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POSTURAL EQUILIBRIUM TESTING OF AVIATORS: NORMATIVE SCORES AND ADAPTATION EFFECTS. K.A.Baylor*[1], B.J. McGrath*[1], S.M. Molstad[2], A.H. Rupert*[1], and F.E. Guedry*[3]. [1]Naval Aerospace Medical Research Laboratory, Pensacola, FL; [2]Northwestern State University, Natchitoches, LA; and [3]University of West Florida, Pensacola, FL.

INTRODUCTION. An estimated 29% of aviators experience symptoms of Simulator Sickness (SS) following simulator training. Highly sensitive measures are required to assess the aftereffects of simulator training on balance and coordination, and the impact on performance and safety. The Neurocom Equitest System is a clinical device that examines the interaction of vestibular, visual and proprioceptive inputs on the balancing ability of subjects. The purposes of this study were to develop a normative aviator database as compared to clinical norms, and to determine learning effects from repeated test sessions. METHODS. Fifty-three male and 33 female aviators were tested on an initial day using an Equitest System. Repeat testing was completed on 19 males and 11 females on four additional days. RESULTS. Sensory Organization Test (SOT) equilibrium scores for the aviators were significantly higher than clinical norms. Equilibrium scores on the first trial were significantly lower than on the two subsequent trials. Differences between males and females existed in a correlation between equilibrium and strategy scores. A significant learning effect existed for equilibrium, with a plateau reached after 3 days. Motor Coordination Test latency scores for male aviators were significantly faster than for females. CONCLUSIONS. The high aviator scores demonstrate the importance of establishing population-specific norms for balance research. Gender differences among the aviators on latency scores support previous research establishing similar differences in reaction time. The learning effects from repeated SOT tests, which reduce the effectiveness of this device to assess SS aftereffects in pre- and post-simulator testing, may be minimized with random-order trials.

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THE PSYCHOPHYSICAL FUNCTION FOR PERCEIVED GRAVITATIONAL-INERTIAL FORCE DOES NOT DEPEND ON THE ORIENTATION OF THE OTOLITH ORGANS. M. Cohen,* R. Welch,* and C. DeRoshia*. NASA-Ames Research Center, Moffett Field, CA 94035.

INTRODUCTION. It has generally been believed that the perceived intensity of a gravitational-inertial force depends on both the magnitude and orientation of the force with respect to the otolith organs, as does the elevator illusion. In this study, we examine the perceived intensity of Gz force and the elevator illusion as a function of the applied force and the orientation of S's head. METHODS. Each of eleven male Ss was seated upright in a swinging chair mounted in the Ames 20-G Human Centrifuge while he set a visual target to his apparent horizon and judged the perceived intensity of Gz forces by cross-modal matches on a hand dynamometer. Plateau Gz levels were 1.00, 1.25, 1.50, 2.00, 2.25, and 2.50; a 30-second ramp to plateau was used in all cases, and the duration of exposure at each plateau was 120 seconds. All measures were obtained both with S's head erect and pitched forward 30 degrees. RESULTS. Although the elevator illusion changed with head orientation ($F(6,60) = 7.56$; $p<0.001$), the perceived intensity of Gz was essentially the same for both orientations of the head ($F(6,60) = 0.61$; $p>.50$). CONCLUSIONS. The results of this experiment suggest that the perceived intensity of gravitational-inertial force does not depend on otolith mechanisms in the same way as does the elevator illusion and that somesthetic, tactile, and other proprioceptive inputs are important for the psychophysical function.

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USE OF INJECTABLE PROMETHAZINE TO DECREASE SYMPTOM SCORES OF SPACE MOTION SICKNESS. B.G. BECK, M.D.* A.E. NICOGOSSIAN, M.D.* MEDICAL OPERATIONS BRANCH, NASA-JSC, HOUSTON, TX 77058

Introduction. Space Motion Sickness (SMS) has been a problem affecting approximately 74% of first-time Shuttle flyers. Promethazine injections have been used for 29 cases of SMS to decrease the severity of their illness. Although reported to be effective in reducing symptoms in 27 of the 29 cases, there has been no proof of its efficacy. **Methods**. Retrospective analyses of Medical Debriefs examining the symptom scores for nausea, vomiting, decreased appetite, and stomach awareness were performed. Each symptom is rated on a mild=1, moderate=2, severe=3 system for each flight day. Crewmember scores from the first three flight days on an initial flight in which injectable promethazine had not been used were compared to scores in a later flight in which the promethazine was utilized. Scores were also compared in a similar group of crewmembers who did not use promethazine. **Results**. There was a decrease in median scores for all symptoms except nausea, however it was significant ($p=.014$) only for the vomiting scores. This significant decrease was not seen in the control group. **Conclusions**. Injectable promethazine has been associated with a significant decrease in vomiting compared to earlier flights in which injectable promethazine was not used.

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THE VESTIBULO-OCULAR REFLEX AND OPTOKINETIC NYSTAGMUS UNDER THE INFLUENCE OF CINNARIZINE. I. Doweck, A. Shupak, O. Spitzer, Y. Melamed and C.R. Gordon*. Motion Sickness and Human Performance Laboratory, Israeli Naval Hyperbaric Institute, Haifa, ISRAEL.

INTRODUCTION. Cinnarizine (Cn) is an antihistaminic agent with specific vestibular Ca++ channel blocking capacity, which has been found effective as an anti-motion sickness drug. We used the Vestibulo-ocular reflex (VOR) and the optokinetic nystagmus (OKN) to evaluate Cn's effects on the eye movement control mechanism. METHODS. The VOR parameters were evaluated using the Smooth Harmonic Acceleration Test (SHA) at 5 frequencies: 0.01-0.16 Hz. The OKN was also evaluated using a sinusoidal rotatory pattern at 3 frequencies: 0.01-0.04 Hz. The study was conducted on 16 healthy subjects aged 18-22. The effects of Cn 50 mg vs placebo were compared using a double-blind, randomized, crossover design 2 hours after drug administration. All 16 subjects underwent the SHA test, but only 12 completed the OKN test. RESULTS. Under the influence of Cn 50 mg, VOR gain at 0.04 Hz and phase lead at 0.16 Hz were significantly lower, while on the OKN test, phase lead values were higher at 0.01 Hz. CONCLUSIONS. Cn 50 mg partially affects both VOR and OKN parameters. The drug's influence on the OKN's phase parameter suggests that Cn affects the oculomotor pathways as well as the vestibular end organ.

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MOTION SICKNESS INVESTIGATION: THE CHOICE OF TREATMENT? I.A. Nichiporuk, A.I. Grigoriev. Institute for Biomedical Problems, Moscow, USSR.

INTRODUCTION. In spite of successful treated motion sickness (MS) episodes during space flights, this problem remains actual until its pathogeny will be clear.
METHODS. More than 100 various susceptible to laboratory induced MS male volunteers were examined by electro-physiological and radioimmune assay methods for estimation of central nerve system (CNS) activity and blood concentration of pituitary-adrenal, thyroid, pancreatic, and vasoactive hormones. Some energy metabolism substrates (EMS) were determined in brain structures during MS simulating animal experiments. Various drugs have been used for MS treatment. RESULTS. MS induced reactions expressed stress-associated hormones blood excess followed CNS excitation, and blood EMS increase for its easy delivery to brain structures. All drugs while being effective in MS treatment, significantly decreased CNS activity, accompanied with reduced endocrine and metabolic changes. CONCLUSION. Our data evidence that any effective pharmacological MS treatment probably would result in physical and psychological activity depression which could complicate flight program success. Therefore, no-drug MS countermeasures, or drug-induced adaptive reactions increase would be prefered.

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HEMODYNAMIC MEASUREMENTS DURING PARABOLIC FLIGHT A. Miyamoto*, S. Nagaoka, K. Suzuki, S. Kaneko, S. Watanabe*, S. Usui, J. Nakayama, T. Kojima.
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INTRODUCTION. A parabolic flight is a useful method as a simulation of weightlessness to study cardiovascular deconditioning, even though the available time is very short.
METHODS. Cardiac output and blood pressure were continuously monitored during parabolic flights performed by a small rear-jet aircraft (MU 300). A male subject, 28 years old, took 9 to 11 parabolic flights a day for 6 days. Two accelerating patterns, 2.5-G and 1.3-G level, were used. Cardiac output was measured by impedance cardiography and blood pressure was measured by a finger pressure cuff method. The positions of the subject were sitting up straight and sitting reclined.
RESULTS. Heart rate increased by 25% at 2.3-G accelerating period and decreased by 10% during low G period in the sitting up position. Stroke volume decreased by 30% at 2.3-G entry and increased by 30% during low G period. These changes became less in the 1.3-G pattern and in the sitting reclined position too. Diastolic blood pressure decreased during low G period. The subject seemed adapted in the latter parabolas in the same day.
CONCLUSION. These results suggested that the hemodynamic changes in the parabolic flight would be modified by the pattern of acceleration and adaptation of the subject.

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EVALUATION OF LBNP AS COUNTERMEASURE TO CARDIAC DECONDITIONING. K. Yajima*[1], M. Igarashi[1], A. Miyamoto*[1], M. Ito[1], K. Hirayanagi[1], T. Nakazato[1], S. Yumikura*[2], M. Doi[2] and C. Sekiguchi*[2]. 1)Nihon University, Tokyo, Japan, 2)NASDA.

PURPOSE and METHOD: To evaluate the effects of LBNP as a countermeasure for cardiac deconditioning in space, seven youngmale volunteers were admitted to the hospital andexperienced 6-degree head-down tilt (HDT) for 3 days. Passive 60-degree head-up tilt (HUT) was performed before and after HDT. Four volunteers received 30 mmHg LBNP for 30 minutes to induce fluid shift to the lower body twice a day (every morning and afternoon)during HDT for 3 days, while 3 of 7 volunteers (the control group) did not receive LBNP. Continuous blood pressure monitoring, heart rate, and impedanceplethysmogram were measured during the HUT test before and after HDT. **RESULTS:** One volunteer became presyncope during the first LBNPand also became presyncope again during the HUT test after HDT. The other LBNP volunteers (3 out of 4) did not show undesirable conditions. One volunteer of control grouphas become presyncope during the HUT test before HDT. However he did not become presyncope during the HUT test after HDT for3 days. **CONCLUSION:** 30 mmHg LBNP loading for 30 minutes twice a day didnot seem to prevent cardiac deconditioning induced by 3 days of 6-degree HDT.

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DISUSE OSTEOPOROSIS: CHANGES IN BIOCHEMICAL PARAMETERS DURING AND FOLLOWING SIMULATED MICROGRAVITY OF DIFFERENT DURATION.

K. Lohn*, DLR Cologne, Germany; S.R. Mohler*., E. Powers*, T. Hangartner, Wright State University, Dayton, OH.

A limiting factor for prolonged human exposure to microgravity is the loss of bone mass. Immobilization and bed rest have proved to be useful models for earth based simulation of weightlessness effects. To further our understanding biochemical bone parameters were observed over a period of 120 days in 15 healthy male volunteers, divided into three groups. Group I (5 subjects) experienced 3 weeks, Group II (5 subjects) 1 week of horizontal bed rest. Group III (5 subjects) served as ambulatory control group All bed rest subjects received a Ca balanced individual diet and were kept under close supervision in a hospital. Blood and urine samples were collected throughout the bed rest periods and during follw up (15 weeks).
Results: Serum and 24h urine parameters of Group I showed changes that resembled the typical mineral and hormonal pattern of disuse osteoporosis (slight increase of Serum Ca, increase of osteocalcin, decrease of serum PTH, increase of urinary Ca and Hydroxyproline). Group II showed similar trends, however, changes were not significant compared to base line.
Conclusion: A bed rest period of more than 1 week appears to be necessary to show significant biochemical changes due to immobilization.

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ENHANCED GAMMA COMPUTED TOMOGRAPHY FOR BONE DENSITY MEASUREMENT IN SHORT TERM BED REST SUBJECTS.

W.E. Powers*, S.R. Mohler*, K. Lohn, T.N. Hangartner, and N. Trimble, Wright State University, Dayton, Ohio 45401.

INTRODUCTION. Prolonged space flight may produce bone density loss of sufficient magnitude to adversely impact extended duration space travel. Trabecular bone density change which occurs early in space flight has not been adequately measured due to the limited accuracy of prior measuring devices. **METHODS.** The OsteoQuant gamma computed tomography device, with 0.5% change in trabecular bone density detection ability, was used to characterize changes in the bone density of healthy male bed rest subjects. Three groups of five subjects received periodic measurements of trabecular bone density of the distal radius and distal tibia: five had three weeks bed rest, five had one week bed rest, and five were controls. **RESULTS.** Trabecular bone density changes in the bed rest groups approached 1%. There was an unexpected rise in tibial trabecular bone density of both bed rest groups in the first week of bed rest , followed by a decline in bone density during the bed rest period. **CONCLUSION.** The initial rise in tibial trabecular bone density at the onset of bed rest may represent a new finding. The OsteoQuant could be used to measure changes in bone density in connection with current space shuttle missions.

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COMPUTER SIMULATION APPLICATIONS IN PLANNING STUDIES OF A NEW COUNTERMEASURE TO FLUID SHIFTS IN WEIGHTLESSNESS.

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Fluid shifts caused by the absence of gravity initiate a series of reflexes to reduce the blood volume (BV) to a new setpoint appropriate to the weightless environment. In addition, there are losses of other body fluids, and together these losses contribute to a reduction in postflight orthostatic tolerance. One possible way to counteract early fluid losses is to preadapt the circulation through a moderate BV reduction preflight. This concept has been validated in short-term water immersion experiments using human subjects, and in preliminary computer simulation studies using a mathematical model of circulation, fluid and electrolyte regulation. Results to date suggest that preflight adaptation of the BV to weightlessness could result in greater BV, extracellular volume, and total body water for 20 to 30 days of exposure. The optimum preflight BV reduction to apply appears to be the volume which would ultimately be lost in adapting to weightlessness; preadaptation by this volume results in the least deviation from fluid homeostasis following fluid shifts. Further modeling studies are planned prior to actual experimentation to test the countermeasure's effectiveness on enhancing postflight orthostatic tolerance by simulation of lower body negative pressure (LBNP), and to simulate fluid loading prior to reentry with and without the countermeasure. Computer simulation is being used to aid in the understanding of relevant mechanisms and in the planning of experimental studies by suggesting the selection and timing of variables to be measured. It is a highly cost-effective method to test interactions of current and planned countermeasures to determine the expected benefits and potential risks of their combined use.

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COMPARISON OF SALINE AND FLUDROCORTISONE AS FLUID-LOADING COUNTERMEASURES FOLLOWING EXPOSURE TO SIMULATED MICROGRAVITY.

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INTRODUCTION. Saline loading (SL) within hours of reentry is currently used as a countermeasure against postflight orthostatic hypotension in astronauts. However, its effects on blood volume expansion is not quantified and its effectiveness has proven marginal at best. The purposes of the present study were: 1) to quantify the effects of SL on plasma volume and orthostatic tolerance following exposure to simulated microgravity and 2) to compare these effects with the use of a pharmacological fluid expander, fludrocortisone (F). METHODS. eleven men (30-45 yr) underwent a 15-min stand test before and immediately after 7 days of head-down bedrest (BR). Five of the subjects ingested SL (8 g salt tablets with 1 liter of water) 2 hr before standing at the end of bedrest while the other 6 subjects received 0.2 mg oral doses of F at 0800 and 2000 hours the day before and 0800 hours the day the subject got out of bed (i.e., 2 hr before standing). Plasma volume (PV) was measured before BR, on day 7 of BR, and after the final SL and F treatments just before the post-BR stand test. Blood pressure and heart rate was measured continuously during the stand tests. RESULTS. BR decreased PV from 40.7±1.9 ml/kg to 35.9±1.1 ml/kg (-11.8%, $P<0.05$). Following SL, PV remained at 36.4±1.5 ml/kg while F returned PV to 39.1±1.8 ml/kg. The post-BR stand test was completed without syncopal symptoms by 5 of 6 F subjects but only 2 of 5 SL subjects. CONCLUSIONS. SL may be ineffective in restoring PV to preflight levels and may provide inadequate protection against postflight orthostatic hypotension. In contrast, F may provide a promising countermeasure since it restored PV and reduced the incidence of syncope following exposure to simulated microgravity in the present study.

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THE SPATIAL DISORIENTATION TRAINING SYSTEM BIULT IN AIR FORCE CHINA

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INTRODUCTION. To reduce the incidence of the Spatial Disorientation (SD) accidents a SD training System was built in AF of China. METHODS. This System consist of a). Education, through which the pilots should acquire adequate knowledge about the SD, its etiology, manifaction and the methods for coping with it ; b). Ground-Based training, through which allow the pilots to safely experience the SD , simulated by Barany chair and Optokinetic stimulator and to acquire adequate skill necessary to copy with SD by Visuo-Instrument Orientation ; c). In-Flight Training, trough which allows the pilots to acquire the factual ability of identifing SD (special for I type SD), induced by a series of flight maneuvers on the training aircraft and to acquire the skill of maitaining correct spatial orientation to solve disorientational conflict and the skill of developing optimum control strategies for recovery from unusual attitudes. More then ten thousands pilots are trained for overall training programm. RESULTS. After training, the SD incedence is reduced from 84.6% to 23.8%; the person-time of SD per every 100 h. flight is reduced from 0.95 to 0.6 ; the person-time of SD per every 100 h. night flight is reduced from 9.9 to 2.6; the averaged frequence of SD fatal accident per one year is reduced from 1.6 case (1980-1984, befor training) to 0.4 case (1985-1989, after training). CONCLUSION. This SD training System is realizable and effective for avoiding SD fatal accident.