of the aircrew survey and correlate those results with the information obtained from the NSC and AFIP. The incidence of self-medication from the survey will be compared to the mishap data. The implications of these results for aircrew, safety personnel, flight surgeons, and policy makers will be discussed.

MODULATION OF FIBRONECTIN AND PROLACTIN BUT NOT BASELINE CORTISOL BY TRAINING STRESS. H.M. Neisler*, W.G. Lotz, and J.L. Saxton. Naval Aerospace Medical Research Laboratory, Pensacola, FL 32508-5700.

INTRODUCTION. Consistent, predictable biochemical markers of cumulative physical stress have not been identified. Increased cortisol levels have traditionally served as a marker of physical stress and typically reflect an acute, rather than chronic stress response. Under similar stressful circumstances, prolactin has been shown to increase in males. In contrast, fibronectin has been shown to beneficially increase after physical training, but fibronectin levels degrade during the adaptive phase of training. No previous reports simultaneously address the predictability and interrelationship among cortisol, prolactin, and fibronectin as stress markers in males. **METHODS.** Ten male aviation officer candidates were studied to simultaneously determine their cortisol, prolactin, and fibronectin response to 16 weeks of intensive training stress. Training consisted of an intensive "boot camp" physical conditioning program with simultaneous college-level aviation classes. Physical and academic stress were greatest during the first 4 weeks of the study and were progressively reduced throughout the remaining weeks. Eight males with similar physical characteristics who were engaged in routine occupational and/or school tasks served as controls. Blood samples were uniformly obtained in early morning of the first day of training and during weeks 2, 4, 7, 11 and 14. **RESULTS.** Neither cortisol, prolactin, nor fibronectin varied over time for the controls. For the test subjects, early morning cortisol ($\bar{x} \pm S.D.$) changed significantly ($p < .05$) only for the final sample (19.7 ± 4.4 ; 20.7 ± 4.9 ; 19.2 ± 4.1 ; 19.9 ± 3.5 ; 19.7 ± 3.6 ; $15.5 \pm 3.1 \mu\text{g/dl}$). Prolactin (5.9 ± 3.6 ; 14.3 ± 4.8 ; 17.6 ± 5.2 ; 14.6 ± 5.8 ; 13.9 ± 4.5 ; $6.4 \pm 2.7 \text{ ng/ml}$) showed a positive correlation and fibronectin (657 ± 72 ; 507 ± 73 ; 543 ± 85 ; 569 ± 91 ; 550 ± 87 and $575 \pm 76 \text{ g/l}$) a negative correlation with the physical and academic stress of the subjects. **CONCLUSION.** These data indicate that either prolactin or fibronectin may be a better indicator of chronic exercise and academic stress than cortisol.

BEAT-TO-BEAT MONITORING OF INOTROPY BY STATIC CHARGE SENSITIVE BED BALLISTOCARDIOGRAPHY. A. Lindqvist* and J. Alihanka. Cardiorespiratory Research Unit and Department of Physiology, University of Turku, FINLAND.

INTRODUCTION. Beat-to-beat chronotropic control of the heart can be analyzed by a heart rate signal acquired from ECG. Aim of the study was to evaluate inotropic control of the heart by static charge sensitive bed (SCSB, BioMatt[®], Biorec Ltd, Finland) ballistocardiogram (BCG) after physical exercise and during pharmacological stimulation. **METHODS.** SCSB-BCG was recorded supine before and 1, 3, 5 and 10 min after submaximal exercise test ($N=6$), an iv bolus of isoproterenol (Isuprel[®], 0.02 mg, $N=3$) and atropine (Atropin[®], 1.5 mg, $N=3$). Systolic amplitudes of SCSB-BCG and respective BCG intervals triggered from R-wave of simultaneous ECG were measured over 10 consecutive cardiac cycles. **RESULTS.** Exercise and isoproterenol increased systolic SCSB-BCG amplitudes and decreased R-BCG intervals. The positive inotropic effect was highly significant in the early systole ($P<0.001$). Atropine with no or slight negative inotropic effect increased remarkably heart rate but changed insignificantly systolic SCSB-BCG amplitudes or R-BCG intervals. **CONCLUSION.** The results indicate that changes of inotropy influence amplitude and electromechanical intervals of systolic SCSB-BCG which may be used as a noninvasive method for beat-to-beat monitoring of cardiac performance.

EFFECT OF SIMULATED MICROGRAVITY ON HUMAN EPITHELIAL CELL ASSOCIATION AND RECOGNITION. J.M. Jessup*, R. Ford, Harvard Medical School, Boston, MA 02215.

INTRODUCTION. Cell differentiation in microgravity may require intercellular recognition and adhesion. We tested the hypothesis that simulated microgravity does not inhibit cell attachment to adhesion molecules.

METHODS. Human colorectal carcinoma cells (5×10^5 MIP-101 or KM-12c cells/ml) were cultured in the NASA Rotating Wall Vessel (RWV). Cells in the RWV are under low shear stress with randomization of the gravity vector. Cells were harvested at 6 - 7 days, labelled with ^{51}Cr , and assayed for binding to carcinoembryonic antigen (CEA), collagen, laminin, or fibronectin in microtiter plates. Cells (5×10^4 /well) were incubated for 90 min at 37°C , nonadherent cells washed off, and the adherent cells counted. Control cells were grown in standard tissue culture flasks. Differences between means assessed by ANOVA with **Bold print** $P < 0.01$ versus None control. **RESULTS:**

Substrate To Which Cells Adhere:	% CELLS BOUND (MEAN \pm SEM)			
	KM-12c		MIP-101	
	RWV	Control	RWV	Control
None	6 \pm 1	3 \pm 1	14 \pm 1	10 \pm 1
CEA	32 \pm 3	6 \pm 3	13 \pm 1	9 \pm 1
Collagen IV	58 \pm 2	26 \pm 1	29 \pm 1	61 \pm 2
Fibronectin	3 \pm 1	4 \pm 1	11 \pm 1	11 \pm 3
Laminin	57 \pm 16	19 \pm 4	53 \pm 1	63 \pm 2

The RWV cultures give similar results to the Control cultures for binding to basement membrane proteins and to CEA, an epithelial intercellular recognition molecule. Thus, microgravity is not likely to alter cell association and adhesion.

TWENTY-FOUR HOUR ESTIMATES OF VENTILATION AND CARDIAC OUTPUT BY AMBULATORY ELECTROCARDIOGRAPHY & IMPEDANCE CARDIOGRAPHY P.N. Kizakevich*, W.J. Jochem, M.L. McCartney, J.H. Raymer, and E.D. Pellizzari. Biomedical Engineering, Research Triangle Institute, Research Triangle Park, NC 27709.

INTRODUCTION. Studies of the physiological effects of environmental conditions such as pollutant exposure, thermal stress, noise, acceleration, and space flight often desire continuous estimates of physiological function during vocational or other activity. To provide data for a physiological model of volatile organic compound washout over a 10 to 34 hour period, we developed an ambulatory monitoring system for periodic estimates of cardiac and pulmonary function during daily activity. **METHODS.** Eight healthy subjects aged 25 to 49 years (7 male, 1 female) were instrumented with electrocardiogram (ECG) and impedance cardiogram (ICG) electrodes and an ambulatory ECG & ICG analyzer for automatic signal acquisition and processing at 5 or 10 minute intervals. At each interval, a one-minute ensemble average of the ECG, ICG, and base impedance (Z_0) was computed, and the waveforms analyzed for heart rate (HRATE), dZ/dt amplitude (dZ/dt), time-to-peak dZ/dt (TZPEAK), average dZ/dt slope (ACCEL), left ventricular ejection time (LVET), and Z_0 , and the resultant measurements stored. Stroke volume (SV) and cardiac output (CO) were estimated off-line using the Kubicek formula. Ventilation was estimated off-line using individualized multivariate regression models relating minute ventilation (V_{min}) by spirometry to the independent variables HRATE, ACCEL, and TZPEAK. **RESULTS.** Laboratory calibrations of multivariate-predicted versus spirometry-measured V_{min} were excellent ($0.95 < r < 0.99$). Ambulatory monitoring ranged from 390 to 1950 minutes, with an average duration of 1251 ± 703 minutes. Variability in subject activities, sleep patterns, and monitoring epochs precluded group statistical analyses, however, individual V_{min} , SV, and CO trends could be generated at 5 or 10 minute intervals. **CONCLUSIONS.** Reliable, 24 hour estimates of ventilation and cardiac output during daily activity are possible using automated ambulatory analysis of the electrocardiogram and impedance cardiogram.

STRATEGIES FOR SYNTHETIC BLOOD DEVELOPMENT: CHARACTERIZATION OF AN ULTRA-FINE PLURIPOTENTIAL SOLID PHASE DELIVERY VEHICLE FOR SELF-ASSEMBLING BIOLOGICALS.

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Solid phase synthetic chemistry based on molecular self assembly is an exciting new area of biological materials research. The scientific principle underlying our use of solid carriers for biologicals is that with appropriate surface modification, biologicals may be adsorbed without denaturation. For synthetic blood, hemoglobin is the preferred biological. In experiments to date, model work has been done using the major envelope protein (gp350) of the Epstein-Barr Virus (EBV). Self assembled in low ionic strength aqueous dispersions, these "viral decoys" display remarkable physical and immunological similarity to native EBV. At physiological pH the mean electrophoretic mobility and average dispersion diameter ($< 150 \text{ nm}$) of these synthetic carriers mimics that of its infectious counterparts. Monoclonal anti-EBV membrane antigen was shown to bind with high frequency to decoy particles through immunogold staining and by particle immunoagglutination. In studies with NZW rabbits and BALB/c mice, EBV decoys and native EBV evoked nearly identical immunospecific IgG responses as characterized by ELISA. These responses were 4 fold and 3.5 fold greater than the responses evoked by pure gp350 and Freund's complete adjuvant plus gp350 respectively. Decoy antisera was also as immunoprotective as EBV antisera and was 25 times more immunoprotective than antisera raised against pure gp350 in neutralization assays with human peripheral blood monocytes. The apparent absence of significant molecular denaturation by the adsorption process suggests that this concept may be extended to synthetic blood; work is now in progress.

BLOOD SUBSTITUTION AND PROFOUND HYPOTHERMIA: EXTENDING THE SAFE LIMITS OF CARDIAC ARREST. J.E. BAILES, A.M. Elrifai, M.L. Leavitt, S.R. Shih, E. Teeple, M.J. Taylor and J.C. Maroon. Allegheny General Hospital, Pittsburgh, PA 15212.

INTRODUCTION. The use of hypothermia as a metabolic suppressant has been widely accepted. However, limitations of its surgical applications to a safe period of one hr. have restricted the widespread use of this technique. To determine if it is possible to extend the duration and depth of hypothermic procedures, a novel technique was developed and applied in conjunction with complete blood substitution, using an aqueous blood substitute in a dog model. **METHODS.** Nineteen adult mongrel dogs were anesthetized and cannulated for extracorporeal pump oxygenation. As temp. was lowered, they were exsanguinated and blood substituted lowering the hematocrit to 1%. After 2½-3 hrs. of cardiac arrest and continuous perfusion at a nadir temp. of 1.3° or 7.3°C, rewarming began. When temp. reached 10°C, the perfusate was drained and the animals were autotransfused. The heart started at 19°C and spontaneous respiration resumed at 29°C. **RESULTS.** Two animals died intra-op. as a result of technical errors, three animals died at 1-4 days of cardiac & pulmonary sequelae, or due to edema. Fourteen animals survived long term. Results indicated that motor behavior, hematological and biochemical parameters showed a faster return to normal in animals exposed to nadir of 7.3°C. **CONCLUSION.** The time constraints of hypothermic procedures could possibly be extended to 3-4 hrs. without significant ischemic injury. This technique may open new avenues for therapeutic intervention through prolonged suppression of cerebral metabolic activity.

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A NEW MODEL FOR ESTIMATING TOTAL BODY WATER FROM BIOELECTRICAL RESISTANCE *S.F. Siconolfi and *K.T. Kear. NASA Johnson Space Center, #KRUG Life Sciences, Inc., Houston, TX 77058

INTRODUCTION Estimation of total body water (T) from bioelectrical resistance (R) is commonly done by stepwise regression models with height squared over R, (H²/R), age, sex, and weight (W). Polynomials of H²/R have not been included in these models. We examined the validity of a model with third order polynomials and W. **METHODS** T was measured with oxygen-18 labeled water in 27 subjects. R at 50 kHz was obtained from electrodes placed on the hand and foot while subjects were in the supine position. A stepwise regression equation was developed with 13 subjects (age, 31.5±6.2 yrs; T, 38.2±6.6 L; W, 65.2±12.0 kg). Correlations, standard error of estimates and mean differences were computed between T and estimated Ts from the new (N) model and those by Lukaski and Bolnochuk [1988] (LB) and Kushner and Schoeller [1986] (KS). Evaluations were completed with the remaining 14 subjects (age, 32.4±6.3 yrs; T, 40.3±8.0 L; W, 70.2±12.3 kg) and two of its subgroups (high and low T). **RESULTS** The regression equation developed from the model is $N = 85.574 - (3.911 \cdot H^2/R) + (0.076 \cdot (H^2/R)^2) - (4.274e-4 \cdot (H^2/R)^3) + (0.113 \cdot W)$. Correlations for all estimates were significant (p<0.05). The only significant mean difference was between T and LB. The results are shown below.

	All Subject (n=14)	High T (n=7)	Low T (n=7)
	r (+SEE)	T(±SD)	r (+SEE) T(±SD)
N	.98(1.8)	39.4(7.6)	46.0(4.2) .91(0.9) 32.7(1.6)
KS	.98(1.7)	40.7(8.1)	47.8(4.4) .67(1.7) 33.6(1.9)
LB	.98(1.8)	33.6(7.1)	39.7(4.0) .69(1.7) 27.4(2.3)
T		40.3(8.0)	47.2(5.0) 33.5(2.3)

CONCLUSION Third order polynomials in regression models may increase the accuracy of estimating total body water. Evaluating the model with a larger population is needed.

INDIRECT MEASUREMENT OF EYE-LEVEL BLOOD PRESSURE (BP) DURING +Gz LOADING USING OSCILLOMETRIC METHOD. C. MIZUMOTO¹, K. SHIMIZU¹, A. NAKAMURA¹, S. YAGURA¹, H. KOBAYASHI², H. SHIMAZU² and H. ITO². 1. Aeromedical Laboratory, JASDF, Sakae-cho, Tachikawa-shi, Tokyo, 190, JAPAN. 2. Dept. of Physiol., Kyorin Univ., Shinkawa, Mitaka-shi, Tokyo, 181, JAPAN.

INTRODUCTION. A new BP monitoring device of the volume oscillometric method (VOM) was developed to measure eye-level BP during G load. We applied this device to the black out monitoring system (BOMS) during HSG. **METHODS.** The device consisted of electro photosensor for the detection of the volume pulsation of superficial temporal artery and disk shaped rubber cuff mounted in a head band which press the artery. From the oscillation curve of pulse wave and cuff pressure applied to the artery, systolic and mean arterial pressures were recorded and calculated. The subjects equipped with the device were exposed to Gz acceleration (2, 3, 4, 5G for 20sec with GOR, 0.1G/sec). For the black out monitor, pulse wave from artery under constant cuff pressure (20-40mmHg) was continuously recorded and correlation between the disappearance of the arterial pulsation and occurrence of ocular symptoms (grey out and black out) was examined. **RESULTS.** During low level of G loads (2-3 G with GOR), eye-level BP maintained normal and constant level. Upon the exposure to 4 to 5 Gz, BP showed sharp decrease with marked fluctuations. The disappearance of the arterial pulsation well corresponded to the occurrence of ocular symptoms. Results suggested a possibility of non-invasive monitoring of BP by VOM even during the HSG and an applicability of the new device to BOMS of advanced fighter aircraft.

STUDIES ON RESPIRATORY SENSATION FOR DEFINING ACCEPTABLE LEVELS OF ADDED RESISTANCE FROM RESPIRATORY APPARATUS. Li Fan Zhang. Dept. Aerospace Physiology, Fourth Military Medical University, Xi'an, 710032, P.R.China.

INTRODUCTION. The aim was to carry on a more systematic study of the sensory magnitude and its relationship with various kinds of added resistance, particularly the combined loads with different inspiratory vs. expiratory load ratios. **METHODS.** A new kind of category scale, the Multistage Evaluation Scale (MES) based on a fuzzy set category judgement model was used to assess the magnitude of respiratory sensation. The equivalent respiratory sensation contours of 2, 3, and 4 JND (Just Noticeable Difference) steps above basal level, respectively, were determined under rest as well as physical activity of light to moderate degree. **RESULTS.** When the intensity of the total added resistance was kept constant, the perceived magnitudes assessed by MES were dependent upon the phase of the breathing cycle loaded. The psychophysical function obtained with MES could be expressed as a power function. The equivalent sensation contours drawn by quadratic polynomial approximation of experimental data were closely related to the intensity of total load added, inspiratory vs. expiratory load ratio, and degree of physical activity. **CONCLUSION.** A new way to predict the psycho-physiological effect of various combined respiratory resistive loads has been proposed. The results obtained are of practical significance in defining the permissible levels of added resistance of protective respiratory equipment.

HEMODYNAMIC CHARACTERISTICS OF Q-G MANEUVER. Hong-zhang Guo*, Shu-yu Cao, Shu-xia Zhang, Bai-sheng Jing. Institute of Aviation Medicine, Beijing 100036 China.

INTRODUCTION. The hemodynamic indices were monitored during performing the Q-G and the L-I maneuvers for tackling the mechanism of blood pressure rise in the former. **METHODS.** 8 young men trained for the two maneuvers served as subjects. Beside blood pressure taken with sphygmomanometer, radial pulse wave was recorded and analysed with a calibrated, computerized radial pulse wave form analyser (CVD-1). Therefrom 36 hemodynamic parameters were derived mathematically. **RESULTS.** (1) Mean arterial pressure was raised 67.2~74.3% above resting level; (2) myocardial O₂ consumption and cardiacwork per unit time, increased by about 1.5 times; ventricular pump force, 60.5%; (3) stroke volume, left atrial max. volume and left ventricular end-diastolic volume increased by 2.4, 0.9 and 2.1% respectively; cardiac output (CO), 56.9%, circulating blood volume (CBV), 173.7%; (4) coronary impedance dropped markedly; peripheral impedance (PI) increased by 99.4%; (5) circulating blood half renewal time and mean stagnation time increased by 100%. The responses to the Q-G and L-I maneuvers, though not totally uniform, were not significantly different from each other except one parameter. **CONCLUSIONS.** Hemodynamic changes occurring during performing the Q-G and the L-I maneuvers match with each other. The increase of HR, CO, PI and CBV indicate and explain the rise of blood pressure and these parameters are of help for further investigation on the mechanism of blood pressure rising in Q-G maneuver.

USE OF THE HOLTZ MONITOR DURING FLYING OPERATIONS. R.D. Banks*, G. Gray*. Canadian Forces, CFB Moose Jaw, Bushell Park, Sask, Canada S0H 0N0.

INTRODUCTION. Centrifuge cardiac evaluation of aircrew is limited to the +G environment and only partially simulates the physical stressors of the operational cockpit. This study evaluated the use of the Holter monitor as an assessment tool during actual flying operations. A secondary aim involved a comparison study of heart rate in pilots and students under various flight conditions. **METHODS.** A single blind study matched a group of student pilots with a group of pilot instructors for age, seated height, resting pulse and blood pressure. A total of 15 subjects were placed on the Holter monitor and flew identical missions involving timed maneuvers ranging from -1G to +5G. Technical problems involving use of equipment were identified and solved as they occurred. Quality of tracings was assessed and heart rates during flight maneuvers identified. Comparison was made of heart rates between groups during each maneuver. **RESULTS.** All technical problems were solved. All tracings were readable and of high quality. Heart rates varied with G-loading as expected, although notable differences occurred between the groups. Heart rates were higher in student pilots at -1G, and higher in instructors at +5G. Students demonstrated lower heart rates when in control of the aircraft. **CONCLUSION.** The Holter monitor is an effective assessment tool when used in the operational cockpit. Differences in cardiac performance noted during this study are reflective of differences in training and experience.