

/A71-23365 Effect of prolonged bed rest on renal diluting capacity in normal man. Murray Epstein (USAF, School of Aerospace Medicine, Brooks AFB, Tex.). *Journal of Applied Physiology*, vol. 30, Mar. 1971, p. 366-369. 19 refs.

The effects of 2 weeks of absolute bed rest on renal diluting capacity were studied in eight normal young male subjects. An acute sustained oral water load of 20 ml/kg was administered during a control period of normal activity, on the 13th day of absolute bed rest and on the 4th or 14th day of postbed-rest recovery. Bed rest did not significantly alter peak urine flow corrected for GFR (V/GFR), ability to generate free water (CH₂O) or to achieve minimal urine osmolality. The results suggest that despite analogies with adrenal insufficiency, including both a decrease in plasma volume and a decrease in adrenocortical reserve, prolonged bed rest does not impair renal diluting capacity. (Author)

FASOLA, A.F.

The renin response to lower body negative pressure stress testing and the effect of exercise during prolonged bedrest.

In: Preprints of the 1970 Annual Scientific Meeting, Aerospace Medical Association, St. Louis, Missouri, April 27-30, 1970.

It would appear from these studies that plasma renin activity is increased as a result of strict bedrest. The observation that renin activity was also increased in the exercising subjects, though not to the same degree, would suggest that the effects of bedrest were attenuated by exercise. If the incidence of syncope is used as the criterion for orthostatic intolerance then exercise as utilized in this study is of no benefit.

It is also apparent that weightlessness, as simulated by strict bedrest, does not remove the stimulus for renin release and that the renin-angiotensin system is reset at a higher than normal level. The mechanism for this increased responsiveness is unknown.

FEDOROV, I.V. 1971.
Hypodynamia and hormonal activity.
Space Biology and Medicine 5(4):85-89.

62
Eng. transl.

[Article by I. V. Fedorov; Moscow, Kosmicheskaya Biologiya i Meditsina (Space Biology and Medicine), Russian, Vol 5, No 4, pp 59-61, 1971, submitted for publication 9 December 1970]

Abstract: Data in the literature on changes in the production of hormones (corticosteroids, adrenalin, adrenocorticotrophic hormone, antidiuretic hormones, and 5-hydroxyindolacetic acid) during hypodynamia are reviewed. Potential results of changes in hormonal activity are discussed.

FISCHER, C.L., C. LEACH, and P.C. JOHNSON. 1971.

Hematologic implications of hypodynamic states.

In: R.H. Murray and M. McCally, eds. Hypogravic and Hypodynamic Environments.
Washington, D.C., National Aeronautics and Space Administration. pp. 27-34.
[NASA-SP-269].

The red cell mass and plasma volume changes noted in the hypodynamic states of bed rest and water immersion are reviewed, and these changes are compared with the hypodynamic and hypogravic state characteristics of earth orbital missions.

Author

A70-19937 *

RENAL FUNCTION, WATER AND ELECTROLYTE EXCHANGE DURING BED REST WITH DAILY EXERCISE.

James H. Fuller, Edmund M. Bernauer, and William C. Adams (California, University, Davis, Calif.).

Aerospace Medicine, vol. 41, Jan. 1970, p. 60-72. 33 refs.

Grant No. NGR-05-004-021.

Investigation of the effect of leg exercise on renal function, electrolyte and water metabolism during bed rest. Eight young adult males underwent nine days of continuous recumbency, during which half exercised 30 min twice daily on a horizontal bicycle ergometer, while the remainder served as controls. Ten days before, and during bed rest, metabolic exchange of water, sodium, potassium, and chloride was calculated; seven days following bed rest, water and electrolyte input was ad libitum and output was measured. Lean body mass (LBM), body fat and total body potassium were measured before and after bed rest. On the first day of recumbency, urinary volumes were increased by 11% and 18%, sodium balance was -71 mEq and -109 mEq, and chloride balance was -61 mEq and -74 mEq in the exercise and control groups, respectively. Thereafter, these parameters were slightly increased, whereas potassium excretion remained elevated throughout bed rest, with a cumulative loss of 80 mEq in the exercise and 174 mEq in the control group. Loss of LBM and total body potassium and gain of body fat was two to three times greater in the controls. It is concluded that the major influence of exercise consists in the attenuation of degenerative changes in certain maintenance systems—i.e., contraction of plasma volume, elevation of renal plasma flow, and glomerular filtration. M.V.E.

FULLER, J. H., E. M. BERNAUER and W. C. ADAMS. *Renal function, water and electrolyte exchange during bed rest with daily exercise*. *Aerospace Med.* 41(1):60-72. 1970.

Eight young adult males underwent nine days of continuous recumbency, during which half exercised 30 min twice daily on a horizontal bicycle ergometer, while the remainder served as controls. Ten days before, and during bed rest, metabolic exchange of water, sodium, potassium and chloride was calculated; seven days following bed rest, water and electrolyte input was ad libitum and output was measured. P-amino hippurate (PAH) and creatinine clearances in resting and exercise states, and blood volume were measured during all three periods, while lean body mass (LBM), body fat and total body potassium were measured before and after bed rest. On the first day of recumbency, urinary volumes were increased by 11% and 18%, sodium balance was -71 mEq and -109 mEq, and chloride balance was -61 mEq and -74 mEq in the exercise and control groups, respectively. Thereafter, these parameters were slightly increased, whereas potassium excretion remained elevated throughout bed rest, with a cumulative loss of 80 mEq in the exercise and 174 mEq in the control group. Renal clearance of PAH increased 250 ml/min, creatinine increased 11 ml/min and plasma volume decreased 7% relative to pre-bed rest values in the control group, whereas these parameters changed only slightly in the exercise group. Loss of LBM and total body potassium and gain of body fat was two to three times greater in the controls. Although body water, sodium, chloride and blood volume seemed to be reset initially at lower levels during recumbency and after several days were less affected, while other parameters appeared to change according to the length of bed rest, and were better stabilized when exercise was employed.

GATTS, J.D., and D.A. BEARD. June 1967.
Human Factors Suitability of the Gravitational Acceleration Simulation
Suit (GASS). Final Report.
Fairchild Hiller Corp., Farmingdale, L.I., N.Y. 52 p.

Studies were performed on five adult male subjects for a period of 3 consecutive weeks to evaluate the human factors suitability and potential use of the Gravitational Acceleration Simulation Suit (GASS) as a protective device for the prevention of the physiological deconditioning associated with prolonged bed rest or weightlessness. The GASS device is designed to simulate the gravitational force acting on an individual in an upright position. This force is perceived by the weight supporting musculoskeletal (antigravity) system independent of gravitational force or the orientation of the longitudinal axis of the body. Therefore, this device has application in a weightless environment. The results of this study indicate that subjects without previous conditioning were able to tolerate the device for 5 hours per day, consecutively for 3 weeks, and then become ambulatory immediately without the deleterious effects of dizziness, weakness, vertigo, and postural degradation normally associated with such an extended recumbent position. The intent of the study was to test the human factors suitability of such a device for use in space flights; however, physiological data was gathered during the course of the study that indicates, though not conclusively, a definite pattern of protection from excessive cardiovascular and musculoskeletal deconditioning. Further research is suggested with larger numbers of test subjects designed to test the physiological acceptability of the GASS device for extended periods.

GENIN, A.M., P.A. SOROKIN, G.I. GURVICH, T.T. DZHAMGAROV, A.G. PANOV, I.I. IVANOV, and I.D. PESTOV. 1969.

Basic results from studies of the influence of 70-day hypodynamia on the human organism.

In: A.M. Genin and P.A. Sorokin, eds. Problems of Space Biology. Volume 13: Prolonged Limitation of Mobility and its Influence on the Human Organism. Washington, D.C., Scripta Technica, Inc. pp. 256-262. [NASA-TT-F-639].

The results obtained during the experiment are examined in juxtaposition to the expected consequences of hypodynamia, which are presented in diagram form. Certain aspects of the influence of prolonged bed rest on the organism are revealed: a decrease in immunological resistance, certain disturbances to the mental functions, the development of trophic changes in the myocardium, and changes in reactivity to medication. The specifically designed physical conditioning procedures were found to be relatively effective in mitigating the detrimental effect of hypodynamia. Author

A70-24696 # Principal results of the investigations of the effect of a 70-day hypodynamia on the human organism (Osnovnye rezul'taty issledovaniia vliianiia 70-sutochnoi gipodinamii na organizm cheloveka). A. M. Genin, P. A. Sorokin, G. I. Gurchich, T. T. Dzhagmarov, A. G. Panov, I. I. Ivanov, and I. D. Pestov). In: Prolonged immobility and its effect on the human organism (Dlitel'noe ogranichenie podvizhnosti i ego vlianie na organizm cheloveka). (A70-24665 10-04) Edited by A. M. Genin and P. A. Sorokin. Moscow, Izdatel'stvo Nauka (Problemy Kosmicheskoi Biologii. Volume 13), 1969, p. 247-253. 8 refs. In Russian.

Comparison of the experimental results obtained with the hypodynamia consequences expected. In the course of the investigation, some new aspects of the effects of prolonged bed rest on the organism came to light: lowering of the immunological resistance, certain psychic-function disorders, development of trophic changes in the myocardium, changes in responses to pharmaceuticals, etc. The specially developed methods of physical training proved to be the relatively most effective means for reducing the unfavorable consequences of hypodynamia. M.V.E.

GENIN, A.M. and P.A. SOROKIN, eds. 1970.
Problems of space biology. Volume 13: Prolonged limitation of mobility and
its influence on the human organism.
Washington, D.C., Scripta Technica, Inc. 271 pages.

Original prepared by: Moscow, USSR, 1969
(Contract NASw-2036)
(NASA-TT-F-639) Avail: NTIS CSCL06S

Papers are presented from a complex clinical-physiology study of healthy subjects who were confined to bed for long periods. The following are described in broad terms: effects of prolonged mobility restriction on functional systems, tolerance to orthostatic tests and load factors, efficacy of physical exercises and other prophylaxis in preventing unfavorable shifts in the organism during prolonged confinement to bed.

GENIN, A.M. and P.A. SOROKIN. 1970.

Prolonged limitation of mobility as a model of the influence of weightlessness on the human organism.

In: A.M. Genin and P.A. Sorokin, eds. Problems of Space Biology. Volume 13: Prolonged Limitation of Mobility and its Influence on the Human Organism.

Washington, D.C., Scripta Technica, Inc. pp. 1-7. [NASA-TT-F-639].

Experimental approaches to evaluation of the biological effects of prolonged weightlessness are examined. Laboratory simulation of weightlessness, with prolonged bed rest as an example, is defended. The initial conception that formed the basis for the 70-day hypodynamia study is formulated.

Author

A70-24666 # Prolonged restriction of mobility as a model of the influence of weightlessness on the human organism (Dlitel'noe ogranichenie podvizhnosti kak model' vlianiia nevesomosti na organizm cheloveka). A. M. Genin and P. A. Sorokin. In: Prolonged immobility and its effect on the human organism (Dlitel'noe ogranichenie podvizhnosti i ego vlianie na organizm cheloveka). (A70-24665 10-04) Edited by A. M. Genin and P. A. Sorokin. Moscow, Izdatel'stvo Nauka (Problemy Kosmicheskoi Biologii. Volume 13), 1969, p. 9-16. 13 refs. In Russian.

Investigation of experimental methods of estimating the biological effects of prolonged weightlessness. Attention is given to the study of reactions arising during laboratory simulation of certain factors which are characteristic for prolonged weightlessness. Emphasis is placed on the relative value of bed confinement, and the basic concepts involved in studies of 70-day hypodynamia are outlined.

T.M.

31,684

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Genin, A.M. and L.I. Kakurin. Thirty-day experiment simulating the physiological effects of weightlessness. Kosmicheskaya Biologiya i Meditsina, Vol. 6, No. 4, pp. 26-28, July-August 1972. (Space Biol. & Med. 6(4):42-44)

S&T ALERT

ITEM NO. 985

Scan Topics: 04-04 Aerospace Medicine
04-06 Physiological Factors

An attempt has been made to correlate data on physiological functions within the scope of a light program, the tolerance of test subjects to stresses produced by transition to the vertical position, and the compatibility of various preventive measures. The experiment involved nine test subjects divided equally into three groups confined to strict bedrest for 30 days. To simulate weightlessness, the foot of the bed was raised at a 4° angle. Two general conclusions are drawn. The use of a hypodynamic model with the test subjects in an anti-orthostatic position revealed certain additional elements in the simulation of weightlessness effects reflected in sensations of temporary hyperemia, face pastosity, and an upside-down illusion with the eyes closed. These phenomena are attended by changes in blood redistribution that could be confirmed by observations of the fundus oculi. The second conclusion applies to a positive assessment of the entire set of preventive measures.

(LD)

GEORGIYEVSKIY, V.S. and V.M. MIKHAYLOV. 1968.
Effect of hypokinesia on human circulation.
Space Biology and Medicine 2(3):73-78.

The combined effect of bedrest and accelerations on human circulation was studied using mechano- and polycardiographic techniques. The experiments were conducted on young healthy male test subjects. The experiments demonstrated an increase in heart rate and average blood pressure, a decrease in the ejection period and development of orthostatic hypotension. Variations in some hemodynamic indices indicated a phasic pattern reaching a maximum on the 32d-42d day.

Author

ACCESS. NO. 15,137

FORM: _____ AUTHOR: ✓ DRILL: ✓

22880. GEORGIEVSKII, V. S., and V. M. MIKHAILOV. Vliyaniye gipokinezii na krovoobrashchenie cheloveka. [Effect of hypokinesia on the human circulation.] KOSM BIOL MED 2(3): 48-51, 1968. [Engl. sum.]

DOCUMENT NO.: BA(50)22880

DESCRIPTORS: Acceleration Y/1, Bedrest GY/39, Biological rhythm GY/21, Circulatory system R/10
Human BL/72, Pressure Y/28, Technique P/1, USSR GR/3.

1968.

ABSTRACT:

--A combined effect of bed rest and accelerations on the human circulation was studied, using mechano- and polycardiographic techniques. The experiments were carried out on young healthy male test subjects. The experiments demonstrated an increase of heart rate and average blood pressure, a decrease of the ejection period and development of orthostatic hypotension. Changes of some hemodynamic indices showed a phasic pattern, reaching maximum on the 32-42nd day.--Authors.

GEORGIEVSKII, V.S., L.I. KAKURIN, B.S. KATKOVSKII, and Yu.A. SENKEVICH. 1969. Maximum oxygen consumption and functional state of the circulation in simulated zero gravity.

In: N.V. Lauer and A.Z. Kolchinskaya, eds. The Oxygen Regime of the Organism and its Regulation (Symposium). Jerusalem, Israel Program for Scientific Translations, Ltd. pp. 181-184. [NASA-TT-F-501].

Elucidated were the effects of prolonged, strict bed rest on a subject's consistency of working at maximum intensity. Tests involved increasing physical loads before and after the stay in bed. In bicycle ergometer tests several respiratory and circulatory indexes were recorded in addition to work performed, oxygen consumption, and pulse rate. Experimental data revealed diminishing muscular activity following restriction of motor activity in all subjects. Although the maximum amount of work performed did not reach the normal level, the capacity for increasing energy production during increased duration of muscular work was retained. Performance of the same work following bed rest with restricted motor activity made severe demands on the cardiovascular system which in turn brought the circulation to its initial level. G.G.

ACCESS. NO. 14,087

FORM: ☒ AUTHOR CARD COMPLETED ☒

MAXIMAL OXYGEN CONSUMPTION AND THE FUNCTIONAL STATE OF THE CIRCULATORY SYSTEM FOLLOWING SIMULATED WEIGHTLESSNESS, Foreign Technology Div Wright-Patterson AFB Ohio V. S. Georgievskii, L. I. Kakurin, B. S. Katkovskii, and Yu. A. Senkevich. 29 Mar 68, 9p Rept no. FTD-HT-23-124-68

Edited trans. of Simpozium. Posvyashchennyi izucheniyu Kislородnogo Rezhima Organizma i Ego Regulirovaniya, Kanev, 1965, also pub. as Kislородnyi Rezhim Organizma i Ego Regulirovanie. Materialy (Oxygen Balance of the Organism and Its Regulation, Materials), Kiev, 1966 400p, by F. Dion.

DOCUMENT SERIES & NO.: AD-679 504-DDC

4 N69-17930

DESCRIPTORS: CARBON DIOXIDE W/72, ACTIVITY GR/58, OXYGEN W/74, CIRCULATORY SYSTEM R/10, SIMULATION BK/36, WEIGHTLESSNESS Y/35, WATER W/77, MUSCULAR SYSTEM R/53, PRESSURE Y/28, HUMAN BL/72, RESPIRATORY SYSTEM R/21, BEDREST GY/39, GRAVITY Y/31, EKG BK/34, BIOINSTRUMENTATION BK/30. 1968.

ABSTRACT:

The effects of simulated weightlessness on oxygen consumption and the functional state of the cardiovascular system were studied in four healthy male subjects aged 22-25 yrs. Weightlessness was simulated by 20 days of rigorous bed rest (the horizontal position of the body during bed rest creating a hydrostatic pressure distribution similar to that produced by the absence of gravity). Motor activity was kept to a minimum; the subjects were aided in feeding and toilet functions by nursing personnel, and passed the time in reading, chatting,

and watching TV. Before and after bed rest the subjects underwent progressive physical-loading tests consisting of work of increasing difficulty on a veloergometer. Endurance limits were considered reached when the subjects were unable to continue and when O2 consumption and pulse rates reached high levels. The amount of work performed during the test, O2 consumption and CO2 excretion, phonocardiograms, carotid sphygmograms, and EKGs were recorded. (Author) AD-679 504 HCS3.00 MFS0.65

GEORGIYEVSKIY, V.S., V.A. GORNAGO, L.Ya. DIVINA, N.D. KALMYKOVA, V.M. MIKHAYLOV, 72
V.I. PLAKHATNYUK, Yu.D. POMETOV, V.V. SMYSHLYAYEVA, N.D. VIKHAREV, and
B.S. KATKOVSKIY. 1974.

Orthostatic stability in an experiment with 30-day hypodynamia.
Space Biology and Medicine 7(6):88-97.

[Article by V. S. Georgiyevskiy, V. A. Gornago, L. Ya. Divina, N. D. Kalmykova, V. M. Mikhaylov, V. I. Plakhatnyuk, Yu. D. Pometov, V. V. Smyshlyayeva, N. D. Vikharev and B. S. Katkovskiy; Moscow, Kosmicheskaya Biologiya i Meditsina, Russian, Vol 7, No 6, November-December 1973, pp 61-68, submitted 1 October 1971]

Abstract: Nine test subjects were kept for 30 days in bed with their heads tilted 4° downwards. At the end of the experiment they exhibited a decrease in orthostatic stability. The use of different countermeasures, including physical exercises and lower body negative pressure (LBNP), considerably improved their orthostatic stability. Electric stimulation of the muscles also produced a preventive effect, although to a lesser extent. It should be expected that a combination of physical exercises, LBNP and electric stimulation of the muscles during prolonged space flight may exert a positive effect on orthostatic stability.

A68-29809 *

RESPONSE TO THE SPACE ENVIRONMENT AND ITS SIMULATION
BY BEDREST.

Siegfried J. Gerathewohl (NASA, In-Flight Science Branch, Washington, D.C.) and Pauline B. Mack (Texas Woman's University, Denton, Tex.).

IN: HUMAN ECOLOGY IN SPACE FLIGHT. VOLUME 2 - PROCEEDINGS OF THE SECOND INTERNATIONAL INTERDISCIPLINARY CONFERENCE, PRINCETON, N.J., OCTOBER 11-14, 1964.
[A68-29808 14-04]

Conference sponsored by the Office of Naval Research of the U.S. Navy and NASA.

Edited by D. H. Calloway.

New York, N.Y. Academy of Sciences, 1967, p. 13-81.

Group discussion of the human response to the space environment and the simulation of this environment by bedrest, including a comparison of U.S. and USSR methods of treating the problem of manned space exploration. Advantages to be realized by combining physics and biology are outlined. Observed responses to space flight are considered with reference to problems of weightlessness, muscular work and posture, and response to long-term bedrest.

F. R. L.

A72-43389 # Calcium metabolism under stress and in repose. R. S. Goldsmith (Mayo Foundation, Rochester, Minn.). In: Life sciences and space research X; Proceedings of the Fourteenth Plenary Meeting, Seattle, Wash., June 21-July 2, 1971. (A72-43381 23-04) Berlin, East Germany, Akademie-Verlag, 1972, p. 87-101. 36 refs.

Derangement of calcium metabolism constitutes a major threat to the health of participants in exploration of space. Experiments are described which indicate that during prolonged bed rest osteopenia and complications of the demineralizing process (resorption of bone) develop and endanger the survival of the organism. Such complications include hypercalcemia, hypercalciuria and nephrolithiasis, and muscle wasting. Available techniques for study of the effects of weightlessness and prophylactic agents are outlined. F.R.L.

ACCESS. NO. 2996

A64-24971

CARDIOVASCULAR DECONDITIONING - ROLE OF BLOOD VOLUME AND SYMPATHETIC NEUROHORMONES.

D. E. Graveline (USAF, Systems Command, Aerospace Medical Div., Brooks AFB, Tex.).

IN: LIFE SCIENCES AND SPACE RESEARCH II; INTERNATIONAL SPACE SCIENCE SYMPOSIUM, 4TH, WARSAW, POLAND, JUNE 3-12, 1963.

Sponsored by the Committee on Space Research (COSPAR).

Edited by M. Florkin and A. Dollfus.

Amsterdam, North-Holland Publishing Co.; New York, Interscience Publishers, 1964, p. 287-298. 29 refs.

FORM: 1 AUTHOR CARD COMPLETED

75

DOCUMENT SERIES & NO.: A64-24971 (IAA)

DESCRIPTORS: Bedrest GY/39, Chemical W/29, Circulatory system R/10, Endocrine system R/65, Gravity Y/31, Human BL/72, Immobilization GR/62, Nervous system R/48, Water immersion P/24

ABSTRACT:

1964

Demonstration, by means of studies of prolonged bed rest and water immersion, that serious deconditioning of certain gravity-oriented biologic systems occurs with extended exposures to environments in which the necessity for gravity compensation has been reduced. It is stated that the precise physiologic mechanisms responsible for the loss of orthostatic tolerance following such studies are unknown, but may be related to diminished blood volume, decreased muscle or tissue pressure in the extremities, or to functional alterations in the sympathetic nervous system. It is noted that, in view of the fact that noradrenaline is the principal agent for maintaining vascular tone, attention has been focused on the sympathetic nervous system as being the system most likely responsible for the loss of orthostatic tolerance following such experiments. The contributory effects of diminished circulating blood volume resulting from such environments are also discussed.

Graveline, D. E. and Barnard, G. W.: Physiologic Effects of a Hypodynamic Environment: Short-term Studies. *Aerospace Med.* 32: 726, 1961.

SUMMARY

By a technique involving complete immersion in water, a hypodynamic situation was produced in which normal weight sensations were altered and movement was relatively effortless. Four subjects were evaluated after six, twelve and twenty-four hours of this environment. Tilt table, centrifuge and heat chamber studies demonstrated significant cardiovascular deterioration even after the six-hour runs, becoming progressively more severe with the twelve and twenty-four-hour experiments. Pertinent psychomotor evaluations, anthropometric measures and urine and blood studies also were done. The results of this study indicate that the cardiovascular adaptation to a hypodynamic environment of this type occurs early and the deterioration from even a six-hour exposure is readily apparent.

TASK NUMBER: 970-21-17-05

0548

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CITATION: GREENLEAF, J.E., H.L. YOUNG, E.M. BERNAUER, R.H. ARMERUSTER, L.A. SAGAN, R.W. STALEY, L. JUHOS, W. VAN BEAUMONT and H. SANDLER. Effects of isometric and isotonic exercise on body water compartments during 14 days bed rest. In: *Preprints of the 1973 Annual Scientific Meeting, Aerospace Medical Association*, Las Vegas, Nevada, May 7-10, 1973. p. 23-24. ~~Avail. Aerospace Medical Association.~~

PERFORMING INSTITUTION: ARC IN HOUSE

KIND OF DOCUMENT: Research Report

SUBJECTS: Seven healthy adult males

RES. OBJECT.

Study the effect of reduction in hydrostatic pressure on fluid and electrolyte shifts and losses and the effect of isometric and isotonic exercise training on fluid and electrolyte changes.

METHOD

Plasma volume (PV) and extracellular fluid volume (ECF) were measured periodically on 7 healthy men (19-22 yr) who underwent 2 14 day ambulatory control period, 3 14-day bed rest periods separated by 2 21-day recovery periods, and a final 4 days of recovery. During the control and recovery periods the subjects exercised 1 hr daily at 50% of their max O₂ uptake in the upright position on a bicycle ergometer. During bed rest the subjects performed in the supine position (a) no exercise (NOE); (b) 2 30-min periods daily of isometric exercise (IME) at 21% of their max leg extension force with 1 min work and 1 min rest; and (c) 2 30-min periods of isotonic leg exercise (ITE) on the ergometer at 60% of their max oxygen uptake. The subjects ate a controlled diet of normal foods. All emunctory functions were performed in the horizontal position. Plasma vol and plasma and urinary electrolytes were measured.

RESULTS

Systolic and diastolic blood pressures, respiration and oral temperature were essentially constant during the control, bed rest and recovery periods and the 2 exercise regimes had no effect on these variables. Body weight decreased about 2.5 kg in the control period and remained constant during bed rest with no exercise and isometric exercise, but declined by 1.8 kg during bed rest with isotonic exercise due, in part, to the increased energy expenditure of about 800 kcal/day (800 kcal/day = wt loss of 1.3 kg/2 wk). Basal pulse rate decreased in the 3 control periods and under all 3 exercise conditions exhibited a 7-day cycle with a maximal amplitude of 6 to 8 beats per minute. The 2 types of exercise appeared to have no influence on the frequency or amplitude of the cycle. Compared with control values, the average ECF values dropped 2.6% and 2.7% on day 4 with IME and ITE, but decreased 4.4% (860 ml) with NOE; the ECF returned to control levels by day 13. Average PV on day 4 decreased by -11.3% (387 ml) with NOE, -11.3% (396 ml) with IME, but only -6.3% (208 ml) with ITE; the control value for ITE was lower than for the other two conditions. By day 13, the PV remained depressed with IME and ITE and continued to decline with NOE. A diuresis was evident on the first day of bed rest, followed by a decline to control levels for 2 days and then stabilization at about 1.8 L/24 hr with IME and NOE and about 1.5 L/24 hr with ITE.

CONCLUSIONS

In general, the fluid and electrolyte changes during 14 days bed rest were not significantly affected by moderately heavy isometric and isotonic exercise. The major stimulus for these changes appears to be the reduction in hydrostatic pressure within the cardiovascular system with the accompanying decreased stress on the muscles and bones. Since ECF was restored to control levels by the end of bed rest in the presence of hypovolemia, it appears the controlling mechanism is influenced by the total ECF vol rather than PV.

19.75 C

CITATION: GREENLEAF, J.E., W. VAN BEAUMONT, E.M. BERNAUER, R.F. HAINES, H. SANDLER, R.W. STALEY, H.L. YOUNG and J.W. YUSKEN. Effects of rehydration on +G_z tolerance after 14-days' bed rest. *Aerospace Medicine* 44(7):715-722. 1973.

PERFORMING INSTITUTION: ARC IN HOUSE

KIND OF DOCUMENT: Research Report

SUBJECTS: Eight healthy young men

RES. OBJECT.	METHOD	RESULTS	CONCLUSIONS
Determine magnitude of reduction in centrifugation (+G _z) tolerance following bed rest deconditioning; evaluate degree of lowered plasma volume (hypovolemia) involved; assess if rehydration prior to acceleration would improve +G _z tolerance.	During a period of 10 weeks, the subjects underwent a 3-week ambulatory control period (C), 2 weeks of bed rest (BR-1), 2 weeks of ambulatory recovery (R), 2 weeks of bed rest (BR-2) with rehydration prior to centrifugation, and a final week of recovery. Centrifugation (+G _z) tolerance was measured immediately before and at the end of each bed rest period. Subjects ate a balanced diet and exercised 1/2 hr each day on a bicycle ergometer at 50% of their maximal oxygen uptake. All subjects were exposed to +G _z acceleration profiles of 2.1, 3.2, and 3.8G, presented in random order, on the ARC 8.8m human centrifuge. Acceleration tolerance was determined by loss of central vision (blackout) or of peripheral vision (greyout). Subjects were rehydrated with 1.0 to 1.9 liters of a cooled drink containing 143 mEq/l Na, 31 mEq/l K, with total osmotic concentration of 620 mOsm/l given over a 3-hr period to replace the calculated loss of extracellular fluid (ECF) volume before centrifugation in BR-2. Plasma volume was determined with the Evans Blue dye dilution method and measurement was made spectrophotometrically.	There were significant reductions in average +G _z tolerances following both bed rest periods at all 3 G-levels. Compared with control values, the average tolerances following BR-1 decreased 36% at 2.1G, 30% at 3.2G, and 44% at 3.8G. Compared with recovery values, the average tolerances following BR-2 decreased 23% at 2.1G, 29% at 3.2G, and 34% at 3.8G. Rehydration increased tolerance only at 2.1G but not to the level of control values. There was large interindividual variability in tolerance. During BR-1 the average plasma volume decreased from 3,118 to 2,787 and the decrease was slightly greater during BR-2. Rehydration increased plasma volume by 6.5% (183 ml) which is approximately half the 11.9% loss during BR-2.	(a) 2 weeks of bed rest with moderate daily isotonic exercise results in a significant decrease in +G _z tolerance; (b) there is no additional loss in tolerance after 2 weeks of bed rest compared with 1 week of bed rest without exercise, i.e., 1/2 hr of moderate isotonic exercise does not alter the reduction in tolerance after bed rest; and (c) at 2.1G, replacement of 59% of the calculated extracellular fluid loss restores 64% of the tolerance lost from bed rest deconditioning.

GREENLEAF, J. E., W. VAN BEAUMONT, E. M. BERNAUER, R. F. HAINES, H. SANDLER, R. W. STALEY, H. L. YOUNG, and J. W. YUSKEN. Effects of rehydration on +G_z tolerance after 14 days' bed rest. *Aerospace Med.* 44(7):715-722. 1973.

To determine if rehydration increases +G_z tolerance following bed rest deconditioning, eight male volunteers (21-23 yrs) were subjected to acceleration levels of 2.1 G (740 sec), 3.2 G (327 sec) and 3.8 G (312 sec) presented in random order; the rate of acceleration was 1.8 G/min. Acceleration tolerance was determined by either loss of peripheral vision (greyout) or by loss of central vision (blackout) to a white light with a luminance of 1.2×10^{-2} candles/cm (35.3 foot-lamberts). The experimental design consisted of a 3-week ambulatory control period (C), 2 weeks of bed rest (BR1), followed by a 2-week ambulatory recovery period (R), then 2 weeks of bed rest with rehydration prior to centrifugation (BR2) and a final week of recovery. +G_z tolerance was measured immediately before and at the end of each bed rest period. The subjects ate a calorically controlled, nutritionally balanced diet and exercised 1/2 hr each day on a bicycle ergometer at 50% of their maximal oxygen uptake approx. 450 kcal/day) during the entire study. The subjects were rehydrated with 1.0 to 1.9 liters of a drink, containing 143mEq/l Na, 31 mEq/l K and a total osmolality of 620 mOsm/l, given over a 3-hour period before centrifugation in BR2.

There were significant ($p < 0.05$) reductions in average +G_z tolerances following both bed rest periods at all three G-levels. Compared with control values, following BR1, average ramp plus plateau tolerances decreased 36% at 2.1 G, 30% at 3.2 G and 44% at 3.8 G. Compared with recovery values, following BR2, average tolerances decreased 23% at 2.1 G, 29% at 3.2 G and 34% at 3.8 G. Rehydration increased tolerance ($p < 0.001$) only at 2.1 G, but tolerance was not completely restored to control values. Compared with control values, average tolerances at all three G-levels were lower after the recovery period, suggesting that 2 weeks of recovery is not long enough to permit tolerance to return to pre-bed rest levels. After bed rest the time full visual capability can be maintained at plateau during these acceleration profiles can be estimated from the equation: Tolerance (sec) = $345 + (1605/G\text{-level})$. In relaxed, deconditioned men without protective garments, tolerance at 2.0 G is 7.6 min and the level of instant blackout is about 4.7 G. It is concluded that 2 weeks of bed rest results in a significant decrease in centrifugation to tolerance which occurred despite the use of moderate daily isotonic exercise. Compared to nonhydration control values, rehydration significantly improves +G_z tolerance only at 2.1 G but did not return tolerance to ambulatory control levels.

A72-28295 * # +Gz tolerance after 14 days bed rest and the effects of rehydration. J. E. Greenleaf, W. van Beaumont, E. M. Bernauer, R. F. Haines, H. Sandler, H. L. Young, and J. W. Yusken (NASA, Ames Research Center, Biotechnology Div., Moffett Field, Calif.). In: Aerospace Medical Association, Annual Scientific Meeting, 43rd, Bal Harbour, Fla., May 8-11, 1972, Preprints. (A72-28251 12-04) Washington, D.C., Aerospace Medical Association, 1972, p. 112, 113; 10 refs.

Measurement of the reduction in centrifugation tolerance after two weeks of bedrest with moderate daily exercise, with an attempt to determine if rehydration improves +Gz tolerance. There were significant reductions in +Gz tolerance during bedrest periods at three acceleration levels. Rehydration resulted in a significant increase in tolerance at 2.1G but it did not restore tolerance to control levels. Rehydration did not affect tolerance at 3.2G and 3.8G. F.R.L.

In: Preprints of the 1972 Annual Scientific Meeting, Aerospace Medical Association, Bal Harbour, Florida, May 8-11, 1972. p. 112-113.

GRINIO, L.P., T.N. KRUPINA, and N.N. BOBKOVA. 1971.
Cytogenetic investigations in relation to manned space flight.
Space Biology and Medicine 5(3):77-83.

[Article by L. P. Grinio, T. N. Krupina and N. N. Bobkova; Moscow, Kosmicheskaya Biologiya i Meditsina, Russian, Vol 5, No 3, 1971, pp 51-55, submitted 20 October 1969]

Abstract: No increase in chromosomal aberrations was found in the blood of test subjects during a 120-day bedrest experiment. No significant changes in the chromosomal apparatus were detected in cytogenetic examinations of the cosmonaut G. T. Beregovoy. These findings indicate that manned space flights made along the trajectories and in radiation environments involved up to this time are genetically safe.

30, 378. GRINIO, L.P., T.N. KRUPINA, and N.N. BOBKOVA. Cytogenetic studies related to a space flight of man (Tsitogeneticheskie issledovaniia v svyazi s kosmicheskim poletom cheloveka). Kosmicheskaya Biologiya i Meditsina, vol. 5, May-June 1971, p. 51-55. 25 refs. In Russian.

A71-39227

A chromosome analysis was carried out in peripheral blood leukocytes from 4 healthy men after 120 day hypokinesia, and cytogenetic tests on Soviet astronaut Beregovoy prior to and after his space flight. An increase in chromosome aberrations in the subjects or significant changes in the chromosome apparatus of the astronaut could not be established by the study. It is concluded that the Soiuz 3 flight of Beregovoy was safe in terms of cytogenetic radiation damage.

40845. GRINIO, L. P., T. N. KRUPINA and N. N. BOBKOVA. Tsitogeneticheskie issledovaniya v svyazi s kosmicheskim poletom cheloveka. [Cytogenetic studies related to manned space flights.] KOSM BIOL MED 5(3): 51-55. illus. 1971. [Engl. summ.]--No increase of chromosome aberrations was found in the blood of test subjects during a 120 day bed rest experiment. No significant changes in the chromosome apparatus were detected through cytogenetic examinations of the cosmonaut G. T. Beregovoy. Manned space flights performed along the trajectories and in the radiation environments used to date are safe from the genetic point of view.--M. L. W.

ACCESS. NO. 24,163

FORM: _____ AUTHOR: LB DRILL: LB

GURFINKEL, V.S., et al. 1970.

Changes in certain human motor functions after prolonged hypodynamia.

In: A.M. Genin and P.A. Sorokin, eds. Problems of Space Biology. Volume 13:

Prolonged Limitation of Mobility and its Influence on the Human Organism.

Washington, D.C., Scripta Technica, Inc. pp. 148-159. [NASA-TT-F-639].

81

DOCUMENT NO.: N70-42869

DESCRIPTORS: Activity GR-58, Human BL-72, Immobilization GR-62, Pathology GY-66, Therapy GY-38,
Technique P-1, USSR GR-3.

1970.

ABSTRACT:

The influence of prolonged hypodynamia on the retention of such motor functions as maintaining vertical position, walking, and rising from the supine position, and the innervation relationships (crossover effects in the spinal cord, vestibulospinal effects) on which these functions are based were investigated and the various ways of preventing hypokinetic disturbances were evaluated. The motor functions studied were selected because they are primarily automatic and independent of voluntary intervention under ordinary conditions. The physical conditioning methods used in the experiments were effective in preventing gross motor disturbances.

R.B.

N67-39112 Joint Publications Research Service, Washington, D. C.

BRAIN HEMODYNAMICS DURING PROLONGED HYPOKINESIA

G. I. Gurvich and G. D. Yefimenko *In its Space Biol. and Med.*, Vol. 1, No. 3 22 Sep. 1967 p 97-102 (See N67-39097 23-04)

The rheoencephalographic technique was applied to a study of cerebral hemodynamics of four test subjects exposed to prolonged (up to 75 days) hypokinesia. Examinations were made prior to, during, and following the bed rest experiment. Observations also were made with the aid of orthostatic tests performed at the end of bed rest. The studies revealed a phasic pattern of changes of cerebral hemodynamics and their correlation with changes of higher nervous activity. In addition, the experiments revealed that the rheoencephalographic technique can be used for early diagnosis of intolerance to prolonged hypokinesia and precollaptoic states during orthostatic tests.

Author

A67-36266 #

BRAIN HEMODYNAMICS DURING PROLONGED HYPOKINESIA [GEMODINAMIKA GOLOVNOGO MOZGA V PROTSESSE DLITEL'NOI GIPOKINEZII].

G. I. Gurvich and G. D. Efimenko.

Kosmicheskaya Biologiya i Meditsina, vol. 1, May-June 1967, p. 62-66. 7 refs. In Russian.

Application of a rheoencephalographic technique to the study of the brain hemodynamics of four human subjects exposed to hypokinesia for periods of up to 75 days. Medical examinations were made before, during, and after the bed-rest period, and included orthostatic tests at the end of the period. The observations revealed a phasic pattern of changes in brain hemodynamics and their correlation with functional changes of the central nervous system. The results indicate that the rheoencephalographic technique is well suited for early diagnosis of intolerance to prolonged hypokinesia and precollaptoic states during orthostatic tests.

V.P.

✓N68-13195# Joint Publications Research Service, Washington, D. C.

CHANGE OF THE PSYCHOPHYSIOLOGICAL STATE OF THE BODY BY AUTOGENOUS AND EXOGENOUS SUGGESTION

G. I. Gurvich, V. L. Marishchuk, M. I. Tishchenko, G. D. Yefimenko, and B. S. Khvoynov. *In its Space Biol. and Med.*, Vol. 1, No. 4 19 Dec. 1967 p 114-118 refs (See N68-13181 04-04)

The objective of this study was an investigation of changes of the activity of organs and systems of the human body subjected to prolonged bed rest by autogenous or exogenous suggestion. Six test subjects underwent a 70-day bed rest. Three test subjects served as controls. The other three subjects were trained for the first two weeks on how to stress or relax different muscle groups with subsequent sleep suggestion. According to ECG and EEG recordings and myotonometric and actographic data sleep began in the seventh-fifteenth minute after the second-third week of the experiment. Beginning with the fifth week the test subjects engaged in autosuggestion, attaining similar results. Exogenous suggestion also was performed, employing a radio and a tape recorder. The procedure described provided sound refreshing sleep of the test subjects at the scheduled time.

Author

A67-41855 #

CHANGING OF THE PSYCHOPHYSIOLOGICAL STATE OF THE ORGANISM BY AUTOGENEOUS AND EXOGENEOUS SUGGESTION [IZMENENIE PSIKHOFIZIOLOGICHESKOGO SOSTOYANIYA ORGANIZMA PUTEM AUTOGENNOGO I EKZOGENNOGO VNUSHENIYA].

G. I. Gurvich, V. L. Marishchuk, M. I. Tishchenko, G. D. Efimenko, and B. S. Khvoynov.

Kosmicheskaya Biologiya i Meditsina, vol. 1, July-Aug. 1967,

p. 73-76. 10 refs. In Russian.

Application of autogenous and exogenous suggestion to the study of the activity of the organs and systems of the human organism after exposure to prolonged (70 days) bed rest. It was found that after three days of training, the test subjects were capable of finding a sound refreshing sleep even against a stress-factor background and to fall asleep at a prescribed time.

V. P.

84

A72-28297 * // Effect of bedrest and positive radial acceleration upon peripheral visual response time. R. F. Haines (NASA, Ames Research Center, Moffett Field, Calif.). In: Aerospace Medical Association, Annual Scientific Meeting, 43rd, Bal Harbour, Fla., May 8-11, 1972, Preprints. (A72-28251 12-04) Washington, D.C., Aerospace Medical Association, 1972, p. 116, 117. 7 refs.

Attempt to determine if peripheral visual response time (RT) could be used as a reliable advanced predictor of +G sub z-related blackout or grayout. The relatively high luminance of the peripheral stimuli used in the experiments may account for the finding that peripheral RT was not sensitive to impending blackout or grayout. The relatively consistent mean RTs within subjects across test days in bed is probably due to the relatively constant response characteristics of the retina and to the high repeatability of the stimuli. F.R.L.

In: Preprints of the 1972 Annual Scientific Meeting, Aerospace Medical Association, Bal Harbour, Florida, May 8-11, 1972. p. 116-117.

A73 24566 * Effect of passive 70-deg head-up tilt on peripheral visual response time. R. F. Haines (NASA, Ames Research Center, Moffett Field, Calif.). *Journal of Applied Physiology*, vol. 34, Mar. 1973, p. 329-333. 32 refs.

Peripheral visual response time was measured continuously in seven young men during a 30-min, 70-deg head-up tilt before and after 14 days of bed rest. Small test lights were flashed on at unexpected times and locations along the subject's horizontal retinal meridian to determine what effect tilt would have on peripheral visual sensitivity and to better understand the physiological mechanisms that underlie peripheral visual sensitivity. Blood pressure was also measured every other minute throughout this period. The results indicated that response time lengthens significantly to stimuli imaged beyond about 70-deg arc from the line of sight for both the pre- and postbed-rest periods during tilt.

(Author)

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N73-15117*# National Aeronautics and Space Administration,
Ames Research Center, Moffett Field, Calif.
EFFECT OF PROLONGED BEDREST AND PLUS G_z
ACCELERATION ON PERIPHERAL VISUAL RESPONSE
TIME

Richard F. Haines Washington Jan. 1973 66 p refs
(NASA-TN-D-7161; A-4566) Avail: NTIS HC \$3.00 CSCL
06S

Peripheral visual response time changes during +G sub z acceleration following fourteen days of bedrest are considered as well as what effect prolonged bedrest has upon this response. Eighteen test lights, placed 10 deg apart along the horizontal meridian of the subject's field of view, were presented in a random sequence. The subject was instructed to press a button as soon as a light appeared. Response time testing occurred periodically during bedrest and continuously during centrifugation testing. The results indicate that: (1) mean response time is significantly longer to stimuli imaged in the far periphery than to stimuli imaged closer to the line of sight; (2) mean response time at each stimulus position tends to be longer at plateau g than during the preacceleration baseline period; (3) mean response time tends to lengthen as the g level is increased; (4) peripheral visual response time during +G sub x acceleration at 2, 3.2, and 3.8 g was not a reliable advanced indicator that blackout was going to occur; and (5) the subject's field of view collapsed rapidly just before blackout. Bedrest data showed that the distribution of response times to stimuli imaged across the subject's horizontal retinal meridian remained remarkably constant from day to day during both the bedrest and recovery periods.

Author

HAINES, R. F. *Effect of prolonged bedrest and +G_z acceleration upon peripheral visual response time.* Aerospace Med. 44 (4): 425-432, 1973.

Cardiovascular deconditioning, dehydration, and other physiological changes which occur as a result of prolonged exposure to the zero-g space environment raise some questions about the applicability of much previous research which has shown that spacecraft reentry accelerations pose no appreciable physiological or performance problems for the astronauts. The present paper deals with whether or not peripheral visual response time changes during +G_z acceleration after 14 days of bedrest. Eighteen test lights, placed 10° arc apart along the horizontal meridian of the subject's field of view, were presented in a random sequence. The subject was instructed to press a button as soon as a light appeared. This testing occurred periodically during bedrest and continuously during centrifugation testing. The results indicated that: (1) mean response time was significantly longer ($p < 0.01$) to stimuli imaged in the far periphery than to stimuli imaged closer to the line of sight during +G_z acceleration, (2) mean response time at each stimulus position tends to be longer at plateau g than during the pre-acceleration baseline period for that run by an amount which ranged from about 20 to 120 msec, (3) mean response time tends to lengthen as g level is increased, and (4) under these testing conditions peripheral visual response time during +G_z acceleration within approximately 40 seconds of blackout does not provide a reliable indicator that blackout is going to occur. The bedrest response time data showed that the distribution of RTs across the horizontal retinal meridian remained remarkably constant within subjects from day to day during the bedrest and recovery periods. These findings are discussed in relation to previous studies and to the design and placement of aerospace vehicle cockpit instruments.

HAINES, R.F. 1973.

Effect of Prolonged Bedrest With Exercise on Body Balance.

In: Preprints of the 1973 Annual Scientific Meeting, Aerospace Medical Association, Las Vegas, Nevada. p. 17-18.

The following questions were raised here:

(1) What effect does 14 days of bedrest have on body balance immediately after bedrest? (2) Is it possible for body balance after bedrest to be maintained at prebedrest levels by daily isometric (IM) or isotonic (IT) leg exercise? (3) What is the learning rate before and relearning rate after bedrest on various balance tests? (4) Are some balance tests more sensitive than others in detecting the effects of prolonged bedrest?

Neither type of leg exercise was effective in preventing the debilitating effects of 14 days of bedrest on body balance. These results suggest that a factor other than bedrest-related muscular weakness or disuse atrophy of the leg muscles accounted for these decrements. This bedrest may have produced sensory, kines-

thetic, and/or proprioceptive neural information to postural control centers that was different from the information produced under normal, upright, ambulatory conditions. Some Ss remarked that, although they knew they were starting to fall, they could not get their limbs or torsos to move fast enough to compensate appropriately to forestall the excessive sway. After bedrest, balance skill was relearned rapidly so that performance on most tests had returned to prebedrest levels by the third recovery day. Nevertheless, the learning rate for the eyes-closed tests was about the same before bedrest as after. The one-leg rail balance/eyes-open test was the most sensitive test of the debilitating effects of bedrest using a criterion of prebedrest balance score stability versus postbedrest change.

A70-33991 * Human circadian circulatory rhythms during weightlessness in extraterrestrial flight or bedrest with and without exercise. Franz Halberg (Minnesota, University, Minneapolis, Minn.), Carlos Vallbona (Baylor University; Texas Institute for Rehabilitation and Research, Houston, Tex.), Lawrence F. Dietlein, John A. Rummel, Charles A. Berry (NASA, Manned Spacecraft Center, Houston, Tex.), Grover C. Pitts, and Sarah A. Nunneley (Ohio State University, Columbus, Ohio). *Space Life Sciences*, vol. 2, May 1970, p. 18-32. 32 refs. PHS Grants No. 5-K6-GM-13,981; No. FR-00254; Grant No. NGR-24-005-006; Contracts No. NAS 9-6162; No. NAS 2-1554; No. NAS 2-2738.

Detection of human circadian rhythms in heart rate and in the durations of electromechanical systole and of the entire cardiac cycle by an inferential statistical analysis, the cosinor method. These findings apply to men on earth in bed for several days, whether or not they intermittently perform isometric exercise. Rhythms also are demonstrated in men at a few hundred nautical miles from earth experiencing weightlessness for several days during extraterrestrial space flight; whether or not these circadian rhythms are 24-hour synchronized cannot be discussed with the data on hand. Such demonstrations of rhythm persistence in astronauts and cosmonauts underline the need for further work on mammals to define and to control those rhythmic factors affecting not only the longer-term scheduling of human activities in extraterrestrial space but also rhythmic behavior in health and disease on earth. Given such background information, the long-term behavior of rhythms in organisms transferred to terrestrial, lunar, and eventually solar orbits remains a major challenge for research in extraterrestrial space. M.V.E.

TASK NUMBER: 970-51-17-02

CITATION: HANTMAN, D.A., J.M. VOGEL, C.L. DONALDSON, R. FRIEDMAN, R.S. GOLDSMITH and S.B. HULLEY. Attempts to prevent disuse osteoporosis by treatment with calcitonin, longitudinal compression and supplementary calcium and phosphate. Submitted for publication to *Journal of Clinical Endocrinology*. May 1973.

PERFORMING INSTITUTION: USPHS Hospital, San Francisco, California

KIND OF DOCUMENT: Research Report

SUBJECTS: 6 healthy males

RES. OBJECT.

METHOD

RESULTS

CONCLUSIONS

To study the efficacy of various treatments in the prevention of disuse osteoporosis during prolonged bed rest.

Subjects were studied during 19 weeks of continuous bed rest and three treatment regimens were tested for their effectiveness in preventing bone mineral loss: 1) 100 MRC units of synthetic salmon calcitonin was administered daily; 2) intermittent compression in the longitudinal axis was applied by springs attached to a special suit (a force equal to 80% of body weight was applied 45 times per minute for 4 hours daily); and 3) calcium and phosphate supplements were administered, increasing daily intake of calcium from 1.0 to 1.8 or 2.3 gm, and that of phosphorus from 1.7 to 3.0 gm.

1) Synthetic salmon calcitonin (100 MRC units daily) did not prevent the negative calcium and phosphorus balances which are observed during untreated bed rest. The increase in urinary calcium and hydroxyproline excretion was unusually large in one of the two subjects. 2) The negative mineral balances were not substantially affected by this regimen. 3) Calcium balances were significantly less negative than those of control subjects in four of five cases; phosphorus balances showed similar patterns. Combined administration of these three regimens to two subjects also produced a beneficial response. These results which are based on mineral balance data were only partially confirmed by gamma ray transmission scanning of the central calcaneus, and some discrepancies were noted.

It was concluded that the two month course of calcium and phosphate supplements retarded the development of disuse osteoporosis, but that the intermittent compression and calcitonin were ineffective.

91
HAMRIN, E. 1971.

Anatomical and functional changes in joints and muscles during long term bed rest.

Nordisk Medicin 85:293-8. 11 Mar. 1971

Anatomical and functional changes in joints and muscles during long-term bed rest

ELISABETH HAMRIN

This paper presents a survey of the literature on *Anatomical and functional changes in joints and muscles during long-term bed rest*. The study was carried out at the Institute of Anatomy and Histology at the University of Uppsala, Sweden. No clinical research has been made at the present stage, but some practical conclusions have been drawn on the basis of experience from the Uppsala sick-care district.

Research on the adverse effects of bed rest has been very sparse. Between 1929 and 1963, only 15 investigations were published, but this figure does not include any reports from Russia, and only 9 of them concerned proper bed rest (29). Space medical research in the 1960s, however, has shown great interest in the effects of bed rest on the organism. Several of these investigations are included in the survey.

A71-39480 * The summation-dial, a vectorial representation of time series data. N. W. Hetherington, C. M. Winget, L. S. Rosenblatt (NASA, Ames Research Center, Physiology Branch, Moffett Field, Calif.), and P. B. Mack (Texas Woman's University, Denton, Tex.). (*International Institute for Interdisciplinary Cycle Research, International Interdisciplinary Cycle Research Symposium, 2nd, Noordwijk, Netherlands, June 14-19, 1970.*) *Journal of Interdisciplinary Cycle Research*, vol. 2, Aug. 1971, p. 365-377.

Development of mathematical methods which would be applicable to data both stationary and nonstationary in time. The basic method suggested has been utilized for many years in the study of geomagnetism, and is here extended to the study of the interrelationships between two rhythms. These methods are described, and examples derived from a study involving 8 male human subjects who had undergone 56 days of bed rest, following a 6-day ambulatory or control period, are cited.

F.R.L.

HOFFLER, G.W., M.D., R.A. WOLTHUIS, PH.D., and R.L. JOHNSON, M.D.

Effect of seven days of bed rest on cardiovascular responses
to lower body negative pressure.

In: Preprints of the 1971 Annual Scientific Meeting, Aerospace Medical
Association, Houston, Texas, April 26-27, 1971.

P. 174-175.

ACCESS. NO. 12,318

FORM: ☒ AUTHOR CARD COMPLETED ☒

~~A68-31829~~ #

CIRCULATORY EFFECTS OF WATER IMMERSION UPON HUMAN SUBJECTS.

William B. Hood, Jr., Raymond H. Murray, Charles W. Urachel, John A. Bowers, and Jack K. Goldman (USAF, Systems Command, Aerospace Medical Div., Aerospace Medical Research Laboratories; Indiana University, Cardiopulmonary Laboratory, Wright-Patterson AFB, Ohio).

Aerospace Medicine, vol. 39, June 1968, p. 579-584. 35 refs.
Contract No. AF 33(616)-8378.

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DOCUMENT SERIES & NO.: A68-31829 (IAA)

DESCRIPTORS: Bedrest GY/39, Bradycardia GY/45, Circulatory system R/10, Human BL/72, Water immersion P/24

ABSTRACT:

1968

Changes in hemodynamics were studied in five human volunteer subjects during two separate eight-hour periods of bed rest and total water immersion. During immersion subjects showed a decline in pulse rate, arterial blood pressure, and peripheral vascular resistance, and exhibited elevation of stroke volume compared to the control state. Central venous mean blood pressure fell with immersion, presumably in response to the relative negativity of the airway pressure supplied to the subjects. These findings suggest that water immersion results in these circulatory changes: (1) relative bradycardia, with a secondary increase in stroke volume, and (2) peripheral vasodilatation, with secondary decline in arterial pressure. These findings are not explained either by loss of plasma volume or by relative negative pressure breathing, and presumably are a consequence of exposure to the "buoyant state."

(Author)

TASK NUMBER: 970-51-17-02

CITATION: HULLEY, S.B., D.R. LOCKWOOD, C.L. DONALDSON and J.M. VOGEL. Attempts to prevent bone mineral loss during prolonged bed rest. Presented at the 23rd International Astronautical Congress, Vienna, Austria, October 8-15, 1972. 10 p.

PERFORMING INSTITUTION: USPHS Hospital, San Francisco, California

KIND OF DOCUMENT: Research Report

SUBJECTS: 34 adult males

RES. OBJECT.

To determine the nature and extent of the alterations in the bone metabolism caused by bed rest, which parallels those of prolonged weightlessness.

METHOD

Over a period of 4 yrs, 34 young men were rested in bed continually for periods of 17-36 wks. Movements in the horizontal plane were not restricted. Whole food metabolic diet contained 1.0 gm calcium and 1.6 gm phosphorus per day. Skeletal changes were assessed by metabolic balance techniques and by ¹²⁵Iodine gamma ray transmission scanning of the calcaneus. The researchers also undertook physical and chemical countermeasures such as longitudinal compression and oral administration of minerals respectively.

RESULTS

Calcium is gained before it is lost. Hypercalciuria reaches a peak of 100 mg/day at about the 6th week of bedrest; similar fecal gains were also shown. However, continued bed rest yields only losses at an overall rate of 1/2% of total body calcium per month.

CONCLUSIONS

Scans show that minerals are lost from the calcaneus at a tenfold greater rate, suggesting that demineralization occurs differentially from weight-bearing bones. Fortunately, the calcaneus is completely replenished during reambulation. But treatment regimens did not prevent phosphorus and calcium loss to any meaningful degree. While treatment worked on hypercalciuria, it failed to prevent increased hydroxyproline excretion during bed rest.

TASK NUMBER: 970-51-17-02

CITATION: HULLEY, S.B., J.M. VOGEL, C.L. DONALDSON, J.H. BAYERS, R.J. FRIEDMAN and S.N. ROSEN. The effect of supplemental oral phosphate on the bone mineral changes during prolonged bed rest. *The Journal of Clinical Investigation* 50(12):2506-2518. 1971.

PERFORMING INSTITUTION: USPHS Hospital, San Francisco, California

KIND OF DOCUMENT: Research Report

SUBJECTS: 5 healthy males

RES. OBJECT.

To determine whether administration of oral potassium phosphate prevents the development of disuse osteoporosis.

METHOD

Subjects underwent 24-30 wk continuous bed rest. Pre- and post bed rest data. Diet consisted of 7 daily menus and 1 hexavitamin tablet daily. Supplemental phosphate was orally administered as Hyper-Phos-K tablets. Serum, stool, urine and sweat were collected. Specimens were digested in nitric acid for Ca and Mg determinations and in sulfuric acid for P and N determinations. Changes in skeletal mineral content were assayed indirectly by Ca balance techniques and directly by gamma ray transmission and scanning of the calcaneus and radius.

RESULTS

During the first 12 wk bed rest the rate of total body Ca in untreated Ss was 0.5-0.7%/month. Rate of loss of central calcaneus material was 10 times higher but mineral content of the radius was unchanged. Changes in P balance resembled Ca pattern and increased N and hydroxyproline also occurred during bed rest. Upon reambulation the Ss' Ca balance became positive after 1 month and recovery of the calcaneus mineral was complete within 10-20 weeks. Potassium phosphate treatments entirely prevented the hypercalciuria of bed rest but fecal Ca tended to increase. In the first 12 wks Ca balance was less negative than during bed rest. Mg patterns of excretion were similar to Ca. Fecal and urinary phosphorus excretions were doubled and phosphorus balance became positive. Mineral loss from the central calcaneus was similar to that of untreated Ss.

CONCLUSIONS

This form of phosphate supplementation reduces urinary Ca excretion but does not prevent bone loss during bed rest.

HYATT, K.H., P.C. JOHNSON, G.W. HOFFLER, P.C. RAMBAUT, J.A. RUMMEL, S.B. HULLEY, J.M. VOGEL, C. HUNTOON, and W.R. SPEARS. 1973. The Effect of Potassium Depletion in Normal Males: An Apollo 15 Simulation.

In: Preprints of the 1973 Annual Scientific Meeting, Aerospace Medical Association, Las Vegas, Nevada. p. 100-101.

Although the bedrest subjects showed no clinical evidence of hypokalemia, the results of this limited study do not totally exclude the possibility of hypokalemic manifestations in the Apollo 15 astronauts. All of the environmental and atmospheric factors of Apollo 15 could not be reduplicated in the present study. In this regard, Knochel has shown that six subjects who underwent intensive physical conditioning in a hot climate showed a mean potassium deficit of 422 meq after 11 days in spite of a daily potassium intake of 100 meq (7).

CONCLUSIONS

The present study, while not providing definitive answers regarding the experiences of Apollo 15, points up the need for more detailed studies of the effect of manned space flight on potassium metabolism. Additional ground-based studies relating ^{42}K measurements to potassium balance under a variety of conditions should be performed. Similar detailed studies should be performed on the astronauts of Skylab to allow correlation with these ground-based studies. Until our knowledge of the effects of space flight conditions on such significant bodily functions as electrolyte metabolism is accurate and sufficient, more extensive space exploration could contain risks for which we are ill-prepared to avoid or manage.

A69-33179

EXTRAVASCULAR DEHYDRATION AS AN ETIOLOGIC FACTOR, IN POST-RECUMBENCY ORTHOSTATISM.

Kenneth H. Hyatt, Leonid G. Kamenetsky, and William M. Smith
(U.S. Public Health Service, Hospital, Cardiopulmonary Laboratory,
San Francisco, Calif.).

Aerospace Medicine, vol. 40, June 1969, p. 644-650. 34 refs. .
NASA-supported research.

The hemodynamic and metabolic effects of two weeks of absolute bedrest have been evaluated in twenty normal volunteers. Post-recumbency tilting resulted in a more profound decrease in stroke volume and cardiac output than had been present before bedrest. This was coupled with a failure to augment stroke volume and cardiac output to prerecumbency levels during 50-watt exercise after bedrest. A large diuresis and saluresis occurred during bedrest. In spite of this, plasma volume was at prerecumbency levels at the end of two weeks of bedrest. It is suggested that the fluid loss must have been derived from extravascular compartments with resultant lowering of tissue pressure. It is likely that a large transudation of plasma water into lower extremity tissue spaces occurred during post-recumbency tilting. The resultant decrease in plasma volume during tilt would then account for the decrement in stroke volume and cardiac output during tilting and exercise. A possible mechanism for induction of vasodepressor syncope is hypothesized. (Author)

HYATT, K.H., W.M. SMITH, L.G. KAMENETSKY, and J.M. VOGEL. 1968.
Extravascular Dehydration as an Etiologic Factor in Post-Recumbency
Orthostatism.

In: Preprints of the 1968 Annual Scientific Meeting, Aerospace Medical
Association, Bal Harbour, Florida. p. 127-128.

HYATT, K.H. 1971.

Hemodynamic and body fluid alterations induced by bedrest.

In: R.H. Murray and M. McCally, eds. Hypogravic and Hypodynamic Environments. Washington, D.C. National Aeronautics and Space Administration. pp. 187-210. [NASA-SP-269]

Studies were undertaken to develop an understanding of deadaptation physiology. In these studies, all subjects were healthy male volunteers, aged 21-35. There have been three types of studies: 10-day, 14-day, and 28-day bed rest. In all cases subjects were carefully screened to exclude disease, and were subjected to a noninstrumented 70 deg foot-down passive tilt prior to entry into the study to exclude those with autonomic insufficiency. Statistical analysis was performed by a paired Student's test. Results of the 14-day and 28-day studies are presented. The results of the 10-day bed rest study have been previously reported by NASA.

A.L.

HYATT, K.H. 1972.

Induction of hemodynamic deterioration by the hypogravic state - An evaluation of mechanisms and prevention.

Presented at the 23rd International Astronautical Congress, Vienna, Austria, October 8-15, 1972. 40 pages.

Bedrest weightlessness-simulation studies of 14 and 28 days were conducted on 20 and 24 healthy male subjects kept on metabolic diets in supine positions followed by placing in the 70 deg tilt posture with or without performing a controlled Valsalva maneuver before tilting. Baseline EKG, heart rate, brachial and pulmonary artery pressure, cardiac output, and oxygen consumption were recorded during the experiments. Ten subjects received 9-alpha-fluorohydrocortisone during the bedrest phase to evaluate the effects of plasma volume maintenance on the changes in tilt and exercise tolerance induced by bedrest. It is concluded that factors other than autonomic insufficiency, extravascular dehydration, increased venous pooling and increased plasma water transudation should be responsible for the decrease in orthostatic tolerance established in subjects after bedrest.

V.Z.

HYATT, K.H., W.M. SMITH, L.G. KAMENESTSKY, and J.M. VOGEL. 1968.
A study of post-recumbency orthostatism and prophylactic measures for
prevention of this phenomenon. Final Report.
Public Health Service Hospital, San Francisco, California. 170 pages.
[NASA-CR-92178]

Part I:

Physiological alterations that result in cardiovascular deconditioning was studied on male subjects, ages 21 to 35, using bed rest as an analog to weightlessness. Normal activity was allowed during the first week, when napping was discouraged; and during two weeks of bed rest, the horizontal position was required at all times. Arm movement was limited to forearm raising with the elbows remaining on the bed; and boredom was relieved by reading materials, games, radio, and television. Average systolic and diastolic blood pressure of 20 subjects showed no trend from either bed rest or treatment with 9-alpha-fluorohydrocortisone; weight loss was approximately twice as great during bed rest as during ambulation. Backache, constipation, and headaches were frequent complaints. A 50% incidence of post-recumbency tilt intolerance was noted before and after bed rest. There was no characteristic alteration in pulmonary artery pressure from tilting, and heart rate showed the most obvious and consistent changes. Tilting was generally accompanied by a fall in cardiac output, stroke volume, and central blood volume, and a rise in peripheral and pulmonary vascular resistance and heart rate. M.W.R.

Part II:

Tables detail data obtained during the study of post-recumbency orthostatism in 20 healthy male volunteers subjected to bed rest and 70° tilt. Hemodynamic alterations from passive tilt are shown for the subjects, half of whom were given 9-alpha-fluorohydrocortisone. Other tables indicate brachial artery pulse pressure, hemodynamic response, cardiac output, and central blood volume. In each case comparison is made with and without the drug administration. Other parameters considered include vasomotor wave activity, heart rate variation, oxygen consumption, and fluid balance. Total blood, plasma, and red cell volumes are presented; as are various mineral balances and urine components. Blood chemistries and hematological data are also tabulated. M.W.R.

103

N73-26056*# Public Health Service Hospital, San Francisco,
Calif. Dept. of Medicine.

**A STUDY OF VENTRICULAR CONTRACTILITY AND OTHER
PARAMETERS POSSIBLY RELATED TO VASODEPRESSOR
SYNCOPE**

Kenneth H. Hyatt, Robert W. Sullivan, William R. Spears, and
William R. Vetter May 1973 89 p refs

(NASA Order T-81035)

(NASA-CR-128968) Avail: NTIS HC \$6.50 CSCL 06P

The effects of diminished orthostatic and exercise tolerance
resulting from prolonged bedrest were studied by noninvasive
methods to determine if alterations in myocardial contractility
were induced by bedrest. These methods were apexcardiography,
systolic time intervals, and echocardiography. It is concluded
that bedrest causes detrimental alterations in the contractile state
of the myocardium which accounts for the decreases in maximal
oxygen uptake during exercise after bedrest. Tabulated test data
are included.

F.O.S.

HYATT, K.H., W.M. SMITH, J.M. VOGEL, R.W. SULLIVAN, W.R. VETTER, et al. 1970.
A study of the role of extravascular cardiovascular deconditioning by simulated weightlessness (bedrest).
Public Health Service Hospital, San Francisco, California. 72 pages.
[NASA-CR-114808; 114809]

Part 1:

Extravascular dehydration occurring during bedrest with resultant loss of plasma water to the extravascular tissues of the lower extremities during the post-recumbency tilt was investigated. Healthy male volunteers underwent a 14 day ambulant control phase, a 28 day bedrest phase, and a 14 day ambulant recovery phase. Details are given on the biochemical and isotopic analyses, dietary control, 70 deg tilt and exercise studies, and pulmonary function studies. The following conclusions were reached. The orthostatic tolerance decrease is not caused by autonomic insufficiency, extravascular dehydration, increased venous pooling, or increase in plasma water transudation. Post-recumbency orthostatism is affected by extracellular volume during bedrest coupled with an unchanged plasma water transudation during post-recumbency tilting. Initial large diuresis and diuresis, and rapid restitution of plasma volume and extracellular fluid volume to normal after bedrest are related to alterations in aldosterone production. A decrease in myocardial function, depressed red cell production by bone marrow, and calcium loss were observed.

N E N.

Part 2:

Data tables are presented for the biochemical and isotopic analyses, tilt and exercise studies, and pulmonary function studies.

N E N.

ACCESS. NO. 25, 674

FORM: AUTHOR: DP DRILL: NP

337—Effect of "Deconditioning" in the Adjustment of the Cardiovascular System to Physical Work (Vlianie "Rastrenirovannosti" na Adaptatsiiu Serdechno-Sosudistoi Sistemy k Myshechnoi Rabote). L. A. IOFFE, M. A. ABRUKOSOVA, and Iv. M. STOIDA.—*Teoriia i Praktika Fizicheskoi Kul'tury*, no. 2, Feb. 1968, p. 33-40. In Russian.

105

DOCUMENT NO.: Aerospace Medicine and Biology #337

DESCRIPTORS: Activity GR/58, Adaptation GY/9, Bedrest GY/39, EKG BK/34, Exercise GR/61, Human BL/72, Muscular System R/53, Rate GY/20, USSR GR/3, 1968, Bioinstrumentation BK/30, Circulatory System R/10.

ABSTRACT:

The influence of 40 days of bed rest upon the adjustment of some cardiovascular parameters during muscular work was studied in five middle and long distance runners 25 to 40 yr. old, and five heavy-weight lifters, 24 to 36 yr. old. The electrocardiograms, phonocardiograms and sphygmograms were recorded during work performed on the treadmill and bicycle ergometer, and for five min. in the recovery period. It was found that prolonged bed rest was accompanied by various changes in the functional state of the circulatory system, reflecting a decrease in the effective functioning of the regulatory mechanisms and the cardiac muscle contraction (increase in the resting heart rate, the heart minute output, decrease of the diastolic time, and alteration of the peripheral vascular circulation). A rapid recovery of the work capacity was observed in all the subjects. With regular training they recovered and even in some cases improved their former conditions ten days after the bed rest.

186

N69-12043# Joint Publications Research Service, Washington, D. C.

UNIDIRECTIONAL CHANGES IN THE HUMAN OXYGEN BALANCE CAUSED BY BED CONFINEMENT AND RESTRICTION TO AN ISOLATION CHAMBER

L. R. Iseev. *In its Space Biol. and Med.*, vol. 2, no. 4, 1968 22 Nov. 1968 p 117-124 refs (See N69-12028 02-04)

Avail: CFSTI

Twenty-day bed confinement experiments revealed a relationship between changes in the human oxygen balance during physical work and the degree of restricted motor activity. A 120-day experiment conducted in an isolation chamber revealed similar changes in the oxygen balance although the hydrostatic pressure of body fluids remained virtually unaltered. The introduction of sanitary measures, including physical exercises, into the program of the 120-day experiment considerably improved the response of test subjects to physical loads. The similarity of oxygen balance changes in test subjects during hypokinesia and its improvement following physical exercises suggest that the changes are caused primarily by hypokinesia.

Author

ACCESS. NO. 13,601

FORM: / AUTHOR CARD COMPLETED /

A68-43891 #

SIMILAR TRENDS OF CHANGES IN THE OXYGEN REGIME OF MAN DUE TO BED REST AND CONFINEMENT IN A SEALED CHAMBER [ODNONAPRAVLENNOST' IZMENENII KISLORODNOGO REZHIMA CHELOVEKA, VYZVANNYKH POSTEL'NYM REZHIMOM I PREBYVANIEM V GERMOKAMERE].

L. R. Iseev and B. S. Katkovskii.

Kosmicheskaya Biologiya i Meditsina, vol. 2, July-Aug. 1968, p. 67-72. 17 refs. In Russian.

DOCUMENT SERIES & NO.: A68-43891 (IAA)

DESCRIPTORS: Bedrest GY/39, Closed ecology BK/18, Exercise GR/61, Human BL/72, Immobilization GR/62, Oxygen W/74, Performance GY/87, Restraint system BK/27, USSR GR/3.

ABSTRACT:

Discussion of the results of two series of space flight hypokinesia simulation experiments in which the oxygen balance was studied in two groups of four healthy male persons 21 to 32 years old, confined (1) to a 20-day bed rest with and without physical exercises, or (2) to a four-month stay in a small sealed chamber in which they performed prescribed physical exercises. The higher oxygen requirements and the lower efficiency of physical performance established by the tests for the subjects in both series of experiments are discussed.

V. Z.

22883. ISEEV, L. R., and B. S. KATKOVSKII. Odnopravlennost' izmenenii kislorodnogo rezhima cheloveka, vyzvannykh postel'nyim rezhimom i prebyvaniem v germokamere. [Similar changes in oxygen balance in humans during bed rest and when spending time in a hermetically-sealed chamber.] *KOSM BIOL MED* 2(4): 67-72. 1968. [Engl. sum.]--The 20-day bed rest experiments showed a relationship between changes of the O₂ balance in man upon physical work and degree of the limited motor activity. The 120-day experiment carried out in an enclosed space revealed similar changes of the O₂ balance although the hydrostatic pressure of body fluids remained practically unaltered and the test subjects were exposed to many other than hypokinesia environmental factors (isolation, varied atmosphere, etc.). An introduction of sanitation measures, physical exercises including, into the program of the 120-day experiment significantly improved the reaction of the test subjects to physical loads. The similarity of O₂ balance changes in test subjects during hypokinesia and its improvements following physical exercises suggest that the changes are primarily caused by hypokinesia. The motor activity of spacecrew members during long-term simulation experiments and space missions should be necessarily included in their work-rest cycles.--Authors.

/† 71643. ISSEKUTZ, B. Jr., J. J. BLIZZARD, N. C. BIRKHEAD, and K. RODAHL. (Lankenau Hosp., Philadelphia, Penn., USA.) Effect of prolonged bed rest on urinary calcium output. J APPL PHYSIOL 21(3): 1013-1020, 1966.--The effect of prolonged supine position on the urinary nitrogen and calcium output was studied on young healthy men. Bed rest increased the excretion of calcium. The nitrogen output did not show any consistent response. Exercise on a bicycle ergometer in sitting or in supine position failed to change the course of calcium excretion. Supine exercise up to 4 hrs./day did not decrease the urinary calcium output which was previously elevated by a complete bed rest. Quiet sitting for 8 hrs. combined with 16 hr lying did not prevent the rise of calcium output. On the other hand, 3 hrs./day quiet standing proved to be sufficient to induce a slow decline of the elevated calcium excretion in 4 out of 5 subjects. Following a complete bed rest in the recovery phase when the subjects resumed their normal up-and-about activities, both the nitrogen and calcium excretion rapidly decreased below the base-line value of the individual. It is concluded that the increase in urinary calcium output in prolonged horizontal position is due to the absence of longitudinal pressure (weight bearing) on the bones rather than the physical inactivity during bed rest.

--Authors.

IVANOV, I.I., et al. 1970.

Investigation of certain biochemical blood serum indicators during prolonged hypodynamia.

In: A.M. Genin and P.A. Sorokin, eds. Problems of space Biology. Volume 13: Prolonged Limitation of Mobility and its Influence on the Human Organism.

Washington, D.C., Scripta Technica, Inc. pp. 96-105. [NASA-TT-F-639]

A trend to lower blood-serum potassium contents was noted toward the end of an extended period of hypodynamia. A rise in the activity of alkaline phosphatases in the blood serum is reported. The activities of aspartate-aminotransferase, alanine-aminotransferase, aldolase, and creatinekinase, and the contents of sodium, phosphorus, calcium, microelements, and urea in the blood serum of the individuals studied showed no change. Author

IVANOV, L.A. 1972.

Change in tissue oxygen metabolism during the initial period of hypokinesia.
Space Biology and Medicine 6(1):123-129.

[Article by L. A. Ivanov; Moscow, *Kosmicheskaya Biologiya i Meditsina*, Russian, Vol 6, No 1, pp 82-86, 1972, submitted for publication 10 March 1971]

Abstract: The effect of a six-day bedrest experiment on external respiration and oxygen metabolism in the subcutaneous connective tissue was studied in healthy test subjects in the age group 24-35 years. During a post-experiment oxygen inhalation test the time interval in which arterial oxygen saturation attained a maximum tended to increase. This was indicative of certain limitations on external respiration functional capabilities: oxygen consumption decreased, spiographic oxygen deficiency increased and the respiration level of the subcutaneous connective tissue slightly declined. After the six-day bedrest experiment oxygen supply and the oxygen tension level in the subcutaneous connective tissue remained virtually unchanged.

A72-29324 // Alteration of the tissue oxygen metabolism in the initial period of hypokinesis (Izmenenie tkanevogo kislorodnogo obmena v nachal'nom periode gipokinezii). L. A. Ivanov. *Kosmicheskaya Biologiya i Meditsina*, vol. 6, Jan.-Feb. 1972, p. 82-86. 14 refs. In Russian.

The effect of a 6-day bed rest experiment on external respiration and oxygen metabolism in the subcutaneous connective tissue was studied in healthy test subjects, aged 24-35. During a post-experiment oxygen inhalation test the time in the course of which arterial oxygen saturation attained maximum tended to increase. This was indicative of certain limitations of functional capabilities of external respiration: oxygen consumption decreased, spiographic oxygen deficiency increased and the respiration level of the subcutaneous connective tissue slightly declined. After the 6-day bed rest experiment oxygen supply and the level of oxygen tension in the subcutaneous connective tissue remained practically unchanged.

(Author)

trans: Space Biol. & Med. 6(1): 123/1972. ^{129.}

ACCESS. NO. 16,518

FORM: AUTHOR CARD COMPLETED ☒

110

A69-37621

STUDIES OF HUMAN ADAPTATION TO SPACE FLIGHT EFFECTS UNDER LOW-CALORIE DIET CONDITIONS.

P. P. Ivanov, Iu. G. Nefiodov, A. S. Ushakov, L. I. Kakurin, K. A. Lariecheva, I. G. Vysotskii, and Iu. V. Latova.

IN: LIFE SCIENCES AND SPACE RESEARCH VII; COSPAR, PLENARY MEETING, 11TH, OPEN MEETING OF WORKING GROUP V AND SYMPOSIUM ON BIOLOGICAL EFFECTS OF RADIATION IN SPACE, TOKYO, JAPAN, MAY 14-16, 1968 AND MAY 10, 1968, PROCEEDINGS. (A69-37612 20-04)

Meeting and symposium co-sponsored by the International Union of Biochemistry, the International Union of Biological Sciences, the International Union of Physiological Sciences, and the International Union of Pure and Applied Biophysics.
Edited by Wolf Vishniac and F. G. Favorite.
Amsterdam, North Holland Publishing Co., 1969, p. 99-101.

DOCUMENT SERIES & NO.: A69-37621 (IAA)

DESCRIPTORS: Acceleration Y/1, Activity GR/58, Adaptation GY/9, Amino Acid W/33, Bedrest GY/39, Circulatory System R/10, Diet GY/35, Human BL/72, Immunology GY/64, Metabolism GY/13, Japan GR/6, Nervous System R/48, Nutrition GY/34, Performance GY/87,

ABSTRACT:

~~Respiratory System R/1, Space Flight GR/30.~~

1969.

Results of experiments performed to establish the activity and performance of man kept on a low-calorie (1800) diet and exposed to some space flight effects. The diet consisted of canned foods with an optimal proportion of basic nutrients and amino acids. Three series of experiments were carried out on 18 healthy male subjects. Each series involved pre- and posttest examinations and 15-day tests. The first series dealt with the effect of low-calorie diets as such, the second one covered the effect of low-calorie diets combined with bed rest, and the third series revealed the above effect aggravated by exposing test subjects to bed rest and acceleration. In the course of the experiments, the state of the central nervous and cardiovascular systems, the function of external respiration, the digestive function, the kinesthetic apparatus, metabolic processes, and immunological resistance of the body were studied. In addition, test subjects underwent thorough clinical examinations.

(Author)

1/1

N74-10091*# National Aeronautics and Space Administration,
Ames Research Center, Moffett Field, Calif.
EVALUATION OF POSITIVE G SUB Z TOLERANCE
FOLLOWING SIMULATED WEIGHTLESSNESS (BEDREST)
Lester B. Jacobson (PHS Hospital, San Francisco), Kenneth H.
Hyatt (PHS Hospital, San Francisco), Robert W. Sullivan (PHS
Hospital, San Francisco), Stephen A. Cantor (PHS Hospital, San
Francisco), Harold Sandler (PHS Hospital, San Francisco),
Salvadore A. Rositano, and Ronald Mancini Aug. 1973 96 p
refs Prepared in cooperation with PHS Hospital, San Francisco
(NASA-TM-X-62311) Avail: NTIS HC \$7.00 CSCL 06S

The magnitude of physiologic changes which are known to occur in human subjects exposed to varying levels of + G sub Z acceleration following bed rest simulation of weightlessness was studied. Bed rest effects were documented by fluid and electrolyte balance studies, maximal exercise capability, 70 deg passive tilt and lower body negative pressure tests and the ability to endure randomly prescribed acceleration profiles of +2G sub Z, +3G sub Z, and +4G sub Z. Six healthy male volunteers were studied during two weeks of bed rest after adequate control observations, followed by two weeks of recovery, followed by a second two-week period of bed rest at which time an Air Force cutaway anti-G suit was used to determine its effectiveness as a countermeasure for observed cardiovascular changes during acceleration. Results showed uniform and significant changes in all measured parameters as a consequence of bed rest including a reduced ability to tolerate +G sub Z acceleration. The use of anti-G suits significantly improved subject tolerance to all G exposures and returned measured parameters such as heart rate and blood pressure towards or to pre-bed-rest (control) values in four of the six cases.

Author

ACCESS. NO. 20,624

FORM: _____ AUTHOR: NP DRILL: NP

N70-25257# Techtran Corp., Glen Burnie, Md.
DAILY FLUCTUATIONS OF METABOLISM AND BODY
TEMPERATURES IN SOBER CONDITION AND COMPLETE
MUSCULAR REST

J. E. Johansson Washington NASA Mar. 1970 60 p refs
Transl. into ENGLISH from Scandinavisches Archiv fuer Physiol., v.
8, 1898 p 85-142
(Contract NASw-2037)

(NASA-TT-F-12875) Avail: CFSTI CSCL 06P

DOCUMENT NO.: N70-25257

DESCRIPTORS: Bedrest GY/39, Biologicla Rhythm GY/21, Carbon Dioxide W/72,
Circadian Rhythm GY/22, Environment Y/58, Metabolism GY/13,
Muscular System R/53, Sound GR/67, Sweden GR/91, Temperature
Y/25. 1970.

ABSTRACT:

The variation of the gaseous metabolism (release of CO₂), the secretion of N and fluctuation of body temperature were investigated during periods of complete muscular inactivity and ordinary bed rest. It is shown that daily fluctuations of these values are primarily functions of the state of activity and largely independent of the time of the day, although they are affected to some extent by daylight, environmental noise and mental activity. The regularity in metabolism and body temperature observed is interpreted as the adaptation of the organism to varying conditions and not as the expression of some unknown factor controlling daily periodicity.

Author

JOHNSON, P. C., C. S. LEACH, and P. C. RAMBAUT. *Estimates of fluid and energy balances of Apollo 17*. Aerospace Med. 44(11): 1227-1230, 1973.

Fluid and caloric balance has been calculated for the Apollo 17 crew. This included measurement of the nitrogen, water, and caloric value of the ingested food and the volume and nitrogen content of the excreted urine and feces. Body composition changes were determined from total body water and extracellular fluid volume differences. The body composition measurements made it possible to divide the weight loss into lean body mass and adipose tissue losses. From this division a caloric equivalent was calculated. These tissue losses indicated that the caloric requirements of the mission were considerably greater than the actual caloric intake. The 3.3 kilo mean loss of body weight represented 1 kilo of lean body mass and 2.3 kilos of adipose tissue. Calculated fluid balance was more positive during the mission than during the control period. These changes are unlike the body composition and fluid balance changes reported in bedrested subjects.

JOHNSON, P.C., M.D., T.B. DRISCOLL, B.S.

Vascular and extravascular fluid volume changes during six days of bedrest.

In: Preprints of the 1971 Annual Scientific Meeting, Aerospace Medical Association, Houston, Texas, April 26-27, 1971.

JOHNSON, P. C., T. B. DRISCOLL and W. R. CARPENTIER.
Vascular and extravascular fluid volume changes during six days of bedrest. Aerospace Med. 42(8):875-878. 1971.

Body fluid spaces were determined before and after one and six days of bedrest. All fluid spaces were calculated and compared on the basis of fluid volume per kilogram body weight. The nine male subjects who participated in the study were divided into two groups according to their deviation from an ideal body weight as determined from individual heights. The subjects below ideal weight had a statistically greater mean ml/kg red cell mass, extracellular fluid volume and total body water than the respective means from the group whose weights were above ideal. During bedrest a decrease of statistical significance was found in the plasma volume but not in the red cell mass, total body water and extracellular fluid volumes. The data does not support the often stated theory of fluid and electrolyte diuresis as the cause of the slowly decreasing plasma volume loss found after the first 24 hours of bedrest.

ACCESS. NO. 3073

FORM: D AUTHOR CARD COMPLETED ✓

KAKURIN, L.A., B.S. KATKOVSKIY, A.N. KOZLOV, and N.M. MUKHARLYAMOV. 1964. *116*
Effect of hypokinesia on certain indexes of efficiency and respiratory
function in man.

In: V.V. Parin, ed. Aviation and Space Medicine. Washington, D.C.,
National Aeronautics and Space Administration. pp. 192-194. [NASA-TT-F-228]

DOCUMENT SERIES & NO.: N65-13693 (NASA)

DESCRIPTORS: Adaptation GY/9, Bedrest GY/39, Circulatory system R/10, Human BL/72,
Immobilization GR/62, Respiratory system R/21, USSR GR/3

ABSTRACT:

1964

An experimental investigation on four healthy young males showed that 20 days in bed caused marked deterioration of human physical fitness. This deterioration was partly from hypokinesia and partly from the body's adaptation to a horizontal position. Also, the deterioration of work efficiency after remaining in bed made heavy demands on the cardiovascular and respiratory systems. *DEW*

N68-28511# Joint Publications Research Service, Washington, D. C.

EFFECT OF LONG-TERM HYPOKINESIA ON THE HUMAN BODY AND THE HYPOKINETIC COMPONENT OF WEIGHTLESSNESS

L. I. Kakurin *In its Space Biol. and Med.*, Vol. 2, No. 2, 1968
27 Jun. 1968 p 85-91 refs (See N68-28499 17-04)

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DOCUMENT SERIES & NO.: N68-28511 (NASA)

DESCRIPTORS: Adaptation GY/9, Circulatory system R/10, Excretory system R/56, Exercise GR/61, Human BL/72, Immobilization GR/62, Immunology GY/64, Kidney R/57, Muscular system R/53, Nervous system R/48, Physiology GY/8, Respiratory system R/21, USSR GR/3, Weightlessness Y/35.

ABSTRACT:

An experimentally diminished muscular activity of man can be used as a model to reproduce some human reactions similar to those induced by weightlessness. The purpose of the 62-day experiment was to study adaptive processes of the human body and to establish the efficiency of physical exercises during hypokinesia. Detailed clinical and physiological examinations revealed disturbances in the functioning of the circulatory, respiratory, and neuromuscular systems, changes in natural immunity, and diuretic deterioration. Physical exercises with a load up to 1,000-1,200 cal/day produced a limited positive effect.

Author

A68-33710 #

INFLUENCE OF PROLONGED LIMITATION OF MUSCULAR ACTIVITY ON THE HUMAN ORGANISM AND THE HYPOKINETIC COMPONENT OF WEIGHTLESSNESS [VLIYANIE DLITEL'NOGO OGRANICHENIYA MYSHECHNOI DEYATEL'NOSTI NA ORGANIZM CHELOVEKA I GIPOKINETICHESKII KOMPONENT NEVESOMOSTI].

L. I. Kakurin.

Kosmicheskaya Biologiya i Meditsina, vol. 2, Mar.-Apr. 1968, p. 59-63. 11 refs. In Russian.

Investigation of the reactions of the human organism to the state of weightlessness, in which weightlessness was simulated by prolonged (62 days) bed rest. The adaptive processes in the human body are studied, together with the effectiveness of physical exercises under hypokinetic conditions. Thorough clinical and physiological examinations revealed functional disturbances of circulation, respiration, and of the neuromuscular system, as well as changes in the natural immunity, and diuretic deterioration. Physical exercises with a load of 1000 to 1200 kcal per day produced a limited positive effect.

V.P.

N70-29900# Joint Publications Research Service, Washington, D.C.

FUNCTIONAL DISORDERS IN HUMANS DURING HYPOKINESIS

L. I. Kakurin et al 26 May 1970 10 p refs Transl. into ENGLISH from Vop. Kurortol., Fizioter. Lech. Fiz. Kul't. (USSR), no. 1, 1970 p 19-24

(JPRS-50595) Avail: CFSTI

Restriction of muscular activity and the characteristic redistribution of blood due to the change in hydrostatic pressure during bed rest were studied. The effects of these factors were compared by having one test group remain in a horizontal position for 62 days with minimum motor activity, while another group performed physical exercises every day. The tests show that functional disorders caused by hypokinesia are not fully eliminated by physical exercise, but physical conditioning does reduce the effects of prolonged bed rest.

R.B.

AC(KAKURIN, L.I., R.M. AKHREM-AKHREMOVICH, Y.V. VANYUSHINA, R. A. VARBARONOV, 119
V.S. GEORGIYEVSKIY, et al. 1966.

The influence of restricted muscular activity of man's endurance of physical stress, accelerations and orthostatics.

In: Reports Presented at Soviet Conference on Space Biology and Medicine, Acad. of Med. Sci., Moscow, 1966. Washington, D.C. Joint Publications Research Service. pp. 110-117. [JPRS-38596]

DOCUMENT SERIES & NO.: N67-13434 (NASA)

DESCRIPTORS: Acceleration Y/1, Bed rest GY/39, Centrifuge BK/37, Circulatory system R/10, Human BL/72, Immobilization GR/62, Muscular system R/53, Respiratory system R/21, Stress GY/76, Tolerance GR/50, USSR GR/3

ABSTRACT: 1966

Four male subjects maintained strict bed rest for 20 days before undergoing endurance tests to determine the orthostatic factors following restricted muscular activity and the influence of hypokinesia on the motor-cardiac and vasopressor components of the circulatory regulation. Exercycle loads after prolonged rest produced decreased work quantities, oxygen consumption, pulse rate acceleration, arteriovenous differences and oxygenation of the blood. Rotation on a centrifuge was also tolerated with much more difficulty than prior to the enforced inactivity and indicated disorders in the functional regulation centers of the cardiac activity. Also discovered were symptoms of decreased lability of the main neural processes. It was concluded that enforced rest and prolonged maintenance of a horizontal position for man resulted in persistent functional disorders of the locomotor area as well as in the visceral system.
G.G.

120
KALIN, G.S. 1970.

State of nervous-system functions during aftereffects of hypodynamia.

In: A.M. Genin and P.A. Sorokin, eds. Problems of Space Biology. Volume 13:
Prolonged Limitation of Mobility and its Influence on the Human Organism.

Washington, D.C., Scripta Technica, Inc. pp. 219-226. [NASA-TT-F-639]

Distinct disturbances to the functions of the nervous system and the neuropsychic sphere were detected in subjects after prolonged hypodynamia. Organic microsymptoms, asthenia, vegetative cardiac instability, and akinetic hypotrophy of the muscles of the lower leg were noted. After load tests administered at the end of hypodynamia, the changes in the animal nervous system increased. There was a certain tendency to preferential weakening of the left (dominant) hemisphere of the brain (the appearance of occasional signs of dextral pyramidal and sinistral cerebellar insufficiency). Subjects who participated in the hypodynamia experiments without preventive measures showed more pronounced functional disturbances; the disturbances were less hypodynamia was combined with physical exercises on a treadmill and with autogenous conditioning.

Author

KATKOVSKIY, B.S. (KATKOVSKII, B.S.), and Y.D. POMETOV. 1971.
Change in cardiac ejection under the influence of 15-day bed confinement.
Space Biology and Medicine 5(3):105-113.

Abstract: A significant increase in cardiac output related mainly to stroke volume was observed in five male test subjects during a 15-day bedrest experiment. Oxygen consumption and carbon dioxide production decreased gradually during the observation period. It is suggested that similar changes in cardiac output may occur during an early period of adaptation to weightlessness during spaceflight.

A71-39231 # Changes in cardiac ejection caused by 15-day bed rest (Izmenenie serdechnogo vybroso pod vlianiem 15-sutochnogo postel'nogo rezhima). B. S. Katkovskii and Yu. D. Pometov. *Kosmicheskaya Biologiya i Meditsina*, vol. 5, May-June 1971, p. 69-74. 30 refs. In Russian.

Study of the changes in the basic hemodynamic and gaseous metabolism parameters of humans subjected to a strict bed rest regime of moderate duration. A significant increase in cardiac output related mainly to stroke volume was found in five male test subjects during a 15-day bed rest experiment. Oxygen consumption and carbon dioxide production decreased gradually during the observation period. It is suggested that similar changes in cardiac ejection may occur during the early period of weightlessness adaptation in space flight.

A.B.K.

KATKOVSKIY, B.S. (KATKOVSKII, B.S.) 1969.

Effect of hypokinesia on human respiration in physical work.

In: N.V. Lauer and A.Z. Kolchinskaya, eds. The Oxygen Regime of the Organism and its Regulation (Symposium). Jerusalem, Israel Program for Scientific Translations, LTD. pp. 231-235. [NASA-TT-F-501]

Studied were the effects of prolonged bed rest on human respiration at rest and in physical work. The latter provided a criterion for the assessment of physical work capacity. Experimental data indicated that even moderate work after prolonged hypokinesia increased the demands upon the cardiovascular, respiratory, and other systems due to lower economy and impaired control of respiration.

G.G.

N69-34837# Joint Publications Research Service, Washington, D.C.

EFFECT OF LONG-TERM HYPOKINESIA ON HUMAN TOLERANCE TO PHYSICAL STRESS

B. S. Katkovskiy, et al. *In its Space Biol. and Med.*, vol. 3, no. 2, 1969 15 Jul. 1969 p 77-85 refs (See N69-34827 20-04)
Avail: CFSTI

DOCUMENT NO.: N69-34837

DESCRIPTORS: BEDREST GY/39, EXERCISE GR/61, HUMAN BL/72, IMMOBILIZATION GR/62, METABOLISM GY/13, PERFORMANCE GY/87, STRESS GY/76, TOLERANCE GR/50, USSR GR/3.

1969.

ABSTRACT:

A 62-day bedrest experiment was performed on six healthy male test subjects. During the experiment an attempt was made to maintain high performance of three test subjects (first group) using physical exercises which compensated for their muscular inactivity (with respect to metabolic rates). The motor activity of the resting subjects (second group) was minimized. After the bedrest experience the tolerance of the members of the second group to physical work decreased, whereas the members of the first group retained tolerance to both moderate and heavy work. The experimental findings suggest that deterioration of the performance level of human subjects subjected to bedrest is due to hypokinesia.

Author

A69-32939 #

EFFECT OF PROLONGED HYPOKINESIA ON THE RESISTANCE OF THE HUMAN ORGANISM TO PHYSICAL STRESS [VLIANIE DLITEL'NOI GIPOKINEZII NA USTOICHIVOST' ORGANIZMA CHELOVEKA K FIZICHESKOI NAGRUZKE].

B. S. Katkovskii, O. A. Piliavskii, and G. I. Smirnova.
Kosmicheskaya Biologiya i Meditsina, vol. 3, Mar.-Apr. 1969, p. 49-55. 15 refs. In Russian.

Investigation of the physical fitness of a group of 60 young male subjects restricted to 62 days of bed rest in a prone position, with or without physical exercises with a daily energy requirement in excess of 1000 kcal. Prior to and after the bed rest, the subjects were exposed to transverse accelerations increasing at a rate of 0.1 to 0.2 g/sec to a level of 12 to 14 g. A veloergometer with a rate of rotation of the pedals of 60 to 70 rpm was used to determine the physical endurance of the subjects after the experiment. The favorable effect of physical exercises during the bed rest on the physical condition of the subjects is noted.

V. Z.

124

N68-17754# Joint Publications Research Service, Washington, D. C.

HUMAN BASAL METABOLISM DURING PROLONGED BEDREST

B. S. Katkovskiy, *In its Space Biol. and Med.*, Vol. 1, No. 5, 1967
9 Feb 1968 p 100-107 refs (See N68-17742 08-04)

The metabolic rate and pulmonary function of healthy test subjects were studied during 20- and 62 day bedrest experiments, before and after which they were subjected to accelerations. Three subjects who performed no physical exercises during the 62 day bedrest revealed a decreased metabolic rate and virtually unaltered pulmonary function. Three test subjects who performed physical exercises during the experiments also manifested a reduction of oxygen consumption and metabolic rate beginning with the third 10 day period. It appears that the latter is unrelated to hypokinesia but is due to an increased physical conditioning or to adaptation to a changed hydrostatic pressure of body fluids. Author

A68-14846 #

BASAL METABOLISM IN HUMANS DURING PROLONGED RESTRICTION OF MOTOR ACTIVITY [OSNOVNOI OBMEN PRI DLITEL'NOM OGRANICHENII DVIGATEL'NOI AKTIVNOSTI CHELOVEKA].

B. S. Katkovskii.

Kosmicheskaya Biologiya i Meditsina, vol. 1, Sept.-Oct. 1967, p. 67-71. 9 refs. In Russian.

Investigation of the basal metabolism in a group of ten male subjects restricted to bed rest for 20 or 62 days, preceded and followed by spine-to-breast tolerance-limit accelerations reached at a rate of 0.1 and 0.2 g/sec below and above 4 g, respectively. Decreased oxygen consumption rates in all the test individuals and decreased basal metabolic rates and a virtually unchanged pulmonary function in individuals who did not perform physical exercises during the 62-day bed rest are noted. V. Z.

N73-22016 Joint Publications Research Service, Arlington, Va.
 PULMONARY VOLUMES OF HUMAN SUBJECTS
 RESTRICTED TO AN ANTIORTHOSTATIC POSITION WITH
 APPLICATION OF DIFFERENT COUNTERACTING AGENTS
 B. S. Katkovskiy, and V. A. Andretsov *In its Space Biol. and
 Med.*, Vol. 6, No. 4, 1972 29-Sep. 1972 p 88-94 refs
 (For availability see N73-22002 13-04)

(Katkovskii, BS)

Total lung capacity (TLC) and other pulmonary volumes of nine test subjects were studied during a 30-day bed rest experiment. The subjects were fixed in their beds with the foot end being lifted at an angle of 4 deg to the horizontal. During the first experimental days all the parameters declined appreciably in the test subjects of all three groups. The TLC of test subjects who performed physical exercises remained decreased until the end of the experiment; that of the second control group approximated the pretest level only on the 17th day, remaining still higher to the end of the experiment, and the TLC of test subjects who underwent electric muscle stimulation exceeded the pretest value on the fifth experimental day and continued to increase by the end of the experiment. Author

31,619

Katkovskiy, B.S. and V.A. Andretsov. Lung volumes of men in the anti-orthostatic position during the application of preventive measures. *Kosmicheskaya Biologiya i Meditsina*, Vol. 6, No. 4, pp. 55-59, July-August 1972.

S&T ALERT

ITEM NO. 990

Scan Topics: 04-04 Aerospace Medicine
 04-06 Physiological Factors

The 30-day bedrest experiment on the pattern of changes in the total lung capacity (TLC) and other lung volumes was conducted on 9 test subjects divided into 3 groups. The subjects of the first group, performing physical exercises, exhibited a lower TLC throughout the experiment, those of the control group came close to the pretest value only on the 17th day, while the subjects of the third group subjected to electric muscle stimulation exceeded the initial level on the 5th experimental day. The initial changes are related to blood displacement in the "thoracic reservoir" (acting as the blood "supplier" to the heart) caused by switching to the antiorthostatic position. The central blood volume (the amount of blood in the pulmonary vessels), however, is said to be responsible for changes in the amount of air in the thorax. The difference in the aeriferous capacity of the lungs between the groups are presumed to be associated with the preventive measures applied by each group.

(LD)

KATZ, F.H. Adrenal function during bed rest. Aerospace Medicine 35:849.
September 1964.

Plasma 17-OH-CS levels as well as adrenal secretory rates of aldosterone and cortisol were measured in healthy subjects before and during periods of bed rest. The circadian rhythm of plasma 17-OH-CS was well maintained during bed rest. There was no change in adrenal cortisol secretion rates during bed rest. Aldosterone secretory rate did not change with bed rest; however, following a period out of bed, there was a diminution of aldosterone secretory rate during a subsequent bed rest period. Inactivity from bed rest therefore does not appear to change adrenal cortisol production. Conclusions cannot be drawn as yet concerning aldosterone production.

KHILOV, K.L., et al. 1970.

Influence of prolonged hypodynamia on the state of the vestibular analyzer.
 In: A.M. Genin and P.A. Sorokin, eds. Problems of Space Biology. Volume 13:
 Prolonged Limitation of Mobility and its Influence on the Human Organism.
 Washington, D.C., Scripta Technica, Inc. pp. 184-191. [NASA-TT-F-639]

Phasing was observed in the excitability changes of the vestibular analyzer. The largest changes were noted on the 7th, 10th, and 20th days of hypodynamia in individuals whose vestibular function was found to be asymmetric before the experiment. The transition to active movement after hypodynamia was accompanied by vestibular function disorder, with normalization only after 2 to 3 weeks. It is concluded that the functions of both vestibular analyzer receptors are disturbed during hypodynamia, but that the otolith apparatus is more strongly affected.

Author

KLAPPER, E.A., and P.B. MACK. 1966.

Regression curves for representative urinary calcium and bone mass values.

In: G.D. Whedon, W.F. Neumann, and D.W. Jenkins, eds. Progress in Development of Methods in Bone Densitometry. Washington, D.C., National Aeronautics and Space Administration. 6 pages.

\$1.50, CFSHC MF31.25

Regression curves are presented as calculated and plotted by the IBM 1620 computer from urinary calcium excretion and bone mass data obtained from men in bed rest and collateral ambulation studies. The studies consisted of feeding 0.7, 1.5, and 2.0 grams of calcium during three bed rest and three corresponding ambulatory periods to four healthy adult male subjects. Three figures illustrate how the regression curve can show trends in bone mass change and change in urinary excretion of calcium.

R N A

129

N68-33916# Joint Publications Research Service, Washington.

KOROBKOV, A.V., L.A. LOFFE, M.A. ABRIKOSOVA, and Y.M. STOYDA. 1968.
Dynamics of orthostatic tolerance of athletes after forty-day hypokinesia.
Space Biology and Medicine 2(3):48-57.

Eng
transl.

The effect of forty-day hypokinesia on the changes of the electrocardiogram, cardiodynamics and tone of vessels of the elastic and muscular type was studied in ten highly trained athletes during their orthostatic tests. The orthostatic response exhibited an increased predominance of sympathetic effects in the heart and a reduced blood filling of the ventricles due to a deterioration of the functional state of the venous system. It was found that the stability of the latter can be maintained by means of specific training.

Author

N69-34835# Joint Publications Research Service, Washington, D.C.

CHANGE IN PRECISE MOVEMENTS IN PERSONS WITH DIFFERENT PHYSICAL FITNESS WHEN EXPOSED TO HYPOKINESIA

A. A. Korobova et al. *In its Space Biol. and Med.*, vol. 3, no. 2, 1969 15 Jul. 1969 p 63-70 refs (See N69-34826 20-04)
 Avail: CFSTI

DOCUMENT SERIES & NO.: N69-34835 (NASA)

A10-13896

DESCRIPTORS: Adynamia GY/57, Bedrest GY/39, Exercise GR/61, Human BL/72, USSR GR/3. 1969.

ABSTRACT:

Changes in the coordination of athletes (runners and weight lifters) exposed to a 40-day bedrest were investigated by the method of vector-operation dynamography. The tests were conducted before and after exercises (performed with a limited load with a bicycle-type ergometer and with a maximum load with a treadmill). A decrease in motor activity resulted in insignificant changes in the level of total error. Use of exercises of the two types helped to reveal qualitative differences (predominance of positive efforts) in the performance of the task. Author

A69-32937 #

CHANGES IN PRECISE MOTIONS OF PERSONS WITH VARIOUS DEGREES OF PHYSICAL PREPAREDNESS UNDER THE EFFECTS OF HYPOKINESIA [IZMENENIE TOCHNYKH DVIZHENII U LITS RAZLICHNOI FIZICHESKOI PODGOTOVLENNOSTI POD VLIANIEM GIPOKINEZII].

A. A. Korobova and T. I. Goriunova.

Kosmicheskaya Biologiya i Meditsina, vol. 3, Mar.-Apr. 1969, p. 41-45. 27 refs. In Russian.

Study of the coordination of motor activity in a group of five runners and five weight lifters subjected to 40 days of bed rest, by using a dynamographic technique. The possible nature of the slackening of the coordination capacity, observed in the subjects after this period, is discussed. It is pointed out that the successful completion of a physical assignment alone should not be regarded as proof of normal coordination of motions under extremal conditions. Further studies of this problem are suggested. V. Z.

KOROBOVA, A.A. and Yu.B. VINICHENKO. 1968.

Dynamics of daily diuresis, creatinine excretion and mean thickness of the fatty skin layer in athletes subjected to prolonged hypokinesia. Space Biology and Medicine 2(3):58-63.

This study was made to determine the dynamics of daily diuresis, creatinine excretion and mean thickness of the fatty skin layer in male athletes (runners and weightlifters) during forty-day hypokinesia. Daily diuresis was determined with an accuracy to 1 ml. creatinine was assessed by the photoelectrocolorimetric technique and the mean thickness of the fatty skin layer was measured with standard calipers. The difference between the mean values of creatinine excretion on different days of the experiment was not statistically significant. The diuresis level decreased in most test cases during the second part of the experiment. The mean thickness of the fatty skin layer increased. Insignificant fluctuations in creatinine excretion and increase in the mean thickness of the fatty skin layer indicate a reduction in protein synthesis, an increase in decomposition processes and replacement of a part of the muscle tissue by fat. The decrease in daily diuresis by the end of the experiment occurs due to a changed level of fat metabolism and the Gauer-Henry reflex.

Author

KOROLEV, B.A. 1968.

Changes in cardiac activity during prolonged hypokinesia.
Space Biology and Medicine 2(5):79-85.

132

Abstract: It is known that long-persisting hypokinesia causes certain changes in the electrocardiogram: a decreased amplitude of the R and T waves, an inversion of the ST segment and T wave and an increased U wave. For the purpose of determining the nature of the changes the integral QRS and T vectors and the ventricular gradient in the frontal plane were studied for healthy male test subjects restricted to 70-day bed confinement. The values of the QRS and T vectors and the ventricular gradient decreased, the QRS vector being more often shifted to the right and the T and G vectors to the left. The angular distance between QRS, T and G varied over a wide range. Distinct decrease of the vector values and increase in angular distances were observed during the third-fifth and seventh-ninth weeks. The changes in vectors, ventricular gradient and angular distances were less in test subjects who regularly performed physical exercises during the bed-rest experiment. The vector analysis revealed that the secondary nature of the changes in the electrocardiogram appear to be related to variations in myocardial metabolism.

ACCESS. NO. 13,310

FORM: ☒ AUTHOR CARD COMPLETED ☒

Korolev, B.A. Changes in myocardial repolarization in healthy persons during restriction of motor activity. In Space Biology and Medicine, Vol.2, No. 6, 1968 (USSR), p.127-134. Washington, D.C., Joint Publ. Res. Serv., Mar.5, 1969. 133

DOCUMENT SERIES & NO.: JPRS-47582

+ N69-19103

DESCRIPTORS: Circulatory system R/10, EKG BK/34, Human BL/72, Hypoxia Y/16, Immobilization GR/62, Metabolism GY/13, Muscular system R/53, USSR GR/3.

ABSTRACT:

Abstract: A repolarization disturbance is indicated by development of the $T_{V_1} > T_{V_6}$ syndrome and appearance or increase in the amplitude of the U wave. It can also be suggested by changes in the ratio of the U and T amplitudes and change in the length of the aT-aU and S-aU segments, as well as by the RR/S-aU ratio. The standard values of these parameters for healthy persons were established by V. P. Nikitin in 1963. The U wave is well pronounced in the U_3 lead. Therefore, the U and T amplitudes, U/T and RR/S-aU ratios and the aT-aU

(over)

ACCESS. NO. 20,405

FORM: _____ AUTHOR CARD COMPLETED NP

N70-16013# Joint Publications Research Service, Washington, D.C.

PATTERN OF CHANGES OF ELECTROCARDIOGRAMS AND CARDIAC CONTRACTION PHASES DURING ORTHOSTATIC TESTS AFTER LONG-TERM HYPOKINESIA

B. A. Korolev *In its Space Biol. and Med.*, Vol. 3, No. 5 31 Dec. 1969 p 96-101 refs (See N70-16001 05-04)

Avail: CFSTI

134

DOCUMENT SERIES & NO.: N70-16013

DESCRIPTORS: Analysis P/2, Bedrest GY/39, Circulatory System R/10, EKG BK/34, Human BL/72, Immobilization GR/62, Tolerance GR/50, USSR GR/3. 1969.

ABSTRACT:

A 70 day bedrest experiment was carried out on sixteen test subjects between the ages of 20 and 25 years. At different time intervals the subjects underwent a 15 minute orthostatic test at a 75 deg tilt. Their electrocardiograms were recorded, phases of systole of the left ventricle were determined and vector analysis of the ECG in the frontal plane was performed. The prolonged bedrest led to orthostatic intolerance of the test subjects which involved intolerance in an erect position, tachycardia, symptoms of ischemia in the subendo- and subepicardiac layers of the myocardium and a decrease in myocardial contractability. Vector analysis of the ECG demonstrated that ECG changes occurred due to a reduction of the blood supply to the myocardium, which when aggravated by altered coronary vessels, may bring about organic disturbances of the myocardium.

Author

A70-19513 #

ON THE PATTERN OF CHANGES OF ELECTROCARDIOGRAMS AND CARDIAC CONTRACTION PHASES DURING ORTHOSTATIC TESTS AFTER PROLONGED HYPOKINESIA (O KHARAKTERE IZMENENII EKG I FAZ SERDECHNOGO SOKRASHCHENIIA PRI ORTOSTATICHESKIKH PROBAKH POSLE DLITEL'NOI GIPOKINEZII).

B. A. Korolev.

Kosmicheskaya Biologiya i Meditsina, vol. 3, Sept.-Oct. 1969, p. 67-71. 8 refs. In Russian.

Results of a 70-day bed rest experiment was carried out on 16 test subjects between the ages of 20 and 25 years. At different time intervals the subjects underwent a 15-min orthostatic test at 75 deg tilt. Their electrocardiograms were recorded, phases of the systole of the left ventricle were determined, and vector analysis of the ECG in the frontal plane was performed. The prolonged bed rest led to orthostatic intolerance of the test subjects, involving intolerance in the erect position, tachycardia, symptoms of ischemia in the subendo- and subepicardiac layers of the myocardium, and decrease of the contractile ability of the myocardium. Vector analysis of the ECG demonstrated that ECG changes occurred due to a reduction of the blood supply to the myocardium which, when aggravated by altered coronary vessels, may bring about organic disturbances of the myocardium.

(Author)

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N73-16055 Joint Publications Research Service, Arlington, Va.
EFFECT OF A GAS MIXTURE WITH AN INCREASED
OXYGEN AND CARBON DIOXIDE CONTENT ON MAN'S
ORTHOSTATIC TOLERANCE

V. I. Korol'kov, A. A. Savilov, and I. Ya. Lunev *In its Space*
Biol. and Med., vol. 6, no. 6, 1972 18 Jan. 1973 p 94-100
refs (For availability see N73-16041 07-04)

The test subjects were exposed to 10-day bedrest which
resulted in a dropoff of orthostatic tolerance. Their exposure to
a 95% O₂ - 5% CO₂ atmosphere during a 30-minute tilt test
improved orthostatic tolerance, as indicated by hemodynamic
parameters, gas composition and blood acid-base equilibrium.

Author

KOTOVSKAYA, A.R. (KOTOVSKAIA, A.R.), et al. 1970.
 Change in load-factor tolerance after 70 days of hypodynamia.
 In: A.M. Genin and P.A. Sorokin, eds. Problems of Space Biology. Volume 13:
 Prolonged Limitation of Mobility and its Influence on the Human Organism.
 Washington, D.C. Scripta Technica, Inc. pp. 227-233. [NASA-TT-F-639]

Stability to the action of transverse g-forces was investigated in 12 subjects before and after a prolonged (70-day) confinement to bed. Overload tolerance was evaluated in terms of the maximum g-force at which the first signs of physiological function disturbance made their appearance, and on the basis of shifts in the physiological reactions during and after action of the load factor. A distinct decrease in the tolerance to transversely directed g-forces was noted after bed rest. Use of drugs and physical exercises during hypodynamia was clearly helpful. The combination of prophylactic measures resulted in an increase in the maximum load factor tolerated after hypodynamia without any substantial decrease of overall stability. In all cases, however, the physiological systems were more severely stressed under a given g-force after hypodynamia.

Author

A70-24695 # Changes in g-force tolerance following 70-day hypodynamia (Izmenenie perenosimosti peregruzok posle 70-sutochnoi gipodinamii). A. R. Kotovskaia, R. A. Vartbaronov, and S. F. Simpura. In: Prolonged immobility and its effect on the human organism (Dlitel'noe ogranichenie podvizhnosti i ego vliianie na organizm cheloveka). (A70-24665 10-04) Edited by A. M. Genin and P. A. Sorokin. Moscow, Izdatel'stvo Nauka (Problemy Kosmicheskoi Biologii. Volume 13), 1969, p. 240-247. 11 refs. In Russian.

Investigation of the stability of 12 test subjects to the effects of transverse g-forces before and after a 70-day bed rest. A distinct lowering in tolerance to transverse g-forces was observed after passive bed rest. The administration of pharmaceuticals and of physical exercise during hypodynamia produced an obviously positive effect. The application of an assortment of prophylactic measures was found to cause a rise in the g-force limit tolerated at hypodynamia's termination, at no substantial lowering in general stability. M.V.E.

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A66-29473 #

KOTOVSKAYA, A.R. (KOTOVASKAIA, A.R.), L.I. KAKURIN, N.I. KONNOVA, S.F. SIMPURA, and I.S. GRISHINA.

Effect of prolonged hypokinesia on human resistance to g-forces.

In: N.M. Sisakyan, ed. Problems of Space Biology. Volume 4. Wahsington, D.c., National Aeronautics and Space Administration. pp. 317-324. [NASA-TT-F-368]

Study of the effect of prolonged hypokinesia on human resistance to transverse g-forces. A detailed study is made of the changes in the respiratory and circulatory systems, motor response, and acuteness of vision of healthy adult males subjected to 3- and 20-day periods of enforced bed rest and then to the action of 7 g's applied from chest to back. Individual differences in the reactions to 20 days of hypokinesia are noted; the resistance of two subjects to g-forces sharply decreased, while the resistance of a third remained unchanged.

A. B. K.

KOTTKE, F.J. 1966.

The effects of limitation of activity upon the human body.
Journal of the American Medical Association 196(10):117-122.

The functional capacity of any organ is dependent within physiological limits upon the intensity and frequency of its activity. Although rest may be protective for a damaged organ it results in progressive loss of functional capacity for normal organs. Limitation of activity during prolonged bed rest causes significant deterioration of multiple organ systems including the skeletal, neuromuscular, cardiovascular, respiratory, urogenital, and nervous systems. Total inactivity of muscle results in loss of strength of approximately 3% per day. Neuromuscular and emotional control and intellectual performance are all impaired by prolonged bed rest. Cardiovascular function decreases during bed rest more rapidly than it is restored when activity is resumed. Years may be required to restore the calcium lost from the skeleton during immobilization.

140
KRASNYKH, I.G. 1970.

Influence of prolonged hypodynamia on heart size and the functional state of the myocardium.

In: A.M. Genin and P.A. Sorokin, eds. Problems of Space Biology. Volume 13: Prolonged Limitation of Mobility and its Influence on the Human Organism. Washington, D.C., Scripta Technica, Inc. pp. 58-65. [NASA-TT-F-639]

The thoracic organs of individuals subject to prolonged hypodynamia (70 to 73 days) were studied roentgenologically. It was established as a result of the study that prolonged hypodynamia leads to substantial hemodynamic abnormalities, with the result that heart size decreases by 12.9 to 17.9%. When complex medication was given by way of prophylaxis, the area changes were half those in the control in two subjects and the same as in the control in one subject. The contractile function of the myocardium changed in all subjects. Physical exercises combined with medication resulted in less significant changes in both heart size and heart contractile function. The extent of heart-area decrease when a set of prophylactic measures was taken (physical exercises, femoral cuffs, and complex medication) was the same as in the control group in 5 of 6 subjects, and even greater in certain individuals. The observed changes in the heart were functional in nature, and returned to normal after the subjects resumed their normal everyday activities.

Author

141
KRASNYKH, I.G. 1970.

Mineral saturation of bone tissue under conditions of prolonged hypodynamia.

In: A.M. Genin and P.A. Sorokin, eds. Problems of Space Biology. Volume 13: Prolonged Limitation of Mobility and its Influence on the Human Organism.

Washington, D.C., Scripta Technica, Inc. pp. 89-95. [NASA-TT-F-639]

The mineral-saturation level of the right calcaneus and the first phalanx of the fifth finger of the right hand was studied by X-ray photometry in individuals subjected to prolonged hypodynamia. It was established that 70 to 73 days of hypodynamia reduced the amount of calcium salts in the calcaneus by an average of 11.8% and in the first phalanx of the fifth finger by 6.9%. Recovery of the calcium salts to the initial level was not complete a month later. Use of complex preventive medication did not favorably influence the level of decalcification by comparison with a control. Physical exercises prescribed for prophylactic purposes and a combination of exercise with inflatable femoral cuffs and medications resulted in smaller (by factors of 2 to 5) losses of phosphorus and calcium salts by comparison with the control. Author

Space Biol. & Med. 8(1): 98/¹⁰³1974.

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ROENTGENOLOGICAL STUDY OF CARDIAC FUNCTION AND MINERAL SATURATION OF BONE
TISSUE AFTER THIRTY-DAY HYPOKINESIA

[Article by I. G. Krasnykh; Moscow, Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina, Russian, Vol 8, No 1, January-February 1974, submitted 19 November 1971, pp 68-71]

Abstract: Before and on the fourth day of a 30-day bedrest experiment the cardiac size and output, as well as the contractile function of the myocardium were measured using teleroentgenokymograms. Bone density of the right heel bone and the first phalanx of the fifth finger on the right hand was determined roentgenophotometrically. In the early recovery period the cardiac size, cardiac output and the force of cardiac contractions decreased whereas the heart rate increased. Bone density also decreased. The countermeasures applied -- physical exercises, lower body negative pressure and muscle electrostimulation -- reduced the mentioned changes but did not eliminate them entirely.

CHANGES IN CARDIAC ACTIVITY DURING PROLONGED RESTRICTION OF MOTOR ACTIVITY

[Article by T. N. Krupina, B. M. Fedorov, T. V. Benevolenskaya, O. I. Boykova, V. S. Nevstruyeva, Ye. N. Kul'kov, R. S. Morozov and V. S. Romanov; Moscow, Kosmicheskaya Biologiya i Meditsina, Russian, Vol 5, No 2, 1971, pp 76-81, submitted for publication 1 June 1970]

Abstract: This paper gives the results of clinical and experimental investigations of animals and human subjects conducted to study the mechanisms underlying the effect of hypodynamia on the cardiac function. Clinical investigations which involved a 120-day bedrest experiment indicated that lessened activity resulted in deterioration of the autonomic function and asthenization of the body at later stages. Cardiac changes were traced in the ECG, largely due to a reduced amplitude of the T waves in the first standard and left chest leads. Hypokinetic experiments on rabbits revealed a drastic reduction in noradrenaline content in the hypothalamus at early stages and an inhibition of the adrenal function at later times. Ultrastructural investigations of myocardial cells revealed focal changes in contractile elements (myofibrillar swelling), trophic formations (reduced number of cristae in mitochondria) and increased permeability of the capillary endothelium. Changes in ECG waves which are typical of hypokinetic exposure can be attributed to disturbances in cardiac regulation and trophic support of the myocardium.

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N68-17753# Joint Publications Research Service, Washington, D. C.

FUNCTIONAL CHANGES IN THE NERVOUS SYSTEM AND FUNCTIONING AND CERTAIN ANALYZERS IN RESPONSE TO THE COMBINED EFFECT OF HYPOKINESIA AND RADIAL ACCELERATION

T. N. Krupina, A. Ya. Tizul, N. M. Boglevskaya, B. P. Baranova, E. I. Matsnev et al. *In its Space Biol. and Med.* Vol. 1, No. 5, 1967 9 Feb. 1968 p. 91-99 refs (See N68-17742 08-04)

The functional state of the nervous system and some analyzers was studied using six healthy male test subjects aged 23 to 36 years who had been subjected to a 62-day bedrest combined with radial accelerations. Three of the subjects performed physical exercises using a bungee cord and bicycle ergometer. Prior to the bedrest experiment, the test subjects were twice (at an interval of 4 to 6 days) exposed to transverse accelerations. Transient neuro-autonomic disturbances were observed, the most distinct being autonomic and vascular disorders and asthenization phenomena which appeared earlier and disappeared later in test subjects performing no physical exercises. Functional changes of the acoustic and vestibular analyzers also were noted. These changes were related to an increase of the acoustic thresholds and decrease of the vestibulo-autonomic tolerance. The functional changes of the nervous system and some analyzers occur due to hemodynamic disturbances and afferent-efferent changes.

Author

ACCESS. NO. 11,767

FORM: HC AUTHOR CARD COMPLETED ✓

✓ A68-14845 #
FUNCTIONAL CHANGES IN THE NERVOUS SYSTEM AND CERTAIN ANALYSORS UNDER COMBINED EFFECTS OF HYPOKINESIA AND RADIAL ACCELERATIONS [IZMENENIE FUNKTSII NERVNOI SISTEMY I NEKOTORYKH ANALIZATOROV PRI KOMPLEKSNOM VOZDEISTVII GIPOKINEZII I RADIAL'NYKH USKORENI].
T. N. Krupina, A. Ia. Tizul, N. M. Boglevskaia, V. P. Baranova, E. I. Matsnev, and E. A. Chertovskikh.
Kosmicheskaiia Biologiia i Meditsina, vol. 1, Sept. -Oct. 1967; p. 61-66. 17 refs. In Russian.

also in Environmental Space Sciences

11364-368 Sept/Oct 1967
trans

DOCUMENT SERIES & NO.: A68-14845 (IAA)

Transl. JPRS: 44,299 A69-11496

DESCRIPTORS: Acceleration Y/1, Adynamia GY/57, Bedrest GY/39, Ear R/33, Immobilization GR/62
Nervous system R/48, Sensory system R/32, USSR GR/3

ABSTRACT:

1967

Investigation of the function of the nervous system and vestibular and auditory analyzers in a group of 6 male subjects confined to bed rest for two months between exposures to breast-to-spine accelerations at the tolerance limit reached at a rate of 0.15 to 0.2 g/sec. Various temporary functional disorders of the vegetative nervous system and acoustic analyzers, and the development of asthenic conditions are noted.

V. Z.

Space Biol. & Med. 7(2): 98-104, 1973.

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REACTIONS OF EYE RETINAL VESSELS AND INTRAOCULAR PRESSURE DURING MAN'S 120-DAY RESTRICTION TO A HORIZONTAL POSITION

[Article by M. P. Kuz'min; Moscow, Kosmicheskaya Biologiya i Meditsina, Russian, Vol 7, No 2, March-April 1973, pp 65-69, submitted for publication 19 June 1972]

Abstract: This paper gives the results of measurements of diastolic pressure in the central retinal artery, blood pressure in the brachial artery, caliber of retinal vessels and intraocular pressure in 10 healthy male test subjects during a 120-day bedrest experiment. Simultaneous phasic changes in the above indices giving evidence of a shift in the tone of retinal vessels were found. At the end of the bedrest experiment and during recovery these indices were similar to the reference levels. During the experiment the intraocular pressure increased, attaining the upper normal limit. In two persons this increase was accompanied by visual disturbances. The paper emphasizes the need for studying the state of intraocular pressure regulation and compensatory possibilities of retinal circulation in cosmonaut candidates during their selection for long-duration space flights.

N73-23038 Joint Publications Research Service, Arlington, Va.
REACTIONS OF EYE RETINAL VESSELS AND INTRA-
OCULAR PRESSURE DURING MAN'S 120 DAY RESTRIC-
TION TO A HORIZONTAL POSITION

M. P. Kuzmin. In *Space Biol. and Med.*, No. 2, 1973 15 May 1973 p 98-104 refs (For availability see N73-23024 14-04)

The results of measurements of diastolic pressure in the central retinal artery, blood pressure in the brachial artery, caliber of retinal vessels and intraocular pressure in 10 healthy male test subjects during a 120 day bed rest experiment are reported. Simultaneous phasic changes in the above indices giving evidence of a shift in the tone of retinal vessels were found. At the end of the bed rest experiment and during recovery these indices were similar to the reference levels. During the experiment the intraocular pressure increased, attaining the upper normal limit.

Author

ACCESS. NO. 9258

LAMB, L.E. 1965.

Circulatory aspects of manned space flight.

In: T.C. Bedwell, Jr. and H. Strughold, eds. Bioastronautics and the Exploration of Space. San Antonio, Texas, Southwest Research Institute. pp. 343-356.

DOCUMENT SERIES & NO.: N66-23064 (NASA)

DESCRIPTORS: ACTIVITY GR-58, BED REST GY-39, CIRCULATORY SYSTEM R-10, GRAVITY Y-31, HUMAN BL-72, PHYSIOLOGY GY-8, SIMULATION BK-36, SPACE CABIN O-56, SPACE FLIGHT GR-30

ABSTRACT:

This report deals with the apparent influence of weightlessness upon man's circulatory function. Consideration is given to the influence and absence of gravity; the influence of activity level; and studies involving chair rest, bed rest, and space cabin simulators. Observations made on the influence of the level of physical activity and other environmental factors upon the human body suggest the following areas for consideration in manned space flight: adequate physical exercise should increase the power requirement of the body, inducing favorable physiological responses commonly noted with adequate physical conditioning; venous occlusion and negative pressure mechanisms that produce alterations in distribution of blood volume and blood flow can influence vascular reflex mechanisms; and some form of artificial gravity may be utilized to provide a normal environment.

C.T.C.

ACCESS. NO. 4380

FORM: AUTHOR CARD COMPLETED

A65-14528 #

CIRCULATORY ASPECTS OF MANNED SPACE FLIGHT.

Lawrence E. Lamb (USAF, Systems Command, Aerospace Medical Div., School of Aerospace Medicine, Brooks AFB, Tex.). Southwest Research Institute and USAF, International Symposium on Bioastronautics and the Exploration of Space, 3rd, San Antonio, Tex., Nov. 16-18, 1964, Paper. 13 p. 8 refs.

DOCUMENT SERIES & NO.: A65-14528 (IAA)

DESCRIPTORS: Bedrest GY/39, Circulatory system R/10, Exercise GR/61, Human BL/72, Space flight GR/30, Tolerance GR/50, Weightlessness Y/35

ABSTRACT:

Consideration of the apparent influence of weightlessness upon man's circulatory function. The subjects treated are: (1) influence of g force, (2) absence of g force, (3) influence of level of activity, (4) pertinent observations, (5) space cabin simulator studies, (6) bed rest studies, (7) manned spaceflight, and (8) significance in aerospace flight. It is stated that observations made on the influence of the level of physical activity and other environmental factors upon the human body suggest the following important areas for consideration in manned spaceflight: first, adequate physical exercise should increase the power requirement of the body, inducing favorable physiological responses commonly noted with adequate physical conditioning. Effective exercise in the absence of the gravitational field must cause a significant alteration of cardiovascular dynamics and a significant power load on the musculoskeletal system. The level and frequency of this form of exercise remain to be determined. It is emphasized that the level of exercise above the individual's customary level can result in increased red blood cell lysis and create other adverse circumstances that would diminish man's tolerance to spaceflight.

M.M.

A66-16823

INFLUENCE OF LOWER BODY NEGATIVE PRESSURE ON THE
LEVEL OF HYDRATION DURING BED REST.

Lawrence E. Lamb (USAF, Systems Command, Aerospace Medical
Div., School of Aerospace Medicine, Aerospace Medical Sciences
Div., Brooks AFB, Tex.) and Paul M. Stevens (USAF, Systems
Command, Aerospace Medical Div., School of Aerospace Medicine,
Aerospace Medical Sciences Div., Internal Medicine Branch,
Brooks AFB, Tex.).

Aerospace Medicine, vol. 36, Dec. 1965, p. 1145-1151. 8 refs.

In four subjects, bed rest was used to induce recumbency
diuresis. This was manifested by a decrease in fluid balance,
body weight, and plasma volume, accompanied with an increase in
hematocrit. After the changes from bed rest had occurred, the use
of lower body negative pressure (LBNP) over a two-day period re-
sulted in rehydration manifested by an increase in fluid balance,
body weight, and plasma volume, accompanied with a decrease in
hematocrit. The use of LBNP is an effective means to restore
hydration after recumbency diuresis has occurred. This has im-
portant applications to manned space flight when it is desirable to
maintain the level of hydration.

(Author)

ACCESS. NO. 9460

FORM: ☒ AUTHOR CARD COMPLETED

LAMB, L.E. 1966.

Status of knowledge of weightlessness.

In: Space Research: Directions for the Future, Part 3. Washington, D.C.
National Academy of Sciences - National Research Council. pp. 191-208.

[NASA-CR-70003]

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DOCUMENT SERIES & NO.: N66-16428 (NASA)

DESCRIPTORS: Bedrest GY/39, Dehydration P/38, Diuresis R/58, Immobilization GR/62,
Manned satellite O/26, Pressurized suit BK/15, Review GR/25, Weightlessness

Y/35

ABSTRACT:

6966

Available information indicates that the initial physiological changes during manned space flight are related to dehydration. From knowledge of recumbency diuresis and decreases in the hydration level with recumbency, it may be presumed that weightlessness is a contributory factor in dehydration. The occurrence of dehydration in recumbency, and presumably during manned space flight, is an acute self-limiting process that is rapidly reversible when normal ambulatory earth activities are resumed. It can be sharply reversed by short-term application of lower-body negative pressure. Immediate post-flight events permit the use of a number of physiological

maneuvers that provide protection against decreased orthostatic tolerance and that, in this sense, the operational environment is not analogous to the responses noted from tilt-table or simple standing studies. These maneuvers may offer major protection against post-flight decreased orthostatic tolerance. The g suit or other pressure clothing can be used to provide significant protection against decreased orthostatic tolerance. Preliminary evidence suggests that the acute improvement in hydration brought on by short-term application of lower-body negative pressure abolishes the problem of decreased orthostatic tolerance after bed rest.

E.E.B.

149
LAMPUSOV, B.A. 1966.

The question of the influence on an organism of prolonged restriction of mobility and ways to compensate for it by physical exercises.

In: V.V. Parin, ed. Problems in Aerospace Medicine, Washington, D.C. Joint Publications Research Service, pp. 325-326. [JPRS-38272]

N67-11574# Joint Publications Research Service, Washington, D. C.

THE QUESTION OF THE INFLUENCE ON AN ORGANISM OF PROLONGED RESTRICTION OF MOBILITY AND WAYS TO COMPENSATE FOR IT BY PHYSICAL EXERCISES

B. A. Lampusov In: *Probl. in Aerospace Med.* 21 Oct. 1966 p 325-326 (See N67-11401 02-04) CFSTI: \$8.40

The effect of hypokinesia on the motor sphere during conditions of restricted mobility is considered, and compensation through physical exercise is examined. Of the subjects tested, the magnitude and character of the negative physiological shifts depended on the amount of motor activity and magnitude of physical loads in their professional work. The strength and tone of the muscles, cardiac activity, and respiratory functioning were affected. S.P.

ACCESS. NO. 17,474

FORM: _____ AUTHOR: ✓ DRILL: ✓

LANCASTER, M.C. 1968.

Cardiovascular aspects of hypodynamics.

In: Pattern Recognition. Body Armour and Aircrew Equipment Assemblies.

Current Space Medical Problems, Aeromedical Evacuation, Paris, France,

Advisory Group for Aerospace Research and Development. 9 pages.

[AGARD-CP-41]

150

DOCUMENT NO.: N69-34768

DESCRIPTORS: ACTIVITY GR/58, BEDREST GY/39, CELL W/4, CIRCULATORY SYSTEM R/10, EXERCISE GR/61,
MUSCULAR SYSTEM R/53, NERVOUS SYSTEM R/48, OXYGEN W/74, PHARMACOLOGY GY/25,
TOLERANCE GR/50.

1968.

ABSTRACT:

Exposure to inactivity produces a gradual decrease in cardiac stroke volume and a rise in resting pulse rate. There is also a decrease in oxygen transport capability. These changes, combined with a decrease in plasma volume and red cell mass and a loss of skeletal muscle, produce a significant decrease in work capacity which fails to completely return during three weeks ambulation. Prevention of this deconditioning by exercise during bed rest appears to be feasible and is being studied. Orthostatic intolerance resulting from bed rest was not obviated by restoration of plasma volume using drugs but can be obviated by exposure to lower body negative pressure during the final few days of bed rest. Decreased sympathetic nervous activity appears to be a factor in producing this intolerance but other factors may be important. Unlike the decreased work capacity, orthostatic tolerance tends to be restored within 48 to 72 hours of ambulation.

Author

LANCASTER, M.C., and J.H. TRIEBWASSER. 1971.

151

The effect of total body exercise on the metabolic, hematologic, and cardiovascular consequences of prolonged bed rest.

In: R.H. Murray and M. McCally, eds. Hypogravic and Hypodynamic Environments. Washington, D.C., National Aeronautics and Space Administration. pp. 225-248. [NASA-SP-269]

The first phase of a study of exercise effects in the prevention of the physiological changes induced by prolonged bed rest has been completed. Because all analyses have not been completed, metabolic and certain special assays, such as renin, renin substrate, and ADH, are not reported. Also, some of the hematologic data have not been evaluated. Eight male subjects participated in the experiment which covered a period of 16 weeks; 5 weeks of control, 5 weeks of bed rest, and 6 weeks of recovery. All exercise was performed on a special total body ergometer that simulates zero gravity while permitting exercise under conditions of normal stress to the fully ambulatory musculoskeletal system. Results are presented of orthostatic stress tests, psychomotor tests, work tolerance, and psychobiologic studies.

A.L.

LANCASTER, M.C. 1971.

Hematologic aspects of bed rest.

In: R.H. Murray and M. McCally, eds. Hypogravic and Hypodynamic Environments. Washington, D.C., National Aeronautics and Space Administration. pp. 299-322. [NASA-SP-269]

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Results are presented of studies in which the red cell mass (RCM) loss that occurs with bed rest was documented by means of direct red cell label. Twenty-one healthy males participated in the experiment which consisted of a 20-day adjustment phase, 35 days of continuous absolute bed rest, and a 20-day recovery phase. Eight additional males were used to control such variables as age, blood lettings, seasonal changes, and stability of red cell and plasma volumes. The RCM decreased during bed rest in 18 of the 21 subjects with an average loss of 140 ml representing approximately 8 percent of the RCM. Plasma volumes determined by indirect estimation of RCM and corrected microhematocrit decreased some 400 ml during bed rest, and plasma volumes determined at the end of the recovery by a direct method showed values well above those obtained prior to bed rest. Stool tests for occult blood were consistently negative. The results reported agree with the previously described plasma volume changes that occurred during bed rest, where plasma volume was determined by either T-1824 or radioiodinated serum albumin, and the RCM was determined indirectly.

A.L.

N68-20559# School of Aerospace Medicine, Brooks AFB, Tex.

HYPODYNAMICS: METABOLIC ASPECTS

Malcolm C. Lancaster *In its Lectures in Aerospace Med.*, 6th Ser.
1967 p 255-263 refs (See N68-20545 10-04)

The metabolic changes associated with prolonged bed rest that appear to be significant at present are those that seem to be the result of the decrease in physical activity. The atrophy and weakness of muscles and the calcium loss appear to be from this effect. The potential deleterious effects of the calcium loss are weakening of trabecular bone structure and renal lithiasis. Author

154
LARSEN, W.E. 1969.

Effects of sustained acceleration, coriolis acceleration and bed rest on precision psychomotor control performance.

In: Preprints of the 1969 Annual Scientific Meeting, Aerospace Medical Association, San Francisco, California, May 1969. p. 206.

Bedrest Effects - Results from moderate-term bedrest studies (Figure 3) did not show the reduction in effective time delay τ_{eff} which had been anticipated on the basis of expected decrease in muscle tone. It had been expected that extended periods of inactivity would result in an increase in neuromuscular lag with a resulting increase in τ_{eff} .

It should be noted that initial learning sessions were accomplished with the subject in a seated position. During the initial week of bedrest, a small decrease in $T_{critical}$ resulted while the subjects relearned the tracking task in the supine position. Within one week, performance returned to the level attained by each subject prior to bedrest, and exceeded previous ambulatory session means in most cases for the remaining three weeks.

The single subject, introduced to the critical tracking task in the 27th week of bedrest, attained peak performance (minimum T_c) levels higher than that for the other six subjects tested. Performance of this subject, (Figure 3) approached a performance plateau at a slower rate than the short-term bedrest subjects. This is either attributable to an inherently slower rate of learning in the supine position, or to adverse effects of his prior 26 weeks of bedrest.

In retrospect, sufficient decline in muscle tone to cause an increase in τ_{eff} should not have been expected. The subjects, although remaining in bed, did use their hands and arms sufficiently (moving in bed, reading, and eating) to maintain muscle

tone in the muscles used in tracking. It is possible that reduced performance would have been observed had the test apparatus been designed to be operated with the feet.

Concluding Remarks - During the several programs carried out to determine the effects of mild stress on the effective time delay of a human operator in a tracking situation, the following general observations are noted:

- Moderate sustained FBI accelerations of 6g resulted in increases in critical time constant of 15 to 30 msec, most of which is attributable to increases in the subjects' effective time delay.
- Mild vestibular disturbance due to coriolis accelerations at 2g FBI accelerations resulted in further increases of 10 to 25 msec in the subjects' effective time delay.
- Short-term bedrest studies indicated no significant decreases in performance; in fact, performance tended to improve slightly during the bedrest period.

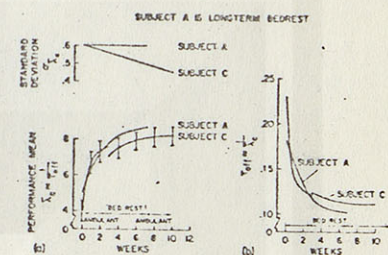


Figure 3.- Effect of bedrest on critical task performance.

CITATION: LEACH, C.S., J. VERNIKOS-DANELIS, C.M. WINGET, P.C. RAMBAUT and B.O. CAMPBELL. The effect of hypokinesia on plasma ACTH and cortisol concentrations. Published by Ames Research Center, Moffett Field, California. 1972. 155

PERFORMING INSTITUTION: Manned Spacecraft Center, Ames Research Center, & Baylor College of Medicine.

KIND OF DOCUMENT: Research report

SUBJECTS: 6 healthy males (20-26 yrs, 55±1kg)

RES. OBJECT.	METHOD	RESULTS	CONCLUSIONS
To examine the effects of bedrest on the documented rhythms of ACTH and cortisol in healthy individuals.	Procedure included: 20-day ambulatory pre-bedrest control period; 56 days absolute bedrest; 20 day post-bedrest recovery; 14L:10D cycle; and a diet of 2500cals/day. Fifteen ml blood (5ml plasma and 2.5ml serum) was recovered by repetitive venous punctures every 4 hrs for 48 hrs 9 times. Blood was kept in ice during collection and separation, frozen promptly, and stored frozen. Once each bleeding, hemoglobin, hematocrit, RBC and WBC's were determined. Blood plasma samples were analyzed for hydrocortisone and adrenocorticotrophic hormone. One control subject was not bled and only temp, heart rate and urine were taken.	Control S showed changes were not due to excessive blood loss. There were significant diurnal fluctuations in ACTH and cortisol. ACTH individual variability was greater than cortisol. Bedrest had little effect on circadian rhythmicity but amplitude was reduced in steroid rhythm and increased in ACTH secretion. Hydrocortisone had a secondary peak during bedrest and postbedrest. Mean ACTH secretion rose gradually beginning with bedrest, sharply after 30 days then gradually returned to control levels post-bedrest. ACTH and cortisol are not directly correlated in early mean rise but final increase mean levels are correlated with decrease in cortisol at 54 days bedrest. Mean 24 hr prebedrest and bedrest levels of cortisol are correlated, S's with lowest initial levels showing greatest increase during bedrest and vice versa. Blood plasma analyses (RBC, etc.) showed no appreciable changes.	Researchers must study projected effect of prolonged spaceflight. Findings indicate significant metabolic change in a weightless environment, which will significantly affect design of mission schedules.

A72-27477 * Effects of bedrest and centrifugation of humans on serum thyroid function tests. C. S. Leach (NASA, Manned Spacecraft Center, Houston, Tex.), P. C. Johnson (Baylor University; Methodist Hospital, Houston, Tex.), and T. B. Driscoll (NASA, Manned Spacecraft Center; Baylor University, Houston, Tex.). *Aerospace Medicine*, vol. 43, Apr. 1972, p. 400-402. 8 refs. Contract No. NAS9-11201; Grant No. PHS-HE-05435-11 P/17.

Changes in plasma volume and protein concentration have been reported when normal subjects are bedrested or centrifuged. Since thyroid hormones are transported by specific plasma proteins, each of these procedures could be expected to change plasma levels of these hormones. In this study centrifugation of normal healthy human subjects produced an increased concentration of total protein and albumin. When these same subjects were bedrested for six days, no change in total protein, albumin or thyroxine binding globulin were found although there was an eight per cent decrease in plasma volume. Centrifugation and, to a lesser extent, bedrest produced changes in serum T-4 levels and the T-3 test results. The direction of these changes (decreased % T-3 values and increased T-4 levels) indicate that these two situations produce an increased plasma concentration of thyroxine binding sites.

(Author)

LECOCQ, F.R. 1971.

The effect of bed rest on glucose regulation in man: Studies in progress.

In: R.H. Murray and M. McCally, eds. Hypogravic and Hypodynamic Environments. Washington, D.C., National Aeronautics and Space Administration. pp. 289-298. [NASA-SP-269].

Data are presented from two bed rest studies in which isolated parameters of glucose balance during bed rest were investigated. In one study, forearm glucose uptake during glucose loading was measured; in the other study, the effect of an intracellular hypoglycemic agent (2 deoxy-D-glucose) on glucoregulatory hormones was examined. The forearm glucose uptake study was designed to determine the quantitative significance of peripheral glucose uptake in subjects maintained at bed rest for 14 days. Infusion of 2 deoxy-D-glucose before, during, and after 14 days of bed rest was designed to confirm and amplify previous observations that the hypodynamic condition imposed by bed rest decreases pituitary growth hormone responsiveness. Test results showed that significant alterations in both peripheral glucose utilization during glucose loading and glucoregulatory hormone response to intercellular glucopenia are induced by simple absolute bed rest. Whether these changes represent a homeostatic adaption to bed rest or have pathophysiological significance could not be concluded from these data. However, these findings have significance for both clinical medicine and for the assessment of human response to the effects of prolonged space flight. A.L.

158

LEVERETT, S.D., Jr., S.J. SHUBROOKS, Jr., and W. SHUMATE. 1970.
Some effects of space shuttle +G_z reentry profiles on human subjects.
Manned Spacecraft Center, Houston, Texas.

Nine healthy (USAF Class III Flying Physical) male USAF volunteer subjects were used in this study. Their ages ranged from 20 - 36 (mean age 26) and all were experienced centrifuge subjects, having been exposed to various acceleration environments at least once per week over an extended period of time. In order to test the proposed experimental protocol, the subjects were exposed to a series of centrifuge runs on the USAF centrifuge one week prior to the control runs conducted at NASA MSC. The initial USAF runs consisted of an exposure to +2.5, 3.0, 3.5 and 4.0G_z, onset rate 10/60 sec. to a plateau for a proposed time period of 370 sec. at each level. In the instance of the SAM runs, the subjects were in an upright fighter type seat and as the centrifuge rotated to peak G level, the inertial resultant vector remained in a head-to-foot direction while the subject remained in a seated position.

Eight of the 9 subjects were able to achieve 4G for varying periods of time while 5 of the 9 completed the total exposure time of 4G/370 sec. with no visual symptoms. From this initial series, it was apparent that by holding the time at G constant and varying the G level, a G-time tolerance could probably be achieved on a group of human subjects.

N68-32800# Systems Research Labs., Inc., San Antonio, Tex.
CARDIOVASCULAR IMPLICATIONS OF SPACE
TUMBLING: CONDITIONING, TRAINING, AND
PROTECTION
S. T. Lim, Brooks AFB, Tex. School of Aerospace Med. Apr.
1968 20 p refs
(Contract AF 41(609)-2897)
(SAM-TR-68-32; AD-671510)

159

DOCUMENT SERIES & NO.: N68-32800 (NASA)

DESCRIPTORS: Circulatory system R/10, Equipment GR/86, Exercise GR/61, Pressure Y/28,
Rotation Y/6, safety GR/32, Training GR/39, Weightlessness Y/35,

ABSTRACT:

1068

Cardiovascular deconditioning occurs as a result of exposure to zero-gravity. Whereas cardiovascular deconditioning produced by water immersion can be prevented by pressure cuffs, and that produced by bed rest can be prevented by passive exercise, such measures are not effective against deconditioning due to space flight. The author suggests certain experiments to study response to tumbling by the conditioned cardiovascular system and by the deconditioned system. The theoretic pressure input resulting from human centrifugation is graphically represented. Tumbling is considered the short-radius spectrum of centrifugation. The concept of the hydrostatic indifference point is discussed in the light of the marked curvature of the pressure profile when the center of rotation is very near one end of the body and the parabolic form of the pressure curve when the center of rotation is within the body.

Author (TAB)