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FREQUENCY AGILE LASER EYE PROTECTION: TECHNOLOGIES VS PERFORMANCE. J. B. Sheehy*. Naval Air Development Center, Warminster, PA 18974.

INTRODUCTION. With the introduction of military laser systems fixed wavelength laser eye protection became a high priority for both the aviator and soldier. Initially the number of wavelengths one might encounter were few and the optical density required to protect the human eye was low. As technology progressed the number of potential wavelengths and the power output of the various laser systems increased to the point were it is extremely difficult to provide protection against all possible wavelengths while ensuring adequate visual performance. With the advent of frequency agile lasers the approaches used in the past are no longer appropriate and new, dynamic forms of laser eye protection are required. Presently all the services are developing various forms of potential agile eye protection. In general, in order for the protection to be effective it must: 1) respond throughout the visible spectrum (400 to 700 nm, outside of the visible can be blocked with fixed filters), 2) activate at .5 uJ/square centimeter, 3) respond in less than a nanosecond (10E-9 sec), 4) relax after cessation of radiation, and ideally 5) become opaque at only the incident wavelength. Presently there are no perfect solutions, however, there are a number of viable non linear candidate materials such as liquid crystals, carbon suspensions, organometallics, thermally induced shifts in refractive index, and sacrificial films under investigation. The advantages, limitations, and the manner in which these technologies must be quantified will be discussed.

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ARTIFICIAL GRAVITY: HOW MUCH, HOW OFTEN, HOW LONG? R. Burton* and J. Vernikos*, Armstrong Laboratory, Brooks Air Force Base, TX 78235 and NASA-Ames Research Center, Moffett Field, CA 94035.

The argument is not overwhelming for the need to provide a continuous 1G environment using tethers or other means of spinning a spacecraft in order to maintain crew health in planetary exploration. Even on earth, we spend a maximum of 16-hrs in 1Gz (upright). Sporadic evidence over the years has suggested that somewhere between 30-min and 4-hrs of 1Gz may suffice to prevent the deconditioning effects of bedrest (orthostatic intolerance and the rise in calcium excretion). However, it is not known what the minimum requirements are, whether they vary for different physiological systems and whether passive Gz or the enhancement of the effects of activity conducted in an increased G field are more effective. It is similarly not known what the optimal duration and frequency of the G stimulus is, and how time of day might alter its effectiveness. Since acceleration level and duration appear to be physiologically interactive, it seems feasible to hypothesize that periodic acceleration exposures to greater than 1Gz levels provided by some on-board centrifuge, would suffice and should be explored.

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THE EFFECT OF INTERMITTENT STANDING OR WALKING DURING HEAD DOWN TILT BEDREST ON PEAK O_2 CONSUMPTION. A. C. Ertl, A. S. Dearborn, & J. Vernikos*. Life Sciences Division, NASA/Ames Research Center, Moffett Field, CA 94035.

INTRODUCTION. The cardiovascular aspect of bedrest deconditioning is manifest by decreases in peak O_2 uptake (VO_{2peak}) during maximal exercise. The effect of intermittent standing ($+G_Z$) or walking ($+G_ZW$) during 4 days of -6° head down tilt bedrest (HDT) on VO_{2peak} was evaluated. METHODS. Five protocols were performed by eight male subjects; control (C) consisting of complete bedrest, and 15-min periods to total 2 or 4 hours daily of standing ($+G_Z2$ and $+G_Z4$, respectively) or walking at 3.0 MPH ($+G_ZW2$ and $+G_ZW4$, respectively). Subjects performed VO_{2peak} tests prior to and on the final day of HDT. VO_{2peak} was determined using open circuit indirect calorimetry during supine leg cycling ergometry. After a 5-min warmup, three 2-min incremental loads of 33 W previously determined to elicit VO_{2peak} were given and the subject cycled to volitional fatigue. RESULTS. The C protocol VO_{2peak} decreased by 16% (2.71±0.16 to 2.27±0.14 L/min). VO_{2peak} decreased by 12% in $+G_Z2$ (2.65±0.14 to 2.33±0.11 L/min) and 11% in $+G_Z4$ (2.72±0.15 to 2.43±0.14 L/min). With $+G_ZW2$, VO_{2peak} decreased by 9% (2.71±0.17 to 2.46±0.14 L/min) and with $+G_ZW4$, VO_{2peak} decreased by 10% (2.71±0.14 to 2.43±0.14 L/min). VO_{2peak} in all protocols decreased with HDT ($P<0.05$). The decrease in C VO_{2peak} was significantly greater ($P<0.05$) than the decreases in either $+G_Z$ or $+G_ZW$ protocols. CONCLUSION. The deconditioning that occurs after only 4 days of HDT was demonstrated by decreases in VO_{2peak}. Intermittent $+G_Z$ or $+G_ZW$ attenuated, but did not prevent, the decrease in VO_{2peak} with HDT.

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PERIODIC UPRIGHT POSTURE NEGATES THE SUPPRESSION OF NEUROENDOCRINE RESPONSE TO HEAD DOWN BEDREST. C. E. Wade*, J. Vernikos*, J. Evans, and D. O'Hara. Life Science Division, NASA/Ames Research Center, Moffett Field, CA 94035.

INTRODUCTION. Head down bedrest (HDT) decreases plasma neurohormone levels, attaining a nadir within four hours. The present study evaluates the effect of periodic standing or exercise ($+G_Z$) on this acute suppression of plasma neurohormones. METHODS. Nine male subjects (mean±SE age 37±2 yr; height 182±2 cm; weight 83±3 kg) were admitted to the Human Research Facility on three occasions separated by one month. Subjects were assigned to head down tilt (-6°) or 15-minutes of standing or moderate exercise at the end of each hour. Initially, during an ambulatory period, subjects were placed in a supine position for 45-min and a control blood sample obtained. The next day following 4-hours of HDT with or without standing or exercise a blood sample was taken 45-min (3 3/4 hours into HDT) after the preceding stand or exercise. Blood was withdrawn and all plasma samples frozen for determination of neurohormone levels within the same assay. Plasma aldosterone, plasma renin activity (PRA), vasopressin (AVP), and cortisol levels were measured by radioimmunoassay. Norepinephrine (NE) and epinephrine (E) levels were measured by electrochemical detection following HPLC. Values were compared by ANOVA, $P<0.05$. RESULTS. Control levels following 45-min supine were not different between treatments. HDT suppressed plasma aldosterone (13.9±3.7 to 6.6±0.7 ng/dl) and NE levels (299±35 to 217±23 pg/ml). Plasma vasopressin (1.1±0.2 to 1.1±0.2 pg/ml), cortisol (11.1±1.4 to 9.3±0.7µg/dl), E (69±15 to 65±21 pg/ml), and PRA (0.64±0.13 to 0.58±0.17 ngAl/ml/hr) were not significantly altered. Standing or exercise negated the decrease in aldosterone and NE levels due to HDT. CONCLUSIONS. Periodic upright posture ($+G_Z$) with or without exercise for 15-min out of each hour negates the acute suppression of aldosterone and NE associated with HDT.

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THE EFFICACY OF PERIODIC +1Gz EXPOSURE IN THE PREVENTION OF BEDREST INDUCED ORTHOSTATIC INTOLERANCE D.A. Ludwig[1], J. Vernikos[1], M.R. Duvoisin & J.L. Stinn. Dept. of Math, Univ. of NC, Greensboro, NC 27412, Life Science Division, NASA-Ames Research Center, Moffett Field, CA 94035 and Biomedical Operations and Research Office, NASA-KSC, Kennedy Space Center, FL 32899.

INTRODUCTION. What is the most efficient dosage of periodic exposure to +1Gz during microgravity to maintain a functional upright posture after returning to a +1Gz environment? The answer has implications for the type of countermeasures astronauts will be required to perform during long term space flight. METHODS. Nine males were subjected to four different +1Gz exposure protocols plus a control protocol ("0Gz") during four days of continuous bedrest. The four +1Gz exposures consisted of periodic standing or walking each for a total period of two or four hours. Each subject was returned for bedrest on five different occasions over a period of approximately one year to obtain data on each of the nine subjects across all four +1Gz treatments and the control. A 30min tilt test was used to measure orthostatic response during pre and post bedrest. RESULTS. In terms of survival rate (percent of subjects who did not faint after 30sec of tilt), 4 hours of intermittent standing was the only protocol that maintained a rate comparable to pre bedrest levels (87.5%). Although the other three +1Gz protocols performed better than the "0Gz" control (22.2%), only the four hour standing returned post bedrest survival rates to pre bedrest levels. CONCLUSIONS. The results will need to be evaluated with regards to a variety of other physiological systems which are known to decondition during microgravity.

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THE VALUE OF THE 4-DAY HEADDOWN BEDREST MODEL FOR SCREENING COUNTERMEASURES. J. Vernikos*, L. Keil, A. C. Ertl, C. E. Wade*, J. E. Greenleaf*, D. O'Hara, and D. Ludwig*. NASA/Ames Research Center, Moffett Field, CA 94035 and University of North Carolina at Greensboro, Greensboro, NC 27403.

In order to evaluate the benefits of periodic exposure to the +Gz vector as a countermeasure to the physiological responses to -6° head-down bedrest (HDT), we considered a two-tiered approach: (a) to use 4-days HDT as a quick and inexpensive means of screening countermeasures, (b) to use a 60 day HDT to validate the most promising candidates. The approach and results of a 4-day study are described here. Methods: Nine males were admitted to our Human Research Facility for one ambulatory control day followed by 4-days HDT and were released on the next day after completion of a peak oxygen consumption test (VO_{2peak}). A battery of tests was selected and standardized to evaluate the known early effects of HDT on plasma volume, early bone markers, orthostatic tolerance, physical performance, and fluid and electrolytes and their hormone regulation. Fluid, sodium (Na) and potassium (K) intake and output in the urine were monitored throughout. Plasma volume was determined with a modified Evans Blue method and orthostatic tolerance with a 60° head-up tilt test for 30 minutes—both of which were determined on the ambulatory control day and on day 4 of HDT. Immediately after completion of the tilt test, subjects were returned to the -6° position until the next morning when a VO_{2peak} (horizontal bicycle ergometer) was done. This was compared to a similar control test determined on 2 separate occasions before subject admission. Results: Four hours after going HDT produced significant decreases ($p<0.05$) in the circulating concentration of fluid and electrolyte regulating hormones. Plasma volume, orthostatic tolerance and VO_{2peak} changed significantly after 4-days HDT. There was also the expected natriuresis on day 1 of HDT but no significant diuresis. The consistency of the pre-bedrest VO_{2peak} tilt tests and plasma volumes was remarkable. Conclusions: The 4-day HDT model seems highly promising for screening a variety of countermeasures alone and in combination before validating their benefits in extended bedrest or flight experiments.