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BED REST STUDIES
BIBLIOGRAPHY

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April 1974



SCIENCES COMMUNICATION DIVISION
THE GEORGE WASHINGTON UNIVERSITY MEDICAL CENTER
2001 S STREET, N.W., WASHINGTON, D.C. 20009
Telephone (202) 462-5828

BED REST STUDIES
BIBLIOGRAPHY

Compiled by
Thora W. Halstead and Linda Pleasant

for
Dr. Sherman P. Vinograd
Director, Biomedical Research Division
Office of Life Sciences
National Aeronautics and Space Administration

April 1974

LINDAN, O. 1971.

160

The relationship between the diurnal and meal-driven rhythms of kidney functions in subjects at rest.

In: R.H. Murray and M. McCally, eds. Hypogravic and Hypodynamic Environments. Washington, D.C., National Aeronautics and Space Administration. pp. 271-280. [NASA-SP-269].

In order to study the relationship between diurnal and meal driven excretory patterns in the human kidney, and the possible effect on the kidney of the removal of the diurnal clock, study subjects with normal controls and patients paralyzed with high spinal cord injury were studied while confined to bed. The test schedules lasted from 14 to 21 days and the total average food intake was identical for each subject. The drinking was given either with meals or independently at random. In this study, the diurnal kidney cycle was dwarfed with meal cycles by having the subject consume large meals at regular frequencies, uncorrelated with the day/night cycle. It was not surprising that the results indicated that the kidney should be governed tightly in its activities by the intake of food, however, it was puzzling that certain of its homeostatic mechanisms should apparently follow a day/night cycle. The primary triggering mechanism and the purpose of the diurnal cycle for electrolyte excretion is unknown.

A.L.

† 20624. LIPMAN, RICHARD L. (Dep. Med., Univ. Miami Sch. Med., Miami, Fla., 33152, USA.), PHILIP RASKIN, TOMMY LOVE, JOHN TRIEBWASSER, FRANK R. LECOCQ and JOEL J. SCHNURE. Glucose intolerance during decreased physical activity in man. DIABETES 21(2): 101-107. illus. 1972. --Impaired glucose tolerance is a well documented consequence of absolute bedrest in man. Previous studies showed a decrease in forearm glucose uptake during i.v. glucose infusion after 14 days of bedrest. Bedrest is associated not only with physical inactivity but with a change in gravitational vector. This study was designed to examine the individual contributions of these factors to the glucose intolerance of bedrest. Thus, glucose tolerance tests were carried out in exercising subjects at bedrest and in rhesus monkeys immobilized in the vertical plane. Exercise in man improved glucose tolerance during bedrest, and vertically immobilized monkeys demonstrated significant glucose intolerance. The glucose intolerance of bedrest is probably a function of the decrease in physical activity.

162

† 25265. LIPMAN, RICHARD L., FRODE ULVEDAL, JOEL J. SCHNURE, EDWIN M. BRADLEY, and FRANK R. LECOCQ. (U. S. Air Force Sch. Aerosp. Med., San Antonio, Tex., USA.) Glucoregulatory hormone response to 2-deoxy-d-glucose infusion in normal subjects at bedrest. META CLIN EXP 19(11): 930-937, illus, 1970.--Plasma glucose, free fatty acids, serum immunoreactive growth hormone and insulin as well as plasma cortisol and urinary epinephrine and norepinephrine were measured before and following an infusion of 2-deoxy-d-glucose in 8 healthy, normal men prior to, on the 14th day of absolute bedrest and 10 days after the bedrest period. With each subject used as his own control, glucose, free fatty acids and serum immunoreactive insulin were no different following bedrest. Plasma cortisol, growth hormone and urinary epinephrine responses to the 2-deoxy-d-glucose infusion were significantly lower following bedrest as compared to the control response. The adaptation to bedrest includes alterations in glucoregulatory hormone responses to intracellular hypoglycemia.

40835. LIPMAN, RICHARD L. (Univ. Miami Sch. Med., Miami, Fla., USA.), JOEL J. SCHNORE, EDWIN M. BRADLEY, and FRANK R. LECOCQ. Impairment of peripheral glucose utilization in normal subjects by prolonged bed rest. *J LAB CLIN MED* 76(4): 221-230, illus. 1970.--[The well-documented similarities between the hypodynamic state of gravity-free space flight and prolonged bed rest, together with the inherent difficulties of performing in-flight investigations, have given impetus to expanding research in the effects of prolonged bed rest.] The effects of 2 wk of absolute bed rest on arteriovenous glucose differences [AVGD], forearm blood flow, and peripheral glucose uptake were studied in 9 subjects. A 180 min infusion of a 20% glucose solution was administered during a control period of normal activity, on the 14th day of absolute bed rest and on the 7th or 14th day of post-bed-rest recovery. Venous glucose was recorded continuously by an AutoAnalyzer. Arterial glucose, serum immunoreactive insulin (IRI), and forearm blood flow were measured. Glucose loads were varied during the bed-rest and recovery infusions to match the venous glucose concentrations obtained during the control period for each subject and thus achieve similar insulinogenic stimuli between periods. While there were no significant differences in fasting preinfusion AVGD or preinfusion peripheral glucose uptakes, there were significant decreases in peripheral glucose uptake during the bed-rest and the 7 day-recovery glucose infusions as compared to the control and the 14 day-recovery infusions. There was a significant decrease in the mean glucose load needed to produce a comparable venous glucose curve during the bed rest as compared to the control infusion. Mean serum immunoreactive insulin concentrations were comparable during each of the 3 infusions. The glucose intolerance of bed rest is due, in part, to an impairment of peripheral glucose uptake which is not the result of insulin deficiency or insulin antagonists but appears to be a cellular alteration.

164

93155. LOBBAN, MARY C., and BARBARA E. TREDRE. (Nat. Inst. Med. Res., London, Engl.) Renal diurnal rhythms in human subjects during the bed-rest and limited activity. In: Proceedings of the Physiological Society, London, 21-22 February, 1964. J PHYSIOL [London] 171(2): 26P-27P. 1964.--Abstract only.

It is known that periods of severe physical exertion may affect the form of the diurnal rhythms of renal excretion in man (Lewis & Lobban, 1958; Lobban, 1960). The opportunity to study the converse situation, i.e. where human subjects are confined to bed and take no exercise at all, arose when thirty-two miners were admitted in three successive groups to the South Wales Sanatorium, Talgarth. All were suffering from a minor degree of pneumoconiosis, not normally sufficient to cause them to stop working. In each group, half of the men were receiving streptomycin and the remainder were given a placebo in the course of a trial to determine the relative advantages of chemotherapy, rest and a sanatorium regime in arresting the course of the disease. None had any history of renal disorder.

For all subjects a week of complete bed-rest was followed by a gradual reduction in the daily rest periods and an increase in physical activity. In each subject urine samples were collected at frequent intervals over a 50 hr period on three occasions during his stay in the sanatorium: (i) during the first week on complete bed-rest; (ii) during the sixth week, when rest periods alternated with very light physical activity; and

(iii) during the twelfth week, when no rest periods occurred during the course of the day and two daily walks of three miles formed part of the routine.

The diurnal rhythms of renal excretion of water, potassium, sodium and chloride were at all times normal in phase (with respect to the time of day) but were somewhat low in amplitude. The pattern of potassium excretion appeared least affected. In general, the amplitudes of the excretory rhythms of all the urinary constituents were greater during the period of moderate daily activity than when the subjects were on bed-rest or on very limited activity; but in the majority of subjects, excretory patterns showed far more disturbance during the period of limited activity than they did during bed-rest. These differences were most marked in the group of men who were admitted to the sanatorium during the spring months. No difference could be detected between subjects under chemotherapy and those receiving a placebo.

The amplitude of the renal diurnal rhythms in man is reduced during and after prolonged periods of severe physical exertion. It would appear that prolonged periods of severe limitation of activity exert a similar effect.

A10. Lockwood, D.R., C.L. Donaldson, J.M. Vogel, S.B. Hulley, and D.A. Hantman. 1972.
The Use of Calcium and Phosphate Supplementation to Prevent Bone Mineral Loss During Prolonged Bed Rest.
Clinical Research 20(2):239. 1972. (abstract only).

165

REFERENCE	DOCUMENTATION	EXPERIMENTAL SUBJECTS	WEIGHTLESSNESS ANALOG	COUNTERMEASURE REGIMEN	EFFECTIVENESS	MEASUREMENTS	NOTES
D.R. Lockwood et al, 1972 USA	research experiment	human (5) (3)	bedrest, 17 weeks	diet supplements, 1315 mg Ca as lactate, 1419 mg P as potassium phosphate	very (Ca balance, wks 1-11) no (Ca balance, wks 12-17) very (P balance, wks 1-11) no (P balance, wks 12-17) moderate (bone density)	Ca balance P balance bone density, gamma scan, calcaneus, tibia	

A67-19857

METABOLIC EFFECTS OF PROLONGED BED REST - THEIR
MODIFICATION BY SIMULATED ALTITUDE.

Theodore N. Lynch (Louisville University, School of Medicine,
Louisville, Ky.), Robert L. Jensen, Paul M. Stevens, Robert L.
Johnson, and Lawrence E. Lamb (USAF, Systems Command, Aero-
space Medical Div., School of Aerospace Medicine, Internal Medicine
Branch, Brooks AFB, Tex.).

Aerospace Medicine, vol. 38, Jan. 1967, p. 10-20. 32 refs.

Metabolic studies were performed on 44 healthy men before
and during bed rest at ground level or at simulated altitudes of
10,000 or 12,000 feet. Simple bed rest brought loss of calcium,
phosphorous, nitrogen, sodium, and chloride with little change
in potassium. The addition of 12,000 feet simulated altitude sig-
nificantly reduced the loss of urinary calcium phosphorous, nitrogen,
sodium and chloride and total nitrogen. The 10,000 foot simulated
altitude was associated with urinary calcium losses quantitatively
intermediate between the ground level and 12,000 foot groups and in-
creased total sodium and potassium losses. The possibility that
reduced bone resorption represents one aspect of acclimatization to
simulated altitude is discussed. (Author)

166

MACK, P.B., et al. 1966.

A bed rest study involving 300 milligrams of dietary calcium daily.
Sixth semiannual report.

Texas Woman's University, Denton, Texas.

COMPARISON OF BONE DENSITOMETRY AND METABOLISM

FINDINGS IN FOUR HEALTHY ADULT MEN DURING A
14-DAY BED REST PERIOD, ON A DIET CONTAINING
300 MILLIGRAMS OF CALCIUM DAILY, WITH A 14-DAY
AMBULATORY CONTROL PERIOD ON THE SAME LEVEL OF
CALCIUM, AND WITH PRE- AND POST-BED REST AND
PRE- AND POST-AMBULATORY CONTROL PERIODS ON
2,000 MILLIGRAMS DAILY

MACK, P.B., et al. 1966.

A bed rest study with and without exercise involving 800 milligrams of dietary calcium daily. Seventh semiannual report.

Texas Woman's University, Denton, Texas. 113 pages.

Two bed rest units were run with 800 milligrams of calcium fed daily during the pre-bed rest, the bed rest and the post-bed rest periods, and with the remainder of the diet similar to that fed other bed rest groups in the Texas Woman's University series.

The first of the bed rest units was maintained as were all former bed rest units except for the level of calcium provided daily. The second bed rest unit included two of the four men who participated in the first unit. All aspects of the second unit were the same as the first except for the fact that a program of isotonic and isometric exercise similar to that used in the flight of Gemini-Titan VII was followed daily, using the same inflight exerciser as that used in NASA Experiment M-3, and followed in the aforementioned space flight.

The loss of calcium by the two men was significantly less in each case during the bed rest in which the exercise was followed than when the men were quietly recumbent, with no exercise taken. When the exercise program was followed in the bed rest program as in the Gemini VII flight, the bone mass of the os calcis was higher in both men than when the exercise program was omitted, by a highly significant difference. This indicates that exercise was one factor to which the low skeletal losses experienced by the two astronauts of Gemini VII could be attributed.

ACCESS. NO. 11,706

FORM: ☒ AUTHOR CARD COMPLETED ☒

164
A68-14406 *
BONE DEMINERALIZATION OF FOOT AND HAND OF GEMINI-
TITAN IV, V AND VII ASTRONAUTS DURING ORBITAL FLIGHT.
Pauline Beery Mack, George P. Vose (Texas Woman's University,
Research Institute, Denton, Tex.), Paul A. LaChance (NASA, Manned
Spacecraft Center, Biomedical Research Office, Flight Food and
Nutrition Div., Houston, Tex.), and Fred B. Vogt (Texas Woman's
University, Research Institute, Denton, Texas, University, Graduate
School of Biomedical Sciences, Houston, Tex.).
American Journal of Roentgenology, Radium Therapy and Nuclear
Medicine, vol. C, July 1967, p. 503-511. 16 refs.
Grants No. NSG-440; No. NSG-44-013-001.

DOCUMENT SERIES & NO.: A68-14406 (IAA)

DESCRIPTORS: Astronaut BK/2, Calcium W/87, Extremities R/28, Gemini O/30, Human BL/72
Immobilization GR/62, Manned satellite O/26, Minerals W/86, Skeletal system
R/27, Space flight GR/30
1967

ABSTRACT:

Discussion of studies aimed at determining the effect of prolonged weightlessness and partial immobilization on the human skeletal system. Roentgenographic densitometry of several appendicular bones of astronauts participating in the Gemini 4, 5, and 7 orbital space flights revealed the occurrence of small but significant losses in bone mass. The lowest negative bone-mass change occurred in the 14-day Gemini 7 flight, while the highest occurred during the 8-day Gemini 5 flight, showing that the duration of a space mission does not correlate with the extent of bone-mass loss. A statistically significant correlation coefficient is found between the mean dietary calcium intake of each astronaut during the respective flights and their losses in bone mass in 6 anatomic sites. The lower bone losses observed for Gemini 7 are attributed to the fact that the astronauts consumed more calcium than the Gemini 4 and 5 astronauts and, in addition, participated in a special program of isometric and isotonic exercise.
V.P.

170

MACK, P.B. 1966.

Calcium loss studies during human bed rest: A preliminary report.

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. pp. 169-177. [NASA-SP-64]

HC

Metabolic and bone mass changes resulting from continuous periods of bed rest are investigated in 17 healthy adult males. Results are given for five 14-day and one 30-day bed rest unit, each unit is preceded by an ambulatory pre-conditioning period and followed by an ambulatory reconditioning period. A summary of data on calcium consumption, excretion, and balance for the individuals participating in the bed rest units shows that the degree of negative balance varies between subjects within each unit, but that a general relationship exists between level of calcium intake and extent of negative balance. Feces are shown to change somewhat more than urine in calcium excretion at different levels of calcium intake. Change of bone mass in the central section of the os calcis generally follow the calcium level of the diet; changes in serum calcium have been very slight.

M.W.R.

171

MACK, P.B., and P.L. LACHANCE. Nov. 1967.
Effects of Recumbency and Space Flight on Bone Density.
Amer. J. Clin. Nut. 20(11):1194-1205.

REFERENCE	DOCUMENTATION	EXPERIMENTAL SUBJECTS	WEIGHTLESSNESS ANALOG	COUNTERMEASURE REGIMEN	EFFECTIVENESS	MEASUREMENTS	NOTES
P.B. Mack et al, 1967 USA	research experiment	human (30)	bedrest, 14 days, 7 experiments				
		(4)		Ca supplement, 0.3gm/day	no (Ca balance) no (bone density)	Ca balance, intake, feces bone density, x-radiography, os calcis	During the control period, the subjects were adjusted to a diet containing 1.5gm/day, except for the group supple- mented with 2.0gm/day which was adjusted to 2.0gm/day.
		(5)		Ca supplement, 0.5gm/day	no (Ca balance) no (bone density)		
		(4)		Ca supplement, 0.7gm/day	slight-no (Ca balance) slight (bone density)		
		(4)		Ca supplement, 0.8gm/day	slight (Ca balance) slight (bone density)		
		(5)		Ca supplement, 1.0gm/day	moderate (Ca balance) moderate (bone density)		
		(4)		Ca supplement, 1.5gm/day	slight (Ca balance) moderate (bone density)		
		(4)		Ca supplement, 2.0gm/day	slight (Ca balance) moderate (bone density)		
		human (2)	1n-flight, Gemini IV, 4 days	Ca intake, 600-700mg/day	slight (bone density)		
		(2)	1n-flight, Gemini V 8 days	Ca intake, 300mg/day	no-slight (bone density)		
		human (2)	1n-flight, Gemini VII, 14 days	Ca intake, 1.0gm/day exercise, isotonic, bungee cords, isometric 4 times/day	moderate (bone density)	bone density, x-radiograph, os calcis, phalanx 5-2 Ca balance	The bone density and Ca balance values were statistically significant between the exercise and control groups. No data was represented. Phalanx lost little density with or without exercise.
		human (2) own controls	bedrest, 14 days,	Same as Gemini VII regimen	See Notes.		

N64-14898* Texas Woman's U., Denton Nelda Childers Stark
Lab. for Human Nutrition Research

FUNDAMENTAL INVESTIGATION OF LOSSES OF SKELETAL
MINERAL IN YOUNG ADULT HUMAN MALES AND COLLAT-
ERALLY IN YOUNG ADULT MALE PIGTAIL MONKEYS (MA-
CACUS NEMESTRIMA) THROUGH IMMOBILIZATION FOR
VARYING PERIODS OF TIME, COUPLED WITH A STUDY OF
METHODS OF PREVENTING OR REDUCING MINERAL LOSS

Semiannual Report [1 Apr.-30 Sep. 1963]
Pauline Beery Mack et al 30 Sep. 1963 50 p

(NASA Grant NsG-440)

(NASA CR-55313) OTS: \$4.60 ph, \$1.70 mf

Two bed rest studies were conducted. Measurements of
radiographic bone densitometry and analyses of calcium and
phosphorus in the urine were made. The first of the two studies
has shown that bed rest of as short a time as 3 days was
followed by a loss in bone mass in the os calcis in all human
subjects. After a 10-day interim period, a second 3-day bed
rest period, in which controlled isometric exercise was given
produced a bone mass status in the central section of the os-
calcis that was significantly increased. In an initial primate
study, bone mass in numerous parts of the body, as measured
from radiographs, was significantly higher following a period
in which vigorous exercise was taken under direction. Bal-
ance studies accompanied the radiographic measurements.

E.W.

172

173
N65-29373*# Texas Woman's Univ., Denton. Nelda Childers
Stark Lab. for Human Nutrition Research.

FUNDAMENTAL INVESTIGATION OF LOSSES OF SKELE-
TAL MINERAL IN YOUNG ADULT HUMAN MALES AND
COLLATERALLY IN YOUNG ADULT MALE PIGTAIL MON-
KEYS (MACACUS NEMESTRIMA) THROUGH IMMOBILIZA-
TION FOR VARYING PERIODS OF TIME, COUPLED WITH
A STUDY OF METHODS OF PREVENTING OR REDUCING
MINERAL LOSS

Pauline Beery Mack, Betty Bohon Afford, Ralph E. Pyke,
Arcienegas Klapper, Sue Nell English et al 31 Mar. 1965
55 p refs

(Grant NsG-440)

(NASA-CN-63993) CFSTI: HC \$3.00/MF \$0.50 C\$CLOS6

A discussion of two 14-day bed rest studies, including
collateral ambulatory pre-bed rest and post-bed rest periods,
is presented. In the first study four subjects were fed a basic
diet which provided 2.0 grams of calcium per day during pre-bed,
and post-bed rest periods. The subjects respectively lost 3.86,
3.00, 6.50, and 6.48 percent of bone mass during bed rest.
They had a mean overall daily calcium balance of -0.257,
-0.320, -0.293, and -0.205 grams, respectively. In the second
study five subjects were daily fed 0.5 grams of calcium during
bed rest after they had been equilibrated on a diet which pro-
vided 1.5 grams of calcium per day. During bed rest the subjects
did not consume all of the food offered them, rejecting chiefly
some of the bread. As a result they consumed a mean ranging
from 0.395 to 0.466 grams of calcium daily. This group was
in marked negative calcium balance with mean daily calcium
balance values ranging from -0.507 to -0.813 grams. R.N.A.

MACK, P.B.

Fundamental investigation of losses of skeletal mineral in young adult human males and collaterally in young adult male pigtail monkeys (*Macacus nemestrina*) through immobilization for varying periods of time, coupled with a study of methods of preventing or reducing mineral loss.

Fifth Semiannual Report on NASA Contract Nsg-440.

Nelda Childers Stark Laboratory for Human Nutrition Research, Texas Woman's University, Denton, Texas. September 30, 1965.

P.B. Mack et al, 1965 USA	research experiment	human (5)	bedrest 30 days	Ca supplement, 2.0 gm/day	moderate (Ca balance) moderate (P balance) moderate (bone density) no (creatinine) moderate (creatinine) moderate (nitrogen)	Ca balance, intake, urine, feces P balance, intake, urine, feces bone density, x-radiograph, os calcis creatinine, urine creatinine, urine nitrogen, urine	Control period diet had 2.0 gm/day of calcium. Ca:P ratio was kept at 1:1.13.
		human (5)	bedrest 30 days	Ca supplement, 1.0 gm/day	moderate (Ca balance) very (P balance) moderate (bone density)	same as above tilt tolerance, blood volume, blood serum, plasma ascorbic acid	Control period diet had 1.0 gm/day. Ca:P ratio was kept at 1:1.8. During 1.0 gm/day post bedrest, the Ca balance remained negative; when Ca was raised to 1.5 gm/day in the post-post bedrest all subjects returned to a positive Ca balance. None of the other test data was reported.

MACK, P. B., and K. B. MONTGOMERY. *Study of nitrogen balance and creatine and creatinine excretion during recumbency and ambulation of five young adult human males.* Aerospace Med. 44(7):739-746, 1973.

Five male university students participated in a study conducted at the Texas Woman's University Research Institute. The study was divided into five periods including two bed-rest periods. At the beginning of both bed-rest periods, the subjects were orally given radioactive Ca-47. All urinary excretions were analyzed for various metabolites. One of the purposes of this study has been to obtain some background information on the progress made in the area of analytical procedures for the determination of creatine. While creatine determinations are made on biological fluids other than urine, this survey will concentrate predominantly upon urinary methods. A careful record was kept of the urinary nitrogen, fecal nitrogen, urinary creatine, and urinary creatinine excreted daily by each subject. The average excretion values for all subjects were within normal range.

8

MACK, P.B. and F.B. VOGT. 1971.

176
Roentgenographic bone density changes in astronauts during representative Apollo space flight.

American Journal of Roentgenology, Radium Therapy and Nuclear Medicine
113:621-633.

Consideration of the combination of space flight and bed rest studies would appear to indicate that: (a) calcium is lost from the body in prolonged hypodynamic conditions; (b) bone mineral shifts occur within the skeleton as well as in losses outside the body; (c) dietary intake of calcium very likely influences the amount of calcium mobilization in the skeleton; and (d) exercise may have an effect on bone mineral changes at the selected sites at which roentgenograms are made.

The general steady time-dependent trend for loss of calcium and bone density during hypodynamic conditions may be influenced or modified extensively by the several fac-

tors discussed.

For a meaningful interpretation of assessment of calcium status to be obtained from future studies on astronauts, 3 conditions should be met: (a) carefully planned calcium balance studies must be implemented preflight and carried through the recovery period; (b) more extensive skeletal density measurements in various parts of the skeleton should be performed and recorded in a manner to allow extensive analysis of the bone mineral distribution; and (c) the activity schedule of the astronauts should be documented throughout preflight, flight, and immediate postflight.

88270. MALM, O. J. (Ullevål Sykehus, Oslo, Norway.) Patofysiologiske forandringer ved sengeleie. [Pathophysiological changes during prolonged bed rest.] *TIDSSKR NOR LÆGEFOREN* 89(7): 478-480, 498, 1969. [Engl. sum.] --Prolonged bed rest leads inevitably to a series of debilitating changes: disuse atrophy of muscle and bone, reduction of blood volume, vasomotoric instability, increase of extracellular free fluid, increased risk of thrombo-embolism, reduced ventilatory capacity and increased stagnation of bronchial mucus in declivous parts of the bronchial tree and possibly pressure ulcer (bedsore). Negative Ca balance due to hypercalciuria, concomitantly with stagnation of urine in the renal pelvis, disposes to pelvic stone formation, with or without infection. No patient should be confined to bed longer than absolutely necessary. Active physiotherapy during obligatory bed rest will counteract the detrimental effects of prolonged bed rest. The need for controlled studies of the true effect of bed rest in a variety of common diseases is pointed out. --E. L. D.

178
MARISHCHUK, V.L., et al. 1970.

Stability of psychic functions during prolonged confinement to bed.

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. 175-183. [NASA-TT-F-639].

Undesirable changes in the psychic functions were investigated in relation to vegetative shifts. The subjects generally retained operational efficiency and matched their original scores or improved on them as a result of training in tests of memory, the stability, distribution, and transfer of attention, sensomotor reactions, accuracy of time-interval judgment, and mentation efficiency. Some of the minor changes had an initial tendency toward deterioration, with a subsequent improvement of the indicators on the function-mobilization pattern, resembling the anxiety reaction to a state of stress, especially during periods when psychopharmaceuticals were being given. The detrimental changes were less frequent in the groups who performed physical exercises. The decrease in emotional stability and the increase in the numbers of errors are explained by preferential weakening of the inhibitory process.

Author

A70-24685 # Stability of psychic functions during prolonged bed rest (Ob ustoichivosti psikhicheskikh funktsii pri dlitel'nom sokhranении postel'nogo rezhima). V. L. Marishchuk, T. T. Dzhamgarov, Iu. K. Dem'ianenko, V. P. Stupnitskii, and B. S. Khvoinev. 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. 175-182. 15 refs. In Russian.

Estimation of the stability of psychic functions in subjects experiencing prolonged (70 days) hypodynamia, and investigation of the effectiveness of various methods and means of maintaining this stability. Unfavorable changes in psychic functions were expressed to a lesser degree than vegetative shifts. The subjects generally retained their operator ability, maintaining at the initial level and even exceeding, owing to training, the results of studies characterizing memory, stability, distribution and switching of attention, sensomotor reactions, accuracy of estimating time intervals, ability to do mental work, etc. The small changes noted sometimes tended toward an initial deterioration, with a subsequent increase in the indices, resembling a mobilization of functions similar to an 'alarm reaction' in a state of stress. These changes were found to be especially pronounced during certain periods when psychopharmacological preparations were used. In groups performing physical exercises unfavorable changes occurred more rarely. A reduction of emotional stability and an increase in wrong actions is attributed to a weakening of a predominantly inhibitory process.

A.B.K.

ACCESS. NO. 14,628

FORM: 1 / AUTHOR CARD COMPLETED ✓

179

A69-80168.
MENTAL STATES IN PROTRACTED HYPOKINESIS
[PSIKHICHESKOE SOSTOIANIE PRI DLITEL'NOI
GIPOKINEZII].
I. A. Maslov (USSR. Min. of Health. Inst. of Med.-Biol. Problems.
Moscow).
Zhurnal Nevropatologii i Psikiatrii, vol. 68, no. 7, 1968.
p. 1031-1034. 10 refs. In Russian.

DOCUMENT SERIES & NO.: A69-80168-LAA

DESCRIPTORS: BRAIN R/50, PSYCHOLOGY GY/68, BEDREST GR/39, INACTIVATION GY/23, USSR GR/3, HUMAN BL/72,
EXERCISE GR/61, ACTIVITY GR/58, CONDITIONED REFLEX GY/81, BIOLOGICAL RHYTHM GY/21,
ENVIRONMENT Y/58, ISOLATION GY/90. 1968.

ABSTRACT:

Mental changes were studied in six normal male subjects in the age group from 23 to 36 yr. All six subjects were put on a bed regimen for 62 days. Three of them daily accomplished a special complex of physical exercises in a lying position. In all the subjects the main form of mental changes was expressed in a neurasthenic syndrome. These changes had certain regularities in their development, which were conditioned by the premorbid features of the subjects. The author stressed the significance of such psychological factors as apprehension of the duration of the experiment. The role of physical exercises on the mental states remained unclear because of the insufficient amount of observations. However, the author expressed the belief that the reason for these changes may be explained primarily by such factors as the change of a habitual life pattern, monotony of the environmental situation, and a certain degree of isolation.

180

MCCALLY, M., L.E. KAZARIAN, and H.E. VON GIERKE. 1971.
Cardiovascular and metabolic effects of bed rest and immobilization - Simulated weightlessness.
In: Proceedings of the 21st International Astronautical Congress, Konstanz, West Germany, October 4-10, 1970. Amsterdam, North-Holland Publishing Co. pp. 264-282.

Summary of recent studies of bed rest with human subjects for periods up to 35 days, and of primates immobilized in plaster cases for periods up to 120 days. The studies examined the structural and functional consequences of disuse in the cardiovascular, metabolic, and musculoskeletal physiological systems. Weightlessness, confinement, and inactivity results in orthostatic tachycardia and orthostatic hypotension during post-flight tilt-table testing. A striking metabolic effect produced by inactivity is glucose intolerance. In the skeleton inactivity produces significant osteoporosis, even of the weight-bearing spine.

F.R.L.

ACCESS. NO.

3531

A64-28340

THE PATHOPHYSIOLOGY OF DISUSE AND SOME PROBLEMS OF PROLONGED WEIGHTLESSNESS.

Michael McCally (Yale University, School of Medicine, New Haven, Conn.).

IN: BIOASTRONAUTICS - FUNDAMENTAL AND PRACTICAL PROBLEMS; PROCEEDINGS OF THE AMERICAN ASTRONAUTICAL SOCIETY SYMPOSIUM HELD AS PART OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, ANNUAL MEETING, 130TH, CLEVELAND, OHIO, DECEMBER 30, 1963 (ADVANCES IN THE ASTRONAUTICAL SCIENCES. VOLUME 17).

Edited by William C. Kaufman.

DOCUMENT SERIES & No. North Hollywood, Western Periodicals Co., 1964, p. 21-28. 9 refs.
A64-28340 (IAA)

FORM: 0 AUTHOR CARD COMPLETED ✓

DESCRIPTORS: Bedrest GY/39, Circulatory system R/10, Diuresis R/58, Gravity Y/31, Human BL/72, Immobilization GR/62, Pathology GY/66, Physiology GY/8, Proceedings GR/26, Safety GR/32, Space flight GR/30, Water immersion P/24, Weightlessness Y/35

ABSTRACT:

Discussion of what is known of the physiologic effects of prolonged human exposure to weightlessness. Bed rest, immobilization, and water immersion of human subjects are being reinvestigated as it is felt that these conditions may bear some physiologic analogy to the weightless state. Shifts in body-fluid distribution, diuresis, and loss of normal orthostatic tolerance are among the known consequences of exposure to such deconditioning environments and have been predicted as likely consequences of exposure to weightlessness. Available physiologic data from manned spaceflight suggest that hemoconcentration, diuresis, and orthostatic hypotension may result from relatively brief exposure to weightlessness. The mechanisms that may be responsible for the observed changes are discussed. A program is urgently needed to integrate the laboratory and clinical study of deconditioning environment with the in-spaceflight study of the effects of prolonged weightlessness. Only by extending his knowledge of the basic physiologic mechanisms involved in antigravity compensation will man be able to define these effects and to devise appropriate protective devices or techniques necessary to each new space operation. Spaceflight is considered to offer the first opportunity to explore the gravity dependence of biologic functions, to which man has previously been adapted.

F. R. L.

182

A67-16286 #

TILT TABLE RESPONSES OF HUMAN SUBJECTS FOLLOWING
APPLICATION OF LOWER BODY NEGATIVE PRESSURE.

Michael McCally, Thomas E. Piemme, and Raymond H. Murray
(USAF, Systems Command, Aerospace Medical Div., Aerospace
Medical Research Laboratories, Biomedical Laboratory, Environ-
mental Medicine Div.; Indiana, University, Cardiopulmonary Labo-
ratory, Aerospace Medical Research Laboratories, Wright-Patterson
AFB, Ohio).

Aerospace Medicine, vol. 37, Dec. 1966, p. 1247-1249. 5 refs.

Demonstration that exposure to low magnitudes of easily tolerated
lower body negative pressure (LBNP) for brief periods (90 min) can
improve subsequent orthostatic tolerance in normal subjects and that
intermittent LBNP at moderate levels will prevent the orthostatic
tachycardia produced by as little as 6 hr of bed rest. These data
support the proposal that LBNP exposure may be useful in maintaining
the orthostatic tolerance of inactive, confined, and weightless astro-
nauts.

S.Z.

MCMILLAN, D.E., and C.L. DONALDSON. 1972.

Adjustments of Serum Proteins, Viscosity and Protein-Bound Carbohydrates During Prolonged Bedrest.

~~Present~~, U.S. Public Health Service Hospital, San Francisco, California.

Studies were carried out on eight young males before, during, and after 24 or more weeks of bedrest. Measurements of serum viscosity, total protein, electrophoretic components, serum total solids, protein-bound carbohydrate, and plasma volume were carried out.

With bedrest a loss of plasma volume occurs which causes an increase in total serum protein. The elevated serum protein is rapidly corrected by a reduction in the level of all electrophoretic components to values very near baseline. Serum viscosity changes paralleled total serum protein changes. Increase in total serum solids was greater than the rise in total serum protein. The excess solid was non-dialyzable and had little effect on viscosity. A rise in protein-bound hexose and fucose was observed during bedrest which persisted during early reambulation. Fucose rise was greater than hexose despite stability of gamma globulin level.

184

N68-25095*# University of Southern Calif., Los Angeles. Dept. of Physiology.

INVESTIGATION TO DETERMINE THE EFFECTS OF LONG TERM BED REST ON G-TOLERANCE AND ON PSYCHOMOTOR PERFORMANCE Final Report

John P. Meehan, James P. Henry, Shannon Brunjes, and Herbert de Vries 19 Sep. 1966 54 p refs
(Contract NAS9-3500)

(NASA-CR-62073) CFSTI: HCS3.00/MFS0.65 CSCL 06S

Fourteen young men were confined to bed for 28 days. They were randomly divided into three subject groups of 5, 5 and 4 individuals. One group exercised, another did pressure breathing and the third did both. Each subject was exposed to a re-entry acceleration profile in the -Gx position while performing a three dimensional tracking task prior to the bed rest and at the conclusion of the bed rest. Tilt table tolerance and blood volumes were determined in a similar sequence. Cardiovascular deconditioning manifested by plasma volume decrements of 20% and decreased tolerance to passive tilting resulted in all subjects and was not differentially affected by the exercise, pressure breathing or the combination maneuvers. Performance on the tracking task during acceleration was not affected by the cardiovascular deconditioning.

Author

185
A70-17288

EFFECT OF TWO WEEKS BED REST ON VENOUS POOLING IN THE LOWER LIMBS.

Richard P. Menninger, Richard C. Mains, Fred W. Zechman, and Thomas A. Piemme (Kentucky, University, Lexington, Ky.; Pittsburgh, University, Pittsburgh, Pa.).

Aerospace Medicine, vol. 40, Dec. (Section 1) 1969, p. 1323-1326. 5 refs.

Contracts No. AF 33(615)-67-C-1370; No. AF 33(615)-67-C-1323.

Greater leg circumference increase with tilt following weightlessness (NASA Gemini V Interim Report, 1966) suggests that increased venous distensibility may contribute to postflight orthostatic intolerance. The present study was conducted to determine by more direct measurements, the effect of inactivity (two weeks bed rest) on the pressure-volume characteristics of the legs. Lower body negative pressure (LBNP) of a magnitude (minus 40 mm. Hg) known to produce blood volume shifts similar to those occurring with tilt was applied to two subjects before and at the end of the bed rest period. Leg volume changes were measured directly at one, three, and five minutes using whole leg water plethysmographs located in the LBNP chamber. The measured volume changes suggest that venous distensibility was not increased by two weeks bed rest. The characteristic increase in heart rate elicited by LBNP was greater following bed rest as anticipated. In view of the apparent inconsistency between previous circumference measurements and the present plethysmographic observations, additional studies are needed to delineate the importance of changes in venous distensibility in 'cardiovascular deconditioning.'

(Author)

VA70-45077 # Determination of optimum bed rest time schedules from some physiological data (Opredelenie optimal'nykh srokov postel'nogo rezhima po nekotorym fiziologicheskim pokazateliam). A. A. Mikhailenko. *Voenno-Meditsinskii Zhurnal*, July 1970, p. 34-37. In Russian.

Study of changes in the motor function of a group of 6 subjects confined to bed for extended periods of time in an attempt to determine optimum bed rest periods for cardiovascular patients. The reaction of the subjects to hypokinesia was determined by neurological observations and dynamometric, electromyographic and myogenic-tonus tests. Certain changes in the motor physiology of the subjects were observed already during the first days of bed rest, reaching their highest intensity at the end of a two-week period. Individual approach is recommended in prescribing bed rest periods for patients.

V.Z.

MIKHASEV, M.I., et al. 1970.

Certain peculiarities of external respiration and gas exchange 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. 66-72. [NASA-TT-F-639].

The effects were studied of 70-day hypodynamia on the basal metabolic level, the spiographic and pneumotachymetric indicators of external respiration, oxygenation of arterial blood, bloodstream velocity, and gas exchange under standard physical load and in orthostatic tests. Basal metabolism was lowered by 5 to 21%, pulmonary ventilation volume was reduced, oxygen demand in the orthostatic tests was increased, and there was a substantial decrease in the tolerance of physical load. The disturbances noted were mitigated by the use of preventive measures, medication and physical exercise.

Author

188
N73-32004*# Techtran Corp., Glen Burnie, Md.
DETERMINING OPTIMAL PERIODS OF BED REST BY
CERTAIN PHYSIOLOGICAL INDICES

A. A. Mikhaylenko Washington NASA Oct. 1973 8 p. Transl.
into ENGLISH from Voenno-Med. Zh. (Moscow), v. 7, 1970
p. 34-37

(Contract NASw-2485)

(NASA-TT-F-15144) Avail: NTIS HC \$3.00 CSCL 06P

A study of two groups of patients placed in a bed rest regime is reported, the first group being the control, the second group being the experiment. The control group, which was not permitted exercise, developed certain motor disorders and symptoms of vascular and emotional instability. The second group developed the same symptoms in spite of the exercise but at a later period. The development of symptoms in the experimental group is attributed to inadequately thorough regimes of exercise.

Author

189

N68-17752# Joint Publications Research Service, Washington

MIKHAYLOVSKIY, G.P. (Mikhailovskii, G.P.), T.V. BENEVOLENSKAYA, T.A. PETROVA, IYa. YAKOVLEVA, O.I. BOYKOVA, et al. 1967.

The combined effect of two-month hypokinesia and radial accelerations on the cardiovascular system.

Space Biology and Medicine 1(5):86-90.

Six healthy male test subjects were exposed to a 62 day bedrest and radial accelerations of the maximum tolerable magnitude. Bedrest reduced the strength of muscular vessels, disturbed ophthalmic and nasal regional circulation, and decreased orthostatic tolerance of all subjects. The latter was associated with some cardiovascular disorders and deterioration of circulatory adaptation mechanisms to a physical load. The combined effect of bedrest and radial accelerations on the cardiovascular system was more distinct than the single effects of acceleration. Physical exercises performed during bedrest yielded positive results.

Author

ACCESS. NO. 11,763

FORM: 712 AUTHOR CARD COMPLETED ☒

EFFECT OF THE COMBINED ACTION OF TWO MONTHS OF
HYPOKINESIA AND ACCELERATIONS ON THE CARDIOVASCULAR
SYSTEM [VLIYANIE KOMPLEKSNOGO VOZDEISTVIA DVOUKHME-
SIACHNOI GIPOKINEZII I USKORENII NA SERDECHNO-SOSUDISTUIU
SISTEMU].

G. P. Mikhailovskii, T. V. Benevolenskaia, T. A. Petrova, I. Ia.
Iakovleva, O. I. Boikova, M. P. Kuz'min, A. A. Savilov, and
S. N. Solov'eva.

Kosmicheskaya Biologiya i Meditsina, vol. 1, Sept.-Oct. 1967,
p. 57-61. 14 refs. In Russian.

(Also in
Environmental
Space Science

1:361-363

Sept-Oct 1967
Kans

DOCUMENT SERIES & NO.: A68-14844 (IAA)

DESCRIPTORS: Transl. JPRS: 44, 299 A69-11495
Acceleration Y/1, Bedrest GY/39, Circulatory system R/10, Eye R/40,
Human BL/72, Immobilization GR/62, Muscular system R/53, Physiology GY/8,
Sensory system R/32, Stress GY/76, USSR GR/3

ABSTRACT:

Investigation of the effect of transverse accelerations of 12 to 14 g on the cardiovascular system and the regional blood circulation of a group of six male subjects confined to bed rest for 62 days. Muscular-vessel tonus reduction, ophthalmic-function and nasal blood-circulation disorders, and orthostatic-tolerance suppression are established in all these individuals. Also indicated are certain cardiac irregularities and changes in the circulatory adaptation function under physical stress.

V. Z.

MIKHAYLOVSKIY, G.P. (MIKHAILOVSKII, G.P.), N.N. DOBRONRAVOVA, M.I. KOZAR',
M.M. KOROTAYEV, N.I. TSIGANOVA, V.M. SHILOV and I.Y. YAKOVLEVA. 1967.
Variation in overall body tolerance during a 62-day exposure to hypokinesia
and acceleration.
Space biology and Medicine 1(6):101-108.

pp. 65-70

Kosnicherstava Biologiya i
Meditsina. Vol. 1, No. 6,
Moscow, 1967

Abstract: The overall tolerance of the human body was studied on six healthy male subjects during a 62-day period of hypokinesia. Beginning with the third week of the experiment the protective properties of the body deteriorated considerably (quantity of blood proparidin, phagocytic activity of neutrophils, lysozyme activity of the saliva and bactericidal function of the skin). In addition to inhibition of natural immunity there was development of inflammatory diseases, mostly affecting the mucous membranes and the vascular system. The results obtained should be taken into account in developing preventive measures for use during prolonged space missions.

191
N71-29216*# Technology, Inc., San Antonio, Tex. Life Sciences
Div.

STUDY OF PHYSIOLOGICAL TOLERANCE TO
CENTRIFUGATION Final Report

D. M. Miller, B. Ward, J. V. Benedict, and J. A. Nickel 15 Jun.
1971 20 p refs

(Contract NAS9-11314)

(NASA-CR-115068) Avail: NTIS CSCL 06S

A centrifuge bed rest study designed to determine the physiological effects of acceleration, following simulated weightlessness, was performed. Procedures involved in the experimental design, maintenance of the subjects, instrumentation scheduling, and data coordination and reduction are outlined. Preliminary results show a general decrease in tolerance to +G sub z acceleration loads following seven days of bed rest. Author

MILLER, P.B., R.L. JOHNSON, and L.E. LAMB. 1964.
Cardiovascular responses to gravitational changes after prolonged bed rest.
Presented at the 11th Annual Air Force Science and Engineering Symposium,
Brooks AFB, Texas, October 20-22, 1964. 22 pages.

Various effects of 4 weeks of absolute bed rest on the circulatory system were studied in 12 healthy male volunteers. The experimental conditions were considered analogous to extended space flight. Tilt-table tests were performed, with and without antigravity garments. Substantial loss in blood and plasma volume, and in red cell mass, was noted by the end of the study. Postural syncope was frequent on the tilt table, except when the subject wore an antigravity suit. The antigravity suit also promoted stability in orthostatic heart rates. Transverse acceleration on the tilt table appeared to cause no cardiac or vision irregularities.

J.M.D.

193
MILLER, P.B., R.L. JOHNSON, and L.E. LAMB. Effects of four weeks of absolute bed rest on circulatory functions in man. Aerospace Medicine 35:1194. December 1964.

Various effects of 4 weeks of absolute bed rest on the circulatory system were studied in 12 healthy male volunteers. Postural tolerance varied from day to day before and after bed rest. Repeated tilt table testing allowed a more accurate appraisal of changes in postural tolerance caused by bed rest. Postural syncope on the tilt table was more frequent after bed rest. Forty-two percent of the subjects, however, did not faint during repeated testing after bed rest. A comparison of the highest orthostatic heart rates recorded during each tilt table test without an antigravity suit before and after bed rest showed a distinctly higher range of orthostatic heart rates after bed rest in each subject studied. When an antigravity suit was worn during tilt table testing after bed rest, postural syncope occurred on one occasion only. The relation of these studies to proposed flights in the Manned Orbiting Laboratory is discussed.

194
A66-13354

EFFECTS OF MODERATE PHYSICAL EXERCISE DURING FOUR WEEKS OF BED REST ON CIRCULATORY FUNCTIONS IN MAN.

Perry B. Miller, Robert L. Johnson, and Lawrence E. Lamb
(USAF, Systems Command, Aerospace Medical Div., School of
Aerospace Medicine, Internal Medicine Branch, Brooks AFB,
Tex.).

Aerospace Medicine, vol. 36, Nov. 1965, p. 1077-1082. 13 refs.

Various effects on circulatory functions of light to moderate physical exercise during 4 weeks of bed rest were studied in 6 subjects. During exercise narrow cuffs, inflated to 60 mm Hg were worn on the upper thighs. Changes in plasma volume during and after bed rest paralleled those characteristic of simple bed rest. In contrast to simple bed rest, the major loss of red cell mass was noted at the end of bed rest and not during ambulation following bed rest. The mean resting heart rate for all subjects increased 15 beats per minute during bed rest. The degree of postural intolerance after bed rest appeared as marked as that observed after absolute bed rest. Physical endurance on the treadmill was decreased after bed rest.

(Author)

195
A66-34365

MEDICAL PROBLEMS OF WEIGHTLESSNESS.

Perry B. Miller (USAF, Systems Command, Aerospace Medical Div., School of Aerospace Medicine, Internal Medicine Branch, Brooks AFB, Tex.).

(Texas Medical Association, Annual Session, 98th, Austin, Tex., May 1, 1965, Paper.)

Texas State Journal of Medicine, vol. 61, Oct. 1965, p. 720-724. 25 refs.

Comparison between prolonged spaceflight and prolonged bed rest, which suggests that the adverse physiologic effects of bed rest may also develop during spaceflight. The effects are a decrease in exercise tolerance, orthostatic tolerance, muscle strength, and blood volume, and an increase in urinary calcium excretion. Orthostatic intolerance has been reported after spaceflights. It is considered that until in-flight methods to protect orthostatic tolerance are perfected, use of antigravity suits may be necessary. Bicycle-type exercise and isometric exercise appear to be necessary. No method of preventing osteoporosis and its attendant hypercalciuria has been discovered.

F.R.L.

196

1393. MILLER, PERRY B., BRYCE O. HARTMAN, ROBERT L. JOHNSON, and LAWRENCE E. LAMB. Modification of the effects of two weeks of bed rest upon circulatory functions in man. AERO-SPACE MED 35(10): 931-939. illus. 1964.--The effects of 2 weeks of bed rest on circulatory functions were studied in 72 healthy subjects, utilizing 2 different intervals of 2 weeks' bed rest. The value of various procedures in maintaining normal cardiovascular reflex regulatory mechanisms during bed rest was evaluated. A 15-fold increase in syncope reactions and a significant increase in orthostatic heart rate occurred after 2 weeks of bed rest. Physical activity and tilt table training for 4 weeks between the 2 bed rest periods resulted in a decrease of the resting heart rate and an improvement in orthostatic tolerance. An improvement in orthostatic tolerance after bed rest was noted with the various prophylactic procedures utilized in this study. A program consisting of exercise and tilt table training before bed rest and intermittent venous occlusion in the extremities during bed rest in a 10-degree head-up bed resulted in almost complete preservation of normal orthostatic tolerance. Various in-bed procedures tended to prevent hematological changes previously noted with simple bed rest. An antigravity suit proved very effective in preventing postural syncope after bed rest.--Authors.

A65-22169 #

PHYSICAL DECONDITIONING DURING PROLONGED SPACE FLIGHT.

Perry B. Miller (USAF, Systems Command, Aerospace Medical Div., School of Aerospace Medicine, Brooks AFB, Tex.). American Institute of Aeronautics and Astronautics, Air Force Logistics Command, and Aeronautical Systems Division, Support for Manned Flight Conference, Dayton, Ohio, Apr. 21-23, 1965, Paper 65-281. 7 p. 20 refs. Members, \$0.50; nonmembers, \$1.00.

Discussion of anticipated medical problems of prolonged space flight, including postural intolerance to gravity after landing, diminished physical work capacity, decreased blood volume, excessive excretion of calcium in the urine, and muscular weakness. An excessive urinary loss of calcium may predispose the astronaut to kidney stones and, eventually, to weakened bones. No significant change is expected in tolerance to the transverse acceleration of re-entry. Prolonged bed rest, analogous in several respects to prolonged space flight, has been used to evaluate the efficacy of various countermeasures adaptable to space flight. No procedure to date (including intermittent inflation of blood pressure cuffs on the extremities, positive pressure breathing, various types of in-bed exercise programs, and lower body negative pressure) has been completely effective in preventing the loss of postural tolerance during bed rest. Preliminary studies suggest that lower body negative pressure may become an effective procedure. In subjects with postural intolerance after bed rest, the wearing of an anti-G suit prevents postural fainting. Physical work capacity can be maintained by vigorous exercise on a bicycle ergometer. No measure to prevent excessive urinary calcium excretion has been found. Muscular strength can be preserved by isometric exercise. It is noted that the observation of postural intolerance after space flights has in-

tensified interest in possible medical problems of prolonged space flight. Postural intolerance had been predicted earlier on the basis of a presumed similarity in several respects of prolonged space flight to prolonged bed rest. In both environments, the need for physical activity is greatly diminished, significant positional changes in hydrostatic pressure in the body fluids are absent, and weight bearing in the erect position is not present. As the body adjusts to the diminished stresses of bed rest, a number of physiological events occur, including changes in the heart and blood vessels, changes in the volume of the blood, changes in muscular strength, and changes in the calcium content of the bones and urine. (Author) M. M.

198

A65-16555

TOLERANCE TO TRANSVERSE (+Gx) AND HEADWARD (+Gz) ACCELERATION AFTER PROLONGED BED REST.

Perry B. Miller and Sidney D. Leverett, Jr. (USAF, Systems Command, Aerospace Medical Div., School of Aerospace Medicine, Internal Medicine Dept. and Biodynamics Branch, Brooks AFB, Tex.).

Aerospace Medicine, vol. 36, Jan. 1965, p. 13-15. 9 refs.

Investigation of the effects of prolonged bed rest on the tolerance to the transverse (+Gx) acceleration of a simulated Gemini re-entry profile, and to a headward (+Gz) acceleration. As judged by the degree of physical discomfort, the ability to respond to a central light, or the presence of electrocardiographic abnormalities, tolerance to +Gx was unaffected by four weeks of absolute bed rest. In each of 11 subjects studied, heart rates during peak acceleration were higher after bed rest than before. As judged by the level of acceleration at which central vision was lost, no significant change in tolerance to headward (+Gz) acceleration of rapid onset was observed after two weeks of modified bed rest or after four weeks of absolute bed rest. After each type of bed rest, the majority of the subjects had decreased tolerance to headward acceleration of gradual onset, but the mean decrease was not statistically significant. Mean heart rate at equivalent levels of +Gz were significantly higher after both periods of bed rests.

(Author) P. K.

A73-30512 Circadian rhythm of urinary calcium excretion during immobilization. M. C. Moore (Guy's Hospital Medical School, London, England) and R. G. Burr (Stoke Mandeville Hospital, Aylesbury, Bucks., England). *Aerospace Medicine*, vol. 44, May 1973, p. 495-498. 15 refs. Research supported by Syntex Pharmaceuticals, Ltd.

Ten healthy subjects were studied during 2 days of normal activity and 2-4 days of strict bedrest. Urinary calcium excretion was raised during bedrest, but the increase was not uniformly distributed over each 24 hr. Instead the incremental calcium excretion showed a marked circadian rhythm with 61% excreted between 09.00 and 15.00 hr. A similar pattern of calcium excretion was seen in four immobilized patients with recent-onset traumatic paraplegia. However two chronic paraplegics without hypercalciuria did not have such an excretory rhythm. Circadian rhythms of bone resorption appear to account for the observed rhythm of urinary calcium excretion.

(Author)

200

/ N68-20558# School of Aerospace Medicine, Brooks AFB, Tex.
ERYTHROKINETIC CHANGES IN MAN ASSOCIATED WITH
BED REST

Bernard S. Morse *In its Lectures in Aerospace Med.* 6th Ser.,
1967 p 240-254 refs (See N68-20545 10-04)

A significant reduction in red cell mass was observed at the completion of 35 days of bed rest. A decreased rate of erythropoiesis was documented by serial reticulocyte counts. Upon resuming ambulation at the completion of bed rest, there was an accelerated rate of erythropoiesis and evidence suggestive of a mild hemolytic process.

Author

201

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. 1973.
NASA/HQ In-House Communication.
re: Ames 1971 Summer Bed Rest Study.

202

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. 1973.
NASA/HQ In-House Communication:
re: Ames 1972 Summer Bed Rest Study.

ACCESS. NO. 0981

FORM: _____ AUTHOR CARD COMPLETED ☒

NATL. AERON. and SPACE ADMIN., MANNED SPACECRAFT CENTER, HOUSTON, TEX. Proceedings
of a research contractors conference. 1964, 156 p. (Conference held at Manned
Spacecraft Center, Dec. 3-4, 1964).
DOCUMENT SERIES & NO.: 11753 (NASA)

203

DESCRIPTORS: Bed rest GY/39, Circulatory system R/10, Excretory system R/56, Exercise GR/61,
Medicine GY/36, Pharmacology GY/25, Physiology GY/8, Proceedings GR/26, Radiation Y/39,
Stress GY/76

1964

ABSTRACT:

A group of articles is presented which deal with biomedical problems of interest to space activities. Among the subjects covered are bedrest, cardiovascular-renal studies, exercise, hemodynamic response to acute heat stress, and effects of proton irradiation on metabolism. Plasma volume and fluid-electrolyte changes following water immersion is considered as is the effect of cuff-tourniquets on tilt table intolerance after immersion. The effects of drugs on post-recumbency orthostatic intolerance is reported and a mathematical expression is given for the arterial pressure pulse contour in man.
M.W.R.

204

10279. NOELLE, H. (Med. Klin., Justus-Liebig-Univ., Giessen, W. Germany.) Bettruhe und Stickstoffbilanz. [Bed rest and nitrogen balance.] *THIER GEGENWART* 103(4): 509-526. illus. 1964.--Accurate measurements of N balance showed that bed rest had no effect on the N excretion of healthy people when the diet supplied 30 cal/Kg and 1.13 g of protein /kg of body weight. Daily records are given for 50 days of diet, body weight, urea N, creative index, stools and N balance for a normal subject and a patient with liver parenchymal damage.
--Richard Adler.

205

N73-32003*# Harding Coll., Searcy, Ark.
AN EVALUATION OF THE EFFECTS OF BED REST, SLEEP
DEPRIVATION AND DISCONTINUANCE OF TRAINING ON
THE PHYSICAL FITNESS OF HIGHLY TRAINED YOUNG
MEN Progress Report, 1 Sep. 1972 - 31 Aug. 1973
Harry D. Olree, Bob Corbin, Gene Dugger, and Carroll Smith
31 Aug. 1973 46 p refs
(Contract NAS9-9433)

(NASA-CR-134044) Avail: NTIS HC \$4.50 CSCL 065

This experiment was conducted to determine what physiological effects result when highly trained subjects are confined to bed, deprived of sleep, or allowed to discontinue training. Results indicated: (1) There was a moderate increase in strength variables due to the training in this experiment but the stress which the subjects received caused a negligible change in strength variables. (2) The training program resulted in highly significant changes in specific bicycle ergometer variables indicating good increases in cardiopulmonary fitness. Five days of bed rest or fifty hours of sleep deprivation caused comparable drastic decreases in cardiopulmonary fitness. Post stress the subjects reverted to a normal daily schedule and after two weeks they had recovered about half of what they lost. (3) Cardiac output remains relatively constant at a constant work load, but stroke volume increases with conditioning and decreases with deconditioning due to stress.

Author

ORLOVA, T.A. 1970.

206

Urea content in the blood during prolonged limitation of mobility.

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. 106-107. [NASA-TT-F-639]

Blood urea content was studied in 19 subjects of a 70-day hypodynamia experiment to determine whether increases previously observed in 15- and 30-day experiments normalize over longer periods of restricted mobility. The results indicate that the effect is nonpathological, that normalization does occur, and that the most probable cause of high blood urea is renal insufficiency rather than increased nitrogen intake or tissue protein breakdown. Author

PAK, Z.P., KOZYREVSKAYA, Yu.S. KOLOSKAYA, A.I. GRIGOR'YEV, Yu.Ye. BEZUMOVA,
and Ye.N. BIRYUKOV. 1973.

Peculiarities of water-mineral metabolism during 120-day hypokinesia.
Space Biology and Medicine 7(4):86-91.

[Abstract: The results of a study of the fluid-electrolyte balance in four test subjects during a 120-day bedrest experiment are presented. The investigations included measurements of the water consumed and the urine eliminated in 24 hours, changes in body weight, water content in the blood, plasma volume, electrolyte composition of the blood and urine, the rate of glomerular filtration and renal blood flow, osmotic concentration of the plasma and urine. The mentioned parameters changed in a wavelike pattern.]

N73-33028 Joint Publications Research Service, Arlington, Va.
PECULIARITIES OF WATER-MINERAL METABOLISM
DURING 120-DAY HYPOKINESIA
Z. P. Pak, G. I. Kozyrevskaya, Yu. S. Koloskova, A. I. Grigoriyev,
Yu. Ye. Bezumova, and Ye. N. Biryukov. *In its Space Biol. and
Med.* Vol. 7, No. 4 (JPRS-60248) 10 Oct. 1973 p 86-91
refs. Transl. into ENGLISH from *Kosm. Biol. Med. (Moscow)*,
v. 7, no. 4, Jul. - Aug. 1973 p 56-59 (For availability see
N73-33014 24-04)

The results of a study of the fluid-electrolyte balance in four test subjects during a 120-day bedrest experiment are presented. The investigations included measurements of the water consumed and the urine eliminated in 24 hours, changes in body weight, water content in the blood, plasma volume, electrolyte composition of the blood and urine, the rate of glomerular filtration and renal blood flow, osmotic concentration of the plasma and urine. The mentioned parameters changed in a wavelike pattern.

Author

208

PANFEROVA, N.Ye., and V.A. TISHLER. 1968.
Arterial tone in relation to restricted muscular activity.
Space Biology and Medicine 2(3):86-95.

Experimental data are presented concerning the dynamics of some indices characterizing arterial tone prior to, during and following 5- to 20-day exposure of sixteen test subjects to hypodynamia or relative physiological rest (in a chair or bed). Recordings were made of the velocity of the pulse wave distribution in the aorta and vessels of the arm and leg; calibrated pulse amplitude of the vessels of the second and fourth fingers and toes (mm³); skin temperature of the chest, forehead, back of the hand and foot and front part of the shin. Before and after the experiment the test subjects underwent 15- to 2-minute tilt table tests during which time the above indices were recorded. It was found that hypodynamia resulted in an increased constriction of vessels in the lower extremities, including skin arterioles, whereas the tone of the aorta and arm vessels remained virtually unchanged. The constriction of the leg vessels was more pronounced during the post-experiment orthostatic tests in comparison with that observed prior to the experiment.

Author

A68-40139 #

ARTERIAL TONE IN RELATION TO A LIMITATION OF HUMAN MUSCULAR ACTIVITY [ARTERIAL'NYI TONUS V SVIAZI S OGRANICHENIEM MYSHECHNOI DEIATEL'NOSTI CHELOVEKA].
N. E. Panferova and V. A. Tishler.

Kosmicheskaya Biologiya i Meditsina, vol. 2, May-June 1968, p. 56-62. 19 refs. In Russian.

Study of the arterial tone of sixteen test subjects prior to, during, and following a 5- to 20-day exposure to hypodynamics or relative physiological rest (on a chair or bed). Recordings were made of the velocity of the pulse-wave distribution in the aorta and in the arm and leg vessels, the calibrated pulse amplitude of vessels of the second and fourth fingers and of the toes (mm³), the skin temperature of the chest, the forehead, the back of the hand, a foot and the front part of the skin was measured. Before and after the experiment, the test subjects underwent orthostatic tilt-table tests for a period of 15 to 20 min, during which time the above-mentioned indices were recorded. It was shown that the hypodynamics resulted in an increased constriction of the vessels of the lower extremities, including the skin arterioles, while the tone of the aorta and of the arm vessels remained practically unchanged. The constriction of the leg vessels was more pronounced during the postexperimental orthostatic tests as compared with the constriction observed during the preexperimental tests.

P.v.T.

PANFEROVA, N.Ye., V.A. TISHLER, and T.G. POPOVA. 1967.
Effect of prolonged bedrest on the dynamics of cardiac contractions in man.
Space Biology and Medicine 1(6):101-108.

pp. 75-78

Kosnischekaya Biologiya i
Meditsina, Vol. 1, No. 6,
Moscow, 1967

Abstract: Experiments with 5- to 20-day hypodynamia were conducted on 15 test subjects for studying their chronocardiometric dynamics with aid of polycardiographic techniques. The results obtained before and after the experiments were analyzed by variational statistics methods and compared. The hypodynamic effect was manifested in the myocardial hypodynamia syndrome, which included an increased tension period (at the expense of the asynchronous and isometric contractions phases), a decreased expulsion period, a reduced intrasystolic index, a decreased rate at which the intraventricular pressure increased and an increased index of myocardial tension. These changes were accompanied by increased pulse rate, a decrease of systolic pressure, minute and stroke blood volumes, and increased diastolic pressure. Duration of general and mechanical systoles remained within normal limits. Possible mechanisms of the described processes are discussed.

PANFEROVA, N.Ye. 1972.

Vascular tone in different parts of the body during prolonged restriction of muscular activity.

Space Biology and Medicine 6(2):74-79.

Abstract: During a 120-day bedrest experiment four test subjects were examined for arterial tone by determining pulse wave propagation and venous tone by the use of occlusion plethysmography and skin temperature measurements. The above indices recorded for different body areas varied differently. The tone of veins and arteries in the legs, including skin arterioles, increased. The tone of head and hand veins remained unchanged. The tone of head and foot arteries decreased. The tone of large vessels of the elastic type, aorta, carotid artery, and arm artery, did not change. It is probably that variation in vascular tone is one of the mechanisms (supplementing endocrine regulation) which is responsible for regulating circulating blood volume during hypodynamia.

29973. PANFEROVA, N. E. Sosudisty tonus v razlichnykh uchastkakh tela pri dlitel'nom ogranichenii myshechnoi deyatel'nosti. [Vascular tone in different body compartments during long-term hypodynamics.] KOSM BIOL MED 6(2): 47-50. illus. 1972. [Engl. summ.]-- During a 120-day bed rest experiment 4 test subjects were examined for arterial tone by the method of the pulse wave propagation, the venous tone by the method of occlusion plethysmography and skin temperature. The above indices recorded in different body areas varied in a dissimilar manner. The tone of veins and arteries of legs, including skin arterioles, increased. The tone of head and hand veins remained unchanged. The tone of head and foot arteries decreased. The tone of large vessels of the elastic type [aorta, carotid artery, arm artery] did not change. Variations of the vascular tone is one of the mechanisms (supplementing endocrine regulation) which is responsible for the regulation of the circulating blood volume during hypodynamics.--A. F. K.

PANOV, A.G., et al. 1970.

Changes in the functions of the nervous and muscular systems under the influence 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. 133-145. [NASA-TT-F-639]

Definite staging of the changes was discerned. The initial stage was characterized by early adaptive reactions, and the intermediate stage by atrophy of muscles, especially those of the lower legs. The advent of the third stage (after 20 days of hypodynamia) was marked by disturbances to higher nervous activity: disturbed sleep, emotional disturbances, and other asthenic symptoms. With the asthenic state as a background, oral-automatism phenomena and signs of pyramidal insufficiency appeared among the subjects. The latter were manifested in increased tendon and periosteal reflexes in the right extremities, loss of strength in these extremities, decrease or loss of the abdominal and plantar reflexes on the right side, smoothing of the right nasolabial fold, and deviation of the tongue to the right. The development of interhemispheric asymmetry with hypodynamia and functional insufficiency of the dominant hemisphere was noted in 14 out of 16 subjects. A gradual recovery of nervous system functions was observed after reactivation.

Author

212
N69-12042# Joint Publications Research Service, Washington, D. C.

SOME NEUROLOGICAL PROBLEMS IN SPACE MEDICINE

A. G. Panov *In its Space Biol. and Med.*, vol. 2, no. 4, 1968

22 Nov. 1968 p 103-116 refs (See N69-12028 02-04)

Avail: CFSTI

A simulation experiment was carried out to evaluate disturbances in functioning of the nervous system which may occur during different stages in manned spaceflight. Four healthy male volunteers age 22 were restricted to a recumbent position for 72 days. An analysis of clinical observations, neurological surveys and other tests revealed three stages in the development of shifts caused by prolonged bedrest. The last stage, developing after 20 days of bedrest, was characterized by the development of disturbances in the higher nervous system. All the test subjects also exhibited muscular atrophy, reduced muscular strength, development of manifestations of oral automatism and other disorders of the nervous function. Some disturbances were also observed during a tilt-table test and exposure to accelerations. The authors believe that the concept of the phasic development of nervous disorders will allow prophylactic and therapeutic measures to be predetermined. They give recommendations on how to choose sleep inducing, sedative, anaphylactic and other drugs and also discuss their peculiar effects during spaceflight.

Author

ACCESS. NO. 5620

FORM: AUTHOR: 11 DRILL: 11

22892. PANOV, A. G., and V. S. LOBZIN. Nekotorye nevrologicheskie problemy kosmicheskoi meditsiny. [Some neurological problems of space medicine.] KOSM BIOL MED 2(4): 59-67. illus. 1968. [Engl. sum.]-

DOCUMENT NO.: BA (50) 22892

DESCRIPTORS: Acceleration Y/1, Analysis P/2, Bedrest GY/39, Human BL/72, Medicine GY/36, Muscular system R/53, Nervous system R/48, Pathology GY/66, Personality GY/96, Psychiatry GY/98, Psychology GY/68, Simulation BK/36, Space Flight GR/30, Therapy GY/38, Tilting GR/37, USSR GR/3.

ABSTRACT:

1968.

-To assay disturbances of the nervous system function that may occur at different stages of manned space flight a simulation experiment was carried out. Four healthy male volunteers at the age of 22 remained in the recumbent position for 72 days. An analysis of clinical observations, neurological surveys and other tests revealed 3 stages in the development of shifts caused by prolonged bed rest. Of the greatest significance is the last stage developing after 20 days of bed rest. The stage is characterized by the development of disturbances in the higher nervous system. At this stage one of the test subjects exhibited acute neurotic reactions which made it necessary to stop the experiment; other test subjects showed sleep and emotional

disorders. All the test subjects also indicated muscle atrophy, reduced muscle strength, development of the phenomena of oral automatism and other disorders of the nervous function. Some disturbances were also noted during the tilt-table test and exposure to accelerations. The concept of the phasic development of nervous disorders will allow prophylactic and therapeutic measures to be predetermined. Recommendations on choosing somniferous, sedative, anaphylactic and other drugs and their peculiar effects during space flight are discussed.

--Authors.

/N71-19067# Joint Publications Research Service, Washington, D.C.

PRINCIPAL CHANGES IN THE HEALTHY HUMAN BODY AFTER A 120 DAY BED CONFINEMENT

V. V. Parin et al. *In its Space Biol. and Med.*, Vol. 4, No. 5, 1970 7 Jan. 1971 p 91-98 refs (See N71-19051 08-04)

Avail: NTIS

Subjects were given pituitrin, deoxycorticosterone acetate, and nerobol to prevent possible disturbances in mineral and protein metabolism. Examinations made once every 10 to 15 days revealed polymorphic changes in almost all systems in the human body. Clinical, physiological and metabolic changes increased with the experimental time, forming distinct clinical symptoms and syndromes by the end of the second month. The following syndromes were most clearly expressed: autonomic-vascular dysfunction, asthenization, allergy, hemocoagulation disturbance, occasionally accompanied by prethrombotic abnormalities, muscular atrophy, aggravated by muscular atony and disordered bioelectric activity. Mineral metabolism was disturbed, diuresis was negative, and weight losses progressively increased until the third month of the hypokinetic condition, after which a tendency to return to the baseline values was noted. The most distinct changes were observed in Ca metabolism. Nerobol gave a good therapeutic effect, but pituitrin and DOCA were ineffective. Author

A71-18371 # Main changes in the human body during a 120-day bed rest experiment (Osnovnye izmeneniia v organizme zdorovogo cheloveka pri 120-sutochnom postel'nom soderzhanii). V. V. Parin, T. N. Krupina, G. P. Mikhailovskii, and A. Ia. Tizul. *Kosmicheskaiia Biologiia i Meditsina*, vol. 4, Sept.-Oct. 1970, p. 59-64, 21 refs. In Russian.

The main results of studying changes developed by 10 test subjects during a 120-day bed rest experiment are presented. The test subjects were divided into three groups: the first group included four people who served as controls, the second and third groups were experimental and consisted of three test subjects each. The second and third group subjects were given pituitrin, deoxycorticosterone acetate and nerobol to prevent possible disturbances of mineral and protein metabolism. Comprehensive examinations conducted once in every 10 to 15 days revealed polymorphic changes in almost all systems of the human body. Clinical, physiological and metabolic changes increased with the experimental time, forming distinct clinical symptoms and syndromes by the end of the 2nd month. The following syndromes were most pronounced: autonomic-vascular dysfunction, asthenization, allergy, hemocoagulation disturbance accompanied occasionally by prethrombotic abnormalities, muscular atrophy aggravated by muscular atony and disordered bioelectric activity, etc. Mineral metabolism was disturbed, diuresis was negative, and weight losses progressively increased till the 3rd month of the hypokinetic condition after which a tendency to return to the baseline values was noted. The most distinct changes were found in Ca metabolism the excretion of which was 2.5 times higher than the pretest value. The use of nerobol gave good therapeutic effect whereas pituitrin and DOCSA were found ineffective. (Author)

214

PAWLSON, L.G., J.B. FIELD, M. MCCALLY, P.G. SCHMID, J.J. BENSY, and
T.E. PIEMME.

Effect of two weeks of bed rest on glucose, insulin, and human growth
hormone levels in response to glucose and arginine stimulations*

In: Preprints of the 1968 Annual Scientific Meeting, Aerospace Medical Association,
Bal Harbour, Florida, May 6-9, 1968.

Bed rest, either because of its necessary attendant inactivity, or as a consequence of alteration of hydrostatic forces, results in relative intolerance to an administered glucose load. Further, the secretion of insulin in response to normal stimuli (glucose and arginine) is enhanced. The insulin to glucose ratios imply that during bed rest a given increment in insulin is less effective in producing a fall in blood glucose than it is under control conditions, either because of interference with peripheral utilization, or because of increased antagonism on some unknown basis. Among known physiologic antagonists to insulin action one must include human growth hormone and circulating plasma cortisol. With respect to the first possibility, the results of these experiments demonstrate during bed rest a decrease, rather than an increase in growth hormone secretion in response to those stimuli

which would be expected to enhance the response. Thus, increases in activity in growth hormone cannot be responsible for the insulin antagonism. Measurements of plasma cortisol levels have not yet been accomplished in these studies, although the results are pending. Previous published experience would indicate, however, that cortisol levels do not rise during bed rest (3). Thus, elucidation of the mechanism for glucose intolerance and insulin antagonism during bed rest awaits further experiments.

The present studies may have implication for a hitherto unanticipated abnormality in metabolism during space flight. Prolonged exposure to zero gravity in confined quarters might well precipitate gross carbohydrate intolerance in congenitally susceptible astronauts. Studies before and immediately following space flight would appear to be indicated.

PEKSHEV, A.P. 1970.

Hemodynamic changes during prolonged hypokinesia on the basis of the dye-dilution method.

215

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. 43-51. [NASA-TT-F-639]

Under the conditions of strict confinement to bed, the hemodynamic changes in the subjects usually increase with increasing time of hypodynamia. In a number of cases, however, stabilization of certain blood-circulation indices is observed, or they return to their original values in the course of the experiments; this makes it possible to speak of a certain adaptability of the cardiovascular system to the abnormal conditions of hypodynamia. Individual peculiarities make their appearance here in the hemodynamics of the subjects. Under the conditions of hypodynamia without prophylactic measures, there is a distinct decrease in stroke volume, minute heart volume, and the mass of central (intrathoracic) blood, a slight decrease in circulating plasma, an increase in the hematocrit, and an increase in the time of a complete blood-circulation cycle. If measures are taken during hypodynamia to prevent circulatory disorders (pharmaceuticals, physical exercises), there are some changes in the directions taken by the hemodynamic shifts. Here the nature of the hemodynamic changes observed in some subjects suggests mitigation of the circulatory disturbances that arise during prolonged hypodynamia.

Author

216

PELLIGRA, R., H. SANDLER, S. ROSITANO, and K. SKRETTINGLAND. 1972.
 Advance Techniques for Monitoring Human Tolerance to $+G_z$ Accelerations.
 In: Preprints of the 1972 Annual Scientific Meeting, Aerospace Medical
 Association, Bal Harbour, Florida. p. 245-246.

A visual response test, described in 1945 by Baldes and Porter (1), is still the most widely used method for measuring human tolerance to $+G_z$ accelerations. This technique is useful because of the observed relationship in time between the loss of vision and consciousness, and because of the obvious importance of vision in aviation—especially to the pilot of high-performance aircraft. However, visual decay is a continuum from grayout through blackout to unconsciousness and there is disagreement as to the end point which best defines the limit of tolerance. It would appear more desirable to measure cardiovascular performance directly since tolerance to positive g is dependent on the vulnerability of the cardiovascular system. This approach has been limited in the past by the inaccessibility of the

MULTICHANNEL DOPPLER BLOOD FLOW MEASUREMENT SYSTEM
 SIMPLIFIED BLOCK DIAGRAM

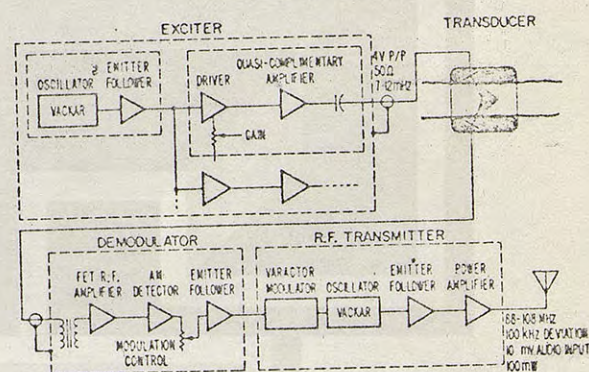


Figure 2: System Block Diagram

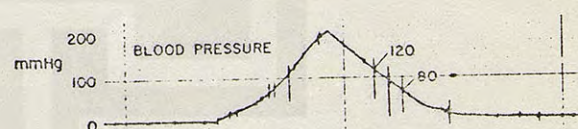


Figure 3: Blood pressure recording prior to centrifugation. A transducer/preamplifier amplifies Korotkoff sounds and provides a voltage output proportional to cuff pressure. Output is recorded as a calibrated cuff pressure tracing with inflections due to Korotkoff sounds superimposed directly upon it.

cardiovascular system except by direct cannulation of blood vessels and other minor surgical procedures. As stated earlier, the recent interest in non-traumatic and continuous evaluation of the critically ill patient has led to a variety of sophisticated instrumentation which could prove useful in the acceleration research laboratory. Our experiments indicate that the transcutaneous Doppler ultrasonic flowmeter, placed strategically on one or more vessels, provides the medical monitor with valuable predictive information regarding the imminent collapse of the cardiovascular system in an increased acceleration environment. The task of collating the information from three or four such sensors placed in various sites on the body and relating it to heart rate, electrocardiogram and other parameters, is well suited to on-line computer analysis. Underlying this approach is the concept of "synergism" in which the amount of information gained from the whole is greater than the sum of its component parts. . . .

The response of blood pressure to $+G_z$ accelerations is complex and dependent on an interplay of hydrostatic forces, diminishing venous return, redistribution of blood and other poorly defined compensatory reflexes. Other factors which must be considered are the level above or below the heart at which the determination is made and the acceleration profile. For the most part, systolic and diastolic pressures measured indirectly by electro-sphygmomanometer at the level of the brachial artery, followed a pattern which could be anticipated given a slow rate of onset and prolonged exposure to acceleration (2). Although this device cannot provide the precise and continuous intra-arterial type measurements often critical to physiological research, it has the advantage of non-invasiveness and does appear to be a useful clinical tool for the centrifuge medical monitor.

217

PESTOV, I.D., et al. 1970.

An investigation of orthostatic stability 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. 238-247. [NASA-TT-F-639]

The reactions of the cardiovascular system to the orthostatic test are examined in men who were restricted to the horizontal position for 70 days. Certain prophylactic measures taken against detrimental effects of prolonged hypodynamia are evaluated. The possible mechanisms of the orthostatic disturbances that result from simulation of weightlessness are discussed. Author

A70-24694 # Investigation of orthostatic stability after prolonged hypodynamia (issledovanie ortostaticheskoi ustoychivosti posle dlitel'noi gipodinamii). I. D. Pestov, M. I. Tishchenko, B. A. Korolev, B. F. Asiamolov, V. V. Simonenko, and A. E. Baikov. 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. 230-240. 16 refs. In Russian.

Study of the reactions of the cardiovascular system to orthostatic tests in a group of 16 subjects restricted to a lying position for a period of 70 days. EKGs, seismocardiograms or phonocardiograms, sphygmograms and tachy-oscillograms are taken daily during the period. Hemodynamic characteristics, the phase structure of the cycle of the heart and the cardiac activity are determined on the basis of these tests. Prophylactics is discussed to prevent or reduce the negative effects of prolonged hypodynamia on these functions. Possible mechanisms of orthostatic disorders are discussed in connection with the simulation of weightlessness. V.Z.

218

N73-22017 Joint Publications Research Service, Arlington, Va.
NEGATIVE PRESSURE ON THE LOWER PART OF THE BODY
AS A METHOD FOR PREVENTING SHIFTS ASSOCIATED
WITH CHANGE IN HYDROSTATIC BLOOD PRESSURE

I. D. Pestov and B. F. Asymolev *In its Space Biol. and Med.*,
Vol. 6, No. 4, 1972 29 Sep. 1972 p 95-102 refs (For
availability see N73-22002 13-04)

Four runs of 18-hour (eight test subjects) and 30-day (nine
test subjects) simulated weightlessness tests were used to study
the relationship between changes in water balance and orthostatic
stability, on the one hand, and the degree of decrease in blood
hydrostatic pressure. It is shown that it is possible to prevent
shifts caused by pressure decrease by means of application of
lower body negative pressure. Author

N69-14025*# Techtran Corp., Glen Burnie, Md.
SOME MECHANISMS RESPONSIBLE FOR THE REDUCTION
OF ORTHOSTATIC STABILITY IN EXPERIMENTS WITH
SIMULATED WEIGHTLESSNESS

I. D. Pestov. Washington NASA Dec. 1968 11 p refs Transl.
into ENGLISH from "Nekotoryye Mekhanizmy Snizheniya
Ortostaticheskoy Ustoychivosti v Eksperimentakh s Imitatsiyey
Nevesomosti" Presented at the 19th Congr. of the Intern. Astron.
Federation, New York, Oct. 1968

(Contract NASw-1695)

(NASA-TT-F-12064) Avail: CFSTI CSCL 065

DOCUMENT NO.: N69-14025 A70-45025

DESCRIPTION: Sque P/1, Simulation BK/36, Weightless Y/35, Water W/77, Water Immersion P/24, Dehydration P/38,
Pharmacology GY/25, Stimulation GY/74, Nervous System R/48, Bedrest GY/39, Circulatory
System R/10, Extremities R/28, Disease GY/40, Therapy GY/38, Design GR/84. 1968.

ABSTRACT:

In 41 experiments involving 18 hours water immersion (18 test subjects) it was established that compensated and noncompensated forms of orthostatic instability arise with identical changes in water volume and therefore cannot be determined by the level of dehydration of the organism alone. Orthostatic collapse appears most frequently in test subjects with unstable vegetative functions and an inclination to vestibular-vegetative reactions. It can be prevented by using pharmacological stimulants (strychnine, caffeine, phenamine). Apparently, one mechanism of compensation of the functions in the vertical pose is the nervous-reflector mechanism. An experiment involving 70 hours bed confinement

showed a reduction in the tensility of the vessels in the lower extremities, which partially facilitates compensation of orthostatic shifts. Maintenance of normal tensility of these vessels by femoral occlusion collars increases the reserve capacity of the blood depot and orthostatic disorders. It is probable that when femoral collars are used this negative effect predominates over the effects for which it is designed.

Author

PETROVYKH, V.A., et al. 1969.
Nutritional state of human subjects kept for long periods in a horizontal position and subsequently exposed to acceleration.
In: V.N. Chernigovskiy, ed. Problems of Space Biology and Medicine. Volume 7: Operational Activity, Problems of Habitability and Biotechnology. Washington, D.C., National Aeronautics and Space Administration. p. 330-337. [NASA-TT-F-529]

ACCESS. NO. 12,472

FORM: ☒ AUTHOR CARD COMPLETED 273

~~A68-38304~~ #
INVESTIGATION OF SOME ASPECTS OF THE HUMAN NUTRITIONAL STATUS UNDER CONDITIONS OF A PROLONGED STAY IN THE HORIZONTAL POSITION WITH SUBSEQUENT EXPOSURE TO OVERLOADS [ISSLEDOVANIYE NEKOTORYKH STORON PISHCHEVOGO STATUSA CHELOVEKA V USLOVIYAKH DLITEL'NOGO PREBYVANIYA V GORIZONTAL'NOM POLOZHENII POSLEDUIUSHCHEGO VOZDEISTVIA PEREGRUZOK].

V. A. Petrovykh, R. V. Kudrova, M. I. Kuznetsov, P. P. Lobzin, I. G. Popov, I. A. Romanova, Ju. K. Syzrantsev, A. M. Terpilovskii, Ju. F. Udalov, and N. A. Chelnokova.
IN: PROBLEMS OF SPACE BIOLOGY. VOLUME 7 [PROBLEMY KOSMICHESKOI BIOLOGII. VOLUME 7].
Edited by V. N. Chernigovskii.
Moscow, Izdatel'stvo Nauka, 1967, p. 355-363. 6 refs. In Russian.

DOCUMENT SERIES & NO.: A68-38304 (IAA)

DESCRIPTORS: Bedrest GY/39, Carbohydrates W/48, Excretory system R/56, Gravity Y/31, Human BL/72, Lipids W/51, Metabolism GY/13, Nutrition GY/34, Protein W/32, USSR GR/3

ABSTRACT:

Investigation of the shifts in the metabolism of healthy subjects subjected to bed rest for periods of 10 and 15 days prior to exposure to overloads. The daily ration consisted of 105 grams of proteins, 126 grams of fats, and 371 grams of carbohydrates, amounting to a total of 2745 cal. The results of the investigation are given in eight tables. These indicate that due to the decreased metabolism in the muscular tissue, there is an increase in the secretion of urea, ammonia, amino acid, and uric acid. The basic indices of the metabolism of lipids and the enzyme activity of the stomach glands remained practically unchanged.
V.P.

221

N69-16345# Joint Publications Research Service, Washington, D. C.

EFFECT OF PROLONGED BEDREST ON CEREBAL BIOPOTENTIAL OF HEALTHY SUBJECTS

B. N. Petukhov et al. *In its Space Biol. and Med.*, Vol. 2, No. 5, 1968 14 Jan. 1969 p 86 94 refs (See N69-16332 06 04)

Avail: CFSTI

A 62 day bedrest experiment was conducted with six healthy male test subjects; three of these performed physical exercises of a known force. The test subjects underwent electroencephalographic studies. The results are presented in relation to the determination of cortical responses to indifferent stimuli and changes in the frequency and amplitude of potentials. At later stages in the experiment there was a gradual shift of cortical responses toward a slow frequency and rate of formation. These changes give evidence of an increasing predominance of the inhibition process induced by bedrest. It was noted that the changes were more distinct in subjects performing no physical exercises. Author

A69-16520 #

EFFECT OF PROLONGED HYPOKINESIS ON THE BRAIN BIOPOTENTIALS OF HEALTHY MEN [VLIYANIE DITEL'NOI GIPOKINEZII NA BIOPOTENTIALY GOLOVNOGO MOZGA ZDOROVYKH LIUDEI].

B. N. Petukhov and Iu. N. Purakhin.

Kosmicheskaya Biologiya i Meditsina, vol. 2, Sept.-Oct. 1968, p. 56-61. 16 refs. In Russian.

Study of the effect of 62 days of bed rest with or without physical exercises on the bioelectrical activity of the cortex in a group of six healthy male subjects. The reactions of EEGs of the subjects to acoustic signals followed by light signals are investigated. Irregularities noted in the functioning of the central nervous system from the twentieth to the thirtieth day of the experiment are discussed. V. Z.

222

N71-33465# Joint Publications Research Service, Washington, D.C.

ELECTRIC ACTIVITY OF LEG MUSCLES DURING STANDING AFTER A 120-DAY BEDREST CONFINEMENT
B. N. Fetukhov et al. *In its Space Biol. and Med.*, Vol. 5, No. 3, 1971 12 Aug. 1971 p 98-104 refs (See N71-33451 20-04)
Avail: NTIS

A #17

Changes in the electromyograms (EMG) of 10 healthy subjects were studied following a 120 day bedrest experiment. The test subjects were classified into three groups: the first, a control group, included four persons; the second and third groups included three men each. The second group of test subjects received pituitrin and DOCA to prevent changes in water and mineral metabolism. The test subjects in the third group were given Nerabol to prevent deviations in protein metabolism. After the hypokinesia the EMG amplitude exhibited a distinct decrease in the test subjects of the first and third groups and a less marked decrease in the second group of test subjects.

Author

67752. PETUKHOV, B. N. and Y. N. PURAKHIN. Elektricheskaya aktivnost' myshts goleni pri stoyanii posle 120-sutochnogo postel'nogo rezhima. [Electric activity of muscles during standing after a 120-day bed rest experiment.] *KOSM BIOL MED* 5(3): 64-69. Illus. 1971. [Engl. summ.]-Changes in the amplitude of electromyograms (EMG) of 10 healthy people were studied following a 120-day bed rest experiment. The test subjects were subdivided into 3 groups: the 1st-control group included 4 persons, the 2nd and 3rd groups consisted of 3 men each. The 2nd group was given pituitrin and deoxycorticosterone acetate to prevent changes in water and mineral metabolism. The test subjects of the 3rd group were given nerobol to prevent deviations in protein metabolism. Electromyograms were recorded from the tibial and gastrocnemius muscles of the test subject occupying a comfortable and strained position. The recordings were taken twice before the bed rest experiment and 3-4 days and 30 days after it. During comfortable standing the EMG of the gastrocnemius muscle registered better. Following the hypokinetic exposure the EMG amplitude decreased distinctly in the test subjects of the 1st and 3rd groups and less markedly in the 2nd group test subjects. This was particularly typical of the gastrocnemius EMG.--P. L. W.

PIEMME, T.E. 1971.

Effects of two weeks of bed rest on carbohydrate metabolism.

In: R.H. Murray and M. McCally, eds. Hypogravic and Hypodynamic Environments. Washington, D.C., National Aeronautics and Space Administration. pp. 281-288. [NASA-SP-269]

In view of the apparent inefficient handling of glucose during bed rest and inactivity, a carefully controlled study was conducted to investigate the nature of the carbohydrate intolerance observed during bed rest and some of the factors that might produce such intolerance. Seven health subjects were placed under strict dietary control and supervised activity for a period of four weeks. The first and fourth weeks served as control and recovery periods, respectively, and the second and third weeks comprised the period of enforced bed rest. All subjects showed an elevated peak glucose level and an increased area under the 4-hr glucose curve during the bed rest period as compared with the control period. Insulin responses to glucose administration were markedly augmented during the bed rest cycle. Insulin response to each of three different stimuli was augmented during bed rest in all subjects. Results appear to indicate that there is a relative ineffectiveness of insulin in lowering blood glucose levels during recumbency. A.L.

224

N73-22013 Joint Publications Research Service, Arlington, Va.
VARIATIONS IN CARDIAC OUTPUT AND GAS EXCHANGE
AT REST DURING HYPOKINESIA

Yu. D. Pometov and B. S. Katkovskiy *In its Space Biol. and Med.*, Vol. 6, No. 4, 1972 29 Sep. 1972 p 62-73 refs
(For availability see N73-22002 13-04)

A 30-day bed rest experiment was carried out during which six healthy male test subjects remained in a horizontal position and nine rest subjects were in an antiorthostatic position. Variations in hemodynamics and gas exchange as related to basal metabolism were studied. The subjects who were confined strictly to bed revealed a significant decrease in gas exchange, regardless of whether they were horizontal or antiorthostatic. Subjects who performed physical exercises or underwent electric muscle stimulation exhibited a smaller dropoff of the parameters.

Author

A72-43915 # Cardiac output and gas exchange variations at bed rest during hypokinesia (Izmenenie serdechnogo vybrosa i gazoobmena v pokoe pri gipokinezii). Yu. D. Pometov and B. S. Katkovskii. *Kosmicheskaya Biologiya i Meditsina*, vol. 6, July-Aug. 1972, p. 39-46. 33 refs. In Russian.

Study of variations in hemodynamics and gas exchange as a function of basal metabolism in 15 healthy male test subjects confined to bed rest for a period of 30 days, 6 in a recumbent position and 9 in an antiorthostatic one. Regardless of position, all 15 subjects showed a significant decline in gas exchange. Subjects who performed some physical exercise or underwent electric muscle stimulation exhibited a lesser decline. Subjects who were in the antiorthostatic position displayed an increase in cardiac output already on the first day of bed rest, whereas those in the recumbent position showed it only on the sixth bed rest day.

M.V.E.

PORTUGALOV, V. V., and E. I. ILYINA-KAKUEVA. *Prolonged space flight and hypokinesia*. Aerospace Med. 44(7):764-768, 1973.

? In the light of the results of experimental morphological and cytochemical studies of antigravity muscles of hypokinetic animals, possible effects of the functional underloading of the musculoskeletal system during a prolonged space flight have been investigated.

Approaches to preventing unfavourable effects of hypokinesia are discussed. The results of experimental studies of the prophylaxis of physiological underloading of the musculoskeletal apparatus are presented.

226

N70-24299 *# Public Health Service Hospital, Baltimore, Md.
THE EFFECT OF PROLONGED SIMULATED NON
GRAVITATIONAL ENVIRONMENT ON MINERAL BALANCE
IN THE ADULT MALE, VOLUME 3, EXHIBIT A Final Report
[1968] 98 p refs
(NASA Order T-58941)
(NASA-CR-108337) Avail: CFSTI CSCL 06S

The psychological aspects of prolonged bed rest are reported as part of an overall study to determine the metabolic effects of simulated nongravitational environment over extensive time periods. The study involved three subjects being subjected to a 36 week period of continuous bed rest. The subjects selected were male, young, in good physical health, and possessing the same basic qualifications as required of astronauts. Since the primary goal of the study was metabolic in nature, there were no direct attempts to do psychologic research and the role of the psychologic team was that of enabling the subjects and staff to complete the study. The purpose of psychologic testing during the study was to evaluate any possible change in the subjects' emotional health so that corrective action could be taken if necessary. A synopsis of each weekly meeting, involving the subjects, psychologic team, and hospital staff, is presented. Results of psychologic tests given the subjects prior to, during, and at the completion of the study are included.

D.L.G.

PURAKHIN, Yu.N., and B.N. PETUKHOV. 1968.

Neurological changes in healthy subjects induced by two-month hypokinesia.
Space Biology and Medicine 19:79-85.

Six healthy male test subjects were twice exposed to accelerations followed by a 62-day bedrest during which three test subjects performed physical exercises of a known intensity. The study included tests of the nervous system, electroencephalographic recordings, physiological tremor and fluctuations of the body center of gravity (stabilography). During the first two weeks of the experiment the test subjects exhibited symptoms of asthenic reactions in their behavior and nervous system. Later the symptoms become more serious, acquiring the form of neurological symptoms and an asthenic syndrome (neurasthenia).

228

N73-16052 Joint Publications Research Service, Arlington, Va.
REGULATION OF VERTICAL POSTURE AFTER FLIGHT ON
THE SOYUZ-6 - SOYUZ-8 SHIPS AND 120 DAY HYPO-
KINESIA c05

Yu. N. Purakhin, L. I. Kakurin, V. S. Georgiyevskiy, B. N. Petukhov,
and V. M. Mikhaylov. *In its Space Biol. and Med.*, vol. 6, no. 6,
1972 18 Jan. 1973 p 74-82 refs (For availability see
N73-16041 07-04)

Control of erect posture was studied before and after the
Soyuz-6 through Soyuz-8 flights (seven cosmonauts) and a
120-day bedrest experiment (ten test subjects). The study was
performed using stabilographic methods, and neurological tests;
circulation reactions in cosmonauts, were also examined.
Coordination disturbances were revealed during flight and bedrest
experiments. After the flight and experiment they increased and
changes in statics and gait appeared. Stabilographic measurements
revealed an increase in the amplitude and frequency (especially
in the test subjects) of fluctuations of the general body center
of mass. The cosmonauts exhibited an increase in pulse rate
and arterial pressure. The test subjects also exhibited a pronounced
autonomic reaction. These changes were more distinct in the
test subjects after the bedrest experiment. Author

Eng transl

A73-20985 # Vertical posture control after Soyuz 6, 7 and 8
flights and 120-day hypokinesia (Regulatsiya vertikal'noi pozy posle
poleta na korabliakh 'Soyuz-6'-'Soyuz-8' i 120-sutochnoi gipokinezii).
Yu. N. Purakhin, L. I. Kakurin, V. S. Georgievskii, B. N. Petukhov,
and V. M. Mikhailov. *Kosmicheskaya Biologiya i Meditsina*, vol. 6,
Nov.-Dec. 1972, p. 47-53. 22 refs. In Russian.

Study of erect posture control in 7 crew members of the Soyuz
6, 7 and 8 spacecraft following their flights and in 10 subjects after
120-day bed rest. Stabilographic measurements and neurological and
blood circulation tests were made before and after exposures,
showing the occurrence of coordination disturbances during flight
and bed rest. Increased heart beat rates and a higher blood pressure
were recorded in the astronauts. Also vegetative nervous system
reactions, more pronounced in bed rest experiments, were recorded.

V.Z.

RAMBAUT, P.C., N.D. HEIDELBAUGH, and M.C. SMITH, JR.

Caloric balance ^{during} simulated and actual space flight.

In: Preprints of the 1973 Annual Scientific Meeting, Aerospace Medical Association, Las Vegas, Nevada, May 7-10, 1973.

DISCUSSION

Numerous previous measurements of in-flight food consumption have been made on Gemini (Lachance) (Lutwak) (Reid), Vostok, Voskhod, and Soyuz (Bychkov). From these measurements, it is evident that a considerably diminished energy intake has prevailed in-flight. Measurements of body mass changes postflight showed that approximately 58 percent of the weight lost in-flight was regained within 24 hours postflight. It is likely, therefore, that this portion of the weight loss was due to water, while the remainder was due to fat. An average of 1.5 kilograms of weight was not regained during this period which, if entirely fat, represents an additional in-flight energy expenditure of about 1350 kilocalories per day or an additional 19.3 kilocalories per kilogram per day for all Apollo missions.

On Apollo 16, some information was obtained on water, potassium, and nitrogen balance, together with changes in total body volume (Berry and Smith). When the in-flight weight losses were compartmentalized into fat, protein and water loss, it was evident that the in-flight energy requirements were considerably higher than the intakes and were not significantly different from the measured ground-based intakes of Apollo astronauts. Measurements of bone density before and after Apollo mission also revealed the occurrence of mineral losses. On Apollo 17, measurements made of water, potassium, and nitrogen balance again indicated that both fat and protein tissue, in addition to water, was lost. The caloric equivalent of these losses must be added to the actual intakes in order to compute the true energy requirement in-flight.

Vanderveen, examining the weight changes observed in some earlier Apollo missions, showed that the difference in adjusted energy requirements among astronauts and chamber subjects was small and not statistically significant. It was concluded that reliable predictions of energy needs could be made by studying the subjects in a ground-based environment similar to that of the spacecraft.

The energy intakes of the chamber-test crewmembers must also be adjusted for body weight changes. For the CDR, it was not possible to discern significant differences between the rate of weight loss

in the chamber, and outside it, indicating no change in caloric demands during chamber exposure. The total weight loss was about 2 kilograms, all of which could be accounted for by the measured water loss.

The crewmember designated "SPT" experienced a continuing weight loss with no significant change in slope prechamber compared to in-chamber. During the period F-15 to R+0, he sustained a total mass loss of 5.4 kilograms and a water loss of 1.8 kilograms. If the difference of 3.6 kilograms is assumed to be fat, a caloric deficit of approximately 456 kilocalories per day was incurred. Measurement of changes in total body volume (1.036 kilograms per liter at F-8 and 1.075 kilograms per liter at R+0) by stereophotogrammetry tended to support the fact that the mass loss consisted of water and fat. Nitrogen balance data did not reveal protein losses.

The energy requirements adjusted for weight changes observed in this chamber study confirmed the earlier findings and also showed that no difference existed between caloric expenditure within the chamber compared to outside it.

Since adjusted caloric intakes in chamber studies did not differ from the caloric intakes of the same subjects outside the chamber, it was decided to utilize a series of ambulatory food consumption tests as the basis for predicting in-flight energy requirements. In predicting the energy requirement of each individual Skylab astronaut, it was assumed that no major difference existed between the cost of metabolic activity in space and on the ground. It was also assumed that no difference in biochemical efficiency existed for the same crewmember on the ground and in space. A mean energy intake of 33.6 ± 4.5 kilocalories per kilogram was established for the Skylab astronauts. Expression of this requirement on the basis of body weight takes into account the fact that the crewmembers all have approximately the same somatotype. Gross body weight is assumed to correlate with the size of the cell mass of the body, and thus determines metabolic rate. With a fixed amount of activity, number, extent, speed and force of movements, it is felt that energy expenditure will be directly proportional to body weight since most energy will be expended in simply moving this mass around.

EFFECT OF PROLONGED HYPOKINESIA ON SOME INDICES OF ENERGY METABOLISM IN THE SKELETAL MUSCLES AND IN SOME INTERNAL ORGANS

[Article by N. P. Rassolova, A. N. Potapov, I. M. Sapelkina and I. I. Grebennikova; Moscow, Kosmicheskaya Biologiya i Meditsina, Russian, Vol 7, No 2, March-April 1973, pp 26-33, submitted for publication 2 April 1971]

Abstract: Metabolic changes in the skeletal muscles, the heart and liver of rats exposed to 120-day hypokinesia were investigated. As the exposure continued, oxidative phosphorylation decreased and anaerobic oxidation increased. This was very clear in the skeletal muscles and less distinct in the myocardium and liver. The muscles also showed morphological signs of atrophy. These changes can be attributed to the cumulative effect of hypokinesia as such and chronic stress.

ACCESS. NO. 25,867

FORM: AUTHOR: NP DRILL: LP

44—Changes of Neuromuscular Excitability Due to Standing Posture (Změny Nervosvalové Dráždivosti Způsobené stojem). V. RAUSER, J. REHACEK, and R. PAVLANSKY.—*Fysiotraký a Reumatologický Věstník*, vol. 46, Jun. 1968, p. 171-174. 5 refs. In Czech.

231

DOCUMENT NO.: Aerospace Medicine and Biology #44

DESCRIPTORS: Bedrest GY/39, Czechoslovakia GR/96, Diagnosis GY/37, Electrical Field Y/50, Extremity R/28, Human BL/72, Immobilization GR/62, Medicine GY/36, Muscular System R/53, Neural R/48, Therapy GY/38. 1968.

ABSTRACT:

The author studied, with the aid of functional electrodiagnosis, neuromuscular excitability and accommodation capacity of some muscles of the lower extremity and patients following operation of the hip joint. Previous papers have shown changes of the parameters before operation, after immobilization and in suspension. The present paper demonstrates changes of excitability and changes due to trophic effects which appear when the patient stands up after bedrest. Decrease of excitability was demonstrated in those muscles which had not been prepared for the standing posture by physical rehabilitation. (Authors' summary)

232
RODAHL, K., N.C. BIRKHEAD, B. ISSEKUTZ, JR., J.J. BLIZZARD, G.J. HAUPT,
et al. 1964.

Effects of prolonged bed rest.

In: T.C. Helvey, ed. Conference on Nutrition in Space and Related Waste
Problems, Washington, D.C., National Aeronautics and Space Administration.
pp. 245-252. [NASA-SP-70]

The effects of prolonged bed rest and how these effects may be eliminated or counteracted are summarized. Changes observed during prolonged bed rest are not all due to inactivity, but factors related to gravitational stress are also involved. Therefore, findings obtained during prolonged bed rest may be relevant to problems encountered during prolonged space flight, especially in the development of orthostatic hypotension. Young men were confined to the horizontal position in bed up to 63 days. The conclusions of previous studies were confirmed; that is: bed rest is indeed harmful to the individual's functional capacity. It was concluded that 1 hour of exercise daily with the aid of a simple ergometer may be sufficient to maintain the astronaut at an adequate level of physical work capacity. Further, the development of orthostatic hypotension or tilt-table intolerance is by far the most serious problem. E.E.B.

N72-32086*// Translation Consultants, Ltd., Arlington, Va.
PHYSIOLOGICAL CHANGES DURING PROLONGED BED
REST

K. Rodahl, N. C. Birkhead, J. J. Blizzard, B. Issekutz, Jr., and E.
D. R. Pruett Washington NASA Aug. 1972 8 p refs Transl.
into ENGLISH from Nord. Med. (Stockholm), v. 75, no. 7, Feb.
1966 p 182-186

(Contract NASw-2038)

(NASA-TT-F-14342) Avail: NTIS HC \$3.00 CSCL 06P

Effects of prolonged bed rest on physical work capacity,
tilt-table tolerance, and urinary calcium excretion were studied. It
was concluded that reduced physical work capacity is caused by
the inactivity associated with prolonged bed rest; impaired
tilt-table tolerance is due to the absence of the necessary
cardiodynamic stress required for the maintenance of the
cardiovascular regulatory mechanism, and increased urinary
calcium excretion is due to the absence of the normal
longitudinal pressure in the long bones. Author

98625. RODAHL, K., N. C. BIRKHEAD, J. J. BLIZZARD, B. ISSEKUTZ, Jr., and E. D. R. PRUETT. Physiological changes during prolonged bed rest. In: Nutrition and physical activity. Almqvist and Wiksell: Stockholm, Swed. SYMP SWED NUTR FOUND 5: 107-113. Illus. 1967.--Prolonged bed rest is injurious, even for normal individuals. The organism must be exposed to stress and stimuli in order for the normal physiological regulatory mechanisms to be maintained. The mechanism responsible for the described changes, the effect of gravity on Ca metabolism in the bone, and the mechanism responsible for the development of orthostatic hypotension during bed rest is yet unknown.--From auth.

88256. RODAHL, KARE. (Arbeidsfysiol. Inst., Oslo, Norway.)
Fysiologiske virkninger av langvarig sengeleie. [Physiological effects
of prolonged bed rest.] TIDSSKR NOR LÆGEFOREN 89(7): 469-
472, 497. illus. 1969. [Engl. sum.] --Most of the knowledge concerning
the complications associated with prolonged bed rest is based on obser-
vations on bed-ridden patients. It is difficult to distinguish between
changes brought about by the bed rest as such and changes caused by the
disease process. Studies of the effects of prolonged bed rest in healthy
individuals are necessary. The most striking changes in healthy young
men confined to bed for prolonged periods are reduced tilt-table tolerance
(orthostatic hypotension), increased urinary Ca excretion and reduced
physical work capacity. In the past all these changes were attributed
to inactivity associated with bed rest. In a series of studies on healthy
young men the role of inactivity and other factors in the development of
the observed changes were examined. The development of orthostatic
hypotension is due to the supine position maintained during bed rest and
is not the result of inactivity. Exercise in the supine position during bed
rest could not prevent the development of orthostatic hypotension. Eight
hr sitting/day in addition to bed rest prevented the development of ortho-
static hypotension in 3 out of 4 subjects. Increased urinary Ca excretion
is not the result of inactivity but is due to the absence of longitudinal pres-
sure on the long bones during bed rest. Bicycle ergometer exercise of
several hr duration during prolonged bed rest had no effect on the elevated
Ca excretion. Nor did 8 hr sitting/day in combination with continuous bed
rest affect the elevated Ca excretion. Three hr quiet standing/day com-
bined with continuous bed rest caused the Ca excretion elevated by pre-
vious bed rest to return to normal levels in all subjects. A similar re-
sult was obtained by applying a longitudinal pressure on the body equal
to the body weight in a subject confined to continuous bed rest. The re-
duced physical work capacity is due to inactivity associated with pro-
longed bed rest. One hr bicycle ergometer exercise at 600 kpm/min/day
combined with continuous bed rest was sufficient to prevent the develop-
ment of a reduced physical work capacity. The reduced maximal O₂ up-
take is due to a reduced cardiac output caused by a reduced stroke volume.

--E. L. D.

A71-43109 .Effects of prolonged bed rest on EEG sleep patterns in young, healthy volunteers. Ralph S. Ryback and Oliver F. Lewis (USAF, School of Aerospace Medicine, Brooks AFB, Tex.). *Electroencephalography and Clinical Neurophysiology*, vol. 31, Oct. 1971, p. 395-399. 25 refs. USAF-sponsored research.

The bed-rest study involved eight subjects, 18-24 years of age, and was divided into control, experimental, and recovery phases of 5, 5, and 6 weeks, respectively. During the bed-rest period, four subjects continued to exercise on the total body ergometer while confined to bed, while the remainder acted as controls. All subjects, except for the controls during the bed-rest period, performed 600 kcal of exercise a day. Results are expressed as mean percent change from baseline values and mean percentage of total sleep time. G.R.

26309. RYBACK, RALPH S. (US. Air Force Sch. Aerosp. Med., Brooks Air Force Base, Tex., 78235, USA.), and OLIVER F. LEWIS. Effects of prolonged bed rest on EEG sleep patterns in young, healthy volunteers. *ELECTROENCEPHALOGR CLIN NEUROPHYSIOL* 31(4): 395-399, 1971. [Fr. summ.]--The bed-rest [BR] study involved 8 subjects, 18-24 yr of age, and was divided into control, experimental (BR), and recovery phases of 5, 5 and 6 wk, respectively. During the bed-rest period, 4 subjects continued to exercise on the total body ergometer while confined to bed, while the remainder acted as controls (without exercise). All subjects, except for the controls during the BR period, performed 600 kcal of exercise a day. Subjects were paired and recorded together: 1 and 8; 2 and 7; 3 and 6; 4 and 5. This grouping remained the same throughout the study. A total of 5 recordings were made: 1 during baseline, 2 during BR1 and BR2 and 2 during recovery. Baseline mean percentages of total night sleep were: rapid eye movement (REM) = 24.64; Stages 1 + 2 = 58.95; Stages 3 + 4 = 16.44; and Stage 4 = 4.62. A Mann-Whitney U test (two-tailed) was performed on all data. A significant increase ($P < 0.01$) in deep sleep (Stages 3 + 4) and a decrease ($P < 0.005$) in light sleep (Stages 1 + 2) for the entire group (non-exercise, NE, and exercise, E) is seen when the entire BR period is combined and compared to baseline values. There was no significant change in REM, although there was a tendency in the NE group for decreased REM sleep. With recovery (R1 + R2), the increase in deep sleep remains but is not significant ($P > 0.05$; < 0.1) as is the decrease in light sleep, relative to baseline values. However, Stage 4 for the entire group showed a significant ($P < 0.05$) increase during bed rest (BR1 + BR2) and recovery (R1 + R2) relative to baseline values. When E and NE are compared separately during bed rest to baseline values for deep sleep (Stages 3 + 4), only the NE group shows significant differences ($P < 0.05$), although there is a progressive increase in deep sleep for the E group over the bed-rest period.--S. B.

A71-29363 # Psychobiologic effects of prolonged bed rest (weightless) in young, healthy volunteers (Study II). Ralph S. Ryback, Oliver F. Lewis, and Charles S. Lessard (USAF, School of Aerospace Medicine, Brooks AFB, Tex.). *Aerospace Medicine*, vol. 42, May 1971, p. 529-535. 53 refs. USAF-sponsored research.

Sleep data, including EEG recording, psychological testing, and psychomotor performance, were obtained from 8 young, healthy men subjected to prolonged bed rest. The study was divided into control, experimental (bed rest), and recovery phases of 5, 5, and 6 weeks, respectively. During the bed rest period, 4 subjects continued to exercise while the remainder acted as controls (without exercise). With the onset of bed rest an increase in deep sleep (Stages 3 and 4) and a decrease in light sleep (Stages 1 and 2) were observed especially in the nonexercise group. An additional or ninth subject was recorded while napping during the day and it was shown that napping decreased the amount of time spent in deep sleep that night relative to control nights. Psychological testing revealed an increase in anxiety, hostility and depression just in anticipation of being put to bed and psychomotor testing demonstrated a decrease in handgrip in the nonexercise group during bed rest. The implications of these findings for the practicing physician are discussed. (Author)

† 87510. RYBACK, RALPH S. (McLean Hosp., Belmont, Mass., USA).
RALPH W. TRIMBLE, OLIVER F. LEWIS, and CHARLES L. JENNINGS.
Psychobiological effects of prolonged weightlessness (bed rest) in
young healthy volunteers. AEROSP MED 42(4): 408-415, illus. 1971.

--The lack of knowledge of the effects of weightlessness has made
scientists apprehensive about putting a man in space for prolonged
periods of time. At the present time prolonged bed rest is the best
method for simulating prolonged weightlessness. Eight airmen aged
18 to 22 yr participated in the bed rest study. The experiments sug-
gest that prolonged bed rest may be understood as a more subtle form
of sensory deprivation. It is suggested that the deprivation observed
here is not just environmental as related to the 5 senses, but somatic
in terms of a decrease in put neurologically from the muscular system
per se. It is proposed that the alert, normal, intelligent, adaptive
homeostatic state in man requires a continuous variation in sensory
and motor-muscular in-put. The significance of this study for the
acutely bedridden or convalescing patient is seen as the psychological
and physiological stress that prolonged bed rest produces.

SAIKI, H., M. NAKAYA, C. SEKIGUCHI

Characteristics of sleep under simulated weightlessness.

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

Electro-encephalographical and electro-oculographical sleep patterns were recorded during each condition and analysed through the modified method of Dement and Kleitman. The results obtained were as follows:

- 1) By short time water immersion, the sleep patterns were changed. It is characterized by shortening of the duration of sleep and shallowing of the depth of sleep.
- 2) By 3 days successive water immersion general cycles of the sleep patterns were changed remarkably. (1) Stage 0 (awake) is more frequent, (2) stage 1-REM (paradoxical sleep) and stage 4 (deepest stage) were shortened.
- (3) In the case of bed rest, stage 1-REM is distributed at the end of the sleep, and stage 4 is distributed mainly at the beginning of the sleep. And in the case of water immersion, stage 1 is concentrated more at the beginning of the sleep, and stage 1-REM is removed to the middle of the sleep. The shortening of the REM stage and stage 4 is thought to influence detrimentally the body if they are continued for a long duration. Data obtained on cardiovascular functions, urination, water, mineral, vitamin, hormonal metabolism and energy utilization by muscular activity were not revealing of any explanation of the changes in the sleep pattern.

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CITATION: SANDLER, H., J.E. GREENLEAF, H.L. YOUNG, E.M. BERNAUER, J.T. MORSE, R.W. STALEY, R.F. HAINES and W. VAN BEAUMONT. Effects of isometric and isotonic exercise during 14 days bed rest on +G_z tolerance. In: *Preprints of the 1973 Annual Scientific Meeting, Aerospace Medical Association*, Las Vegas, Nevada, May 7-10, 1973. p. 21-22. ~~AASAP: Aerospace Medical Association.~~

PERFORMING INSTITUTION: ARC IN HOUSE

KIND OF DOCUMENT: Research Report

SUBJECTS: Seven healthy adult males

RES. OBJECT.

Determine the effect of moderately hard isotonic and isometric exercise on +G_z tolerance and orthostatic tolerance after 2 weeks of bed rest.

METHOD

Seven healthy male subjects underwent a 2 week ambulatory control period (C-1) followed by 3 2-week bed rest (BR) periods, separated by 2 3-week recovery periods (C-2, C-3). A horizontal body position was maintained throughout each BR period. During BR each subject experienced isometric exercise (IME), isotonic exercise (ITE) or no exercise (NOE), i.e., 1 routine in each of the 3 BR periods in a selected randomized order. The IME was performed intermittently at 21% of maximal leg extension force for 1 min followed by 1 min rest for 30 min each morning and 30 min each afternoon. The ITE was performed continuously for identical periods each day using a bicycle ergometer at 60% of each subject's maximal oxygen uptake (VO₂). Immediately before and at the end of each BR period, each subject was exposed to 3 +G_z levels on the Ames 8.8m centrifuge in a predetermined random order. Tolerance was determined by loss of peripheral (greyout) or central vision (blackout). Maximal oxygen uptake (max VO₂) was measured and response to lower body negative pressure (LBNP) was determined.

RESULTS

A comparison of average acceleration tolerance times during the control and BR periods for each exercise regime indicated that neither ITE nor IME resulted in significant changes compared with each other or with NOE. Average heart rates (HR) for the 10 sec period just prior to the onset of deceleration do not show any consistent pattern either within or between G-levels. Significant differences in HR during control or BR periods were not observed at 3.2 or 3.8G, regardless of exercise regime. Compared with control values, max VO₂ was reduced 11.7% with NOE. Maximal ventilation was unchanged and average HR during exercise was unchanged with ITE but significantly increased with NOE and IME during BR. There was no difference in the three exercise values for VO₂, ventilation or HR during the control periods or during BR. There was no effect of BR or the 2 exercise sequences upon systolic or diastolic blood pressure during LBNP.

CONCLUSIONS

It is concluded that neither isometric nor elevated levels of isotonic exercise are capable of returning +G_z tolerance to pre-bed rest levels, particularly at +2.1 G_z. It appears that the cardiovascular changes occurring with prolonged bed rest are more related to reductions in hydrostatic pressure than to inactivity or fluctuation in levels of blood pressure.

SCHMID, P.G., M. MCCALLY, T.E. PIEMME, and J.A. SHAVER. 1971.
Effects of bed rest on forearm vascular responses to tyramine and norepinephrine.
In: R.H. Murray and M. McCally, eds. Hypogravic and Hypodynamic Environ-
ments, Washington, D.C., National Aeronautics and Space Administration.
pp. 211-224. [NASA-SP-269].

SCIENCE SCENARIOS

To test for disturbances in the peripheral adrenergic nerve function, observations were made of forearm vascular responses to brachial artery infusions of tyramine and norepinephrine after two weeks of bed rest and after control periods of normal vigorous daily activity. The study was subdivided into three periods. An initial control period consisted of 8 days of unrestricted activity. The second period consisted of 12 days of bed rest. The third, or recovery period, consisted of 6 more days of activity and began when the subjects got out of bed. Experiments were conducted on the last day of each period and care was taken to conduct separate sessions under the same conditions. The test periods are discussed and results are presented of the basal values measured before and during infusions of the drugs. Measurements of total catecholamines in the urine are also presented.

A.L.

12 32116*# Translation Consultants, Ltd., Arlington, Va.

DANGERS OF BED REST

J. Schouten and J. Th. R. Schreuder Washington NASA Aug.
1972 13 p refs Transl. into ENGLISH from Ned. Tijdschr.
Geneesk. (Hastern), v. 112, no. 29, Jul. 1968 p 1337-1341
(Contract NASw-2038)

NASA-TT-F-14349) Avail: NTIS HC \$3.00 CSCL 06P

The hazards of bed rest as a therapeutic measure are
described with respect to circulatory, respiratory and urogenital
facts. Effects on musculature, joints, skeleton and skin are
discussed.

Author

SEREGIN, M.S. et al. 1970.

Nutrition and metabolism 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. 73-88. [NASA-TT-F-639].

Examination of subjects who spent 70 days in hypodynamia indicated a decreased energy requirement coupled with a decrease in body weight. The level of protein metabolism was depressed. A negative nitrogen balance was established. The protein loss averaged 8 g/day. Calcium excretion was up 40%. The excretion of vitamins C1, B1, B2, and PP with the urine decreased. The blood concentration of corticosteroids had fallen, and smaller amounts were excreted with the urine. The orthostatic test was accompanied by considerable enhancement of hypophyseal-adrenal function. Neither physical exercises nor medications prevented the metabolic disturbances.

Author

244

SIMONENKO, V.V. 1970.

Hemodynamic changes during prolonged hypokinesia according to mechanocardiographic data.

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. 34-42. [NASA-TT-F-639].

A dominant influence of the sympathetic innervation on the cardiovascular system is observed during prolonged hypokinesia. Prolonged hypokinesia changes the reaction of man to cold, as manifest in the phasing of the reactions, lower strength of the response reaction, and lowering of the tonicity coefficient of the blood vessels. The cuff test can serve as a tentative indicator of the ability of the cardiovascular system to react during hypokinesia to compensate exclusion of a certain amount of blood from circulation. Physical conditioning mitigates the deconditioning effect of hypokinesia on the cardiovascular system to some degree, but does not eliminate it completely.

Author

ACCESS. NO. 19,618

FORM: AUTHOR: VG DRILL:

A70-24670 # Changes in the hemodynamics during prolonged hypokinesia on the basis of mechanocardiography data (Izmeneniia gemodinamiki pri dlitel'noi gipokinezii po dannym mekhanokardiografii). V. V. Simonenko. 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. 42-49. 17 refs. In Russian.

DOCUMENT NO.: A70-24670

DESCRIPTORS: Bedrest GY/39, Circulatory System R/10, Human BL/72, Immobilization GR/62, Measure P/3, Nervous System R/48, Physiology GY/8, Stimulation GY/74, USSR GR/3. 1969.

ABSTRACT:

Investigation of the hemodynamics and of the vascular tonus in 16 healthy young (21 to 23 years of age) men who were confined to a strict regimen of restricted physical activity for a 70-day period. Prolonged hypokinesia is accompanied by an increased influence of sympathetic innervation on the cardiovascular system. Hypokinesia changes human reaction to cold as expressed by a changed phase of reaction, a decreased intensity of the reaction, and reduced vascular tonicity. Physical training somewhat decreases the effects of hypokinesia on the cardiovascular system but does not overcome them entirely.

T.M.

24, 103
SKRYPNIK, V.G. 1970.

Changes in the biochemical peculiarities of walking under the influence of hypodynamia according to ichnographic data.

In: R.H. Murray and M. McCally, eds. Hypogravic and Hypodynamic Environments. Washington, D.C., National Aeronautics and Space Administration. pp. 160-169. [NASA-SP-269].

245

DOCUMENT NO.: N70-42870

DESCRIPTORS: Bedrest GY-39, Exercise GR-61, Immobilization GR-62, USSR GR-3.

1970.

ABSTRACT:

The locomotor act of walking was studied in six subjects before and after an experiment during which they were confined to bed in the supine position for an extended period. Studies of the gait of the subjects produced data indicating reconstruction of the original stereotype of walking. A relative shortening of the distance covered in a double step and the symmetry between its component elements were noted. A change in the habitual kinematics of the trunk and extremities and disturbance of the ability to walk a straight line also occurred. Use of physical conditioning as a prophylactic measure reduces but does not eliminate the detrimental effects of prolonged hypodynamia. Use of the physical conditioning appliances in the supine position results in development of a new stereotype whose stability is greater the closer the similarity between the motions and load of the motor apparatus.

Author

A70-24683 # Changes in the biochemical features of walking under the action of hypodynamia according to ichnographic data (Izmenenie biokhimicheskikh osobennostei khod'by pod vliyaniem gipodinamii po dannym ikhnografii). V. G. Skrypnik. 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. 161-170. In Russian.

Comparative study of the locomotor act in six subjects before and after prolonged bed rest in a reclining position. As a result of this study of walking behavior, data are obtained which indicate a restructuring of the initial walking stereotype. This is expressed in a relative shortening of the length of a double step and in a codimensionality between its constituent elements, and leads to a change in the habitual kinematics of the torso and the extremities, as well as to a disturbance of the ability to maintain a given direction of motion. The use of physical training (a veloergometer and a treadmill) as a preventive measure reduces, but does not eliminate the negative effect of prolonged hypodynamia. During prolonged hypodynamia in a reclining position the use of physical training devices leads to the development of a new stereotype, the stability of which is all the greater, the greater the resemblance between the motions and the load of the motor apparatus under conditions of ordinary locomotor skill and under the conditions of the experiment. This leads to a slowing down of the rate of incorporation into the initial stereotype, but to greater stability in locomotion directly after the experiment.

A.B.K.

ACCESS. NO.

6091

A66-32180 *

PREVENTION OF CARDIOVASCULAR DECONDITIONING BY 9-
ALPHA-FLUOROHYDROCORTISONE.

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

IN: AEROSPACE MEDICAL ASSOCIATION, ANNUAL SCIENTIFIC
MEETING, 37TH, LAS VEGAS, NEV., APRIL 18-21, 1966, PRE-
PRINTS. [A66-32134 17-04]

Washington, D.C., Aerospace Medical Association, 1966, p. 166,
167. Abridged.

FORM: / AUTHOR CARD COMPLETED

246

DOCUMENT SERIES & NO.: A66-32180 (IAA)

DESCRIPTORS: Bedrest GY/39, Circulatory system R/10, Immobilization GR/62, Tilting GR/37
Weightlessness Y/35

ABSTRACT:

1966

Experimental study of 9- α -fluorohydrocortisone as a means of preventing the orthostatic intolerance of weightlessness. Normal male subjects subjected to 14 days of complete bed rest developed cardiovascular deconditioning. The prime manifestation of this change was the exaggerated cardioacceleration seen during tilting. It appears that vascular reflexes are inadequate to sustain peripheral resistance. In most cases marked vagotonia supersedes earlier adrenergic effects, and vasodepressor syncope follows. In this study, 9- α -fluorohydrocortisone appears to have been effective in preventing the occurrence of vasodepressor syncope. F. R. L.

- 30,256. SOKOLKOV, V. I. Basic metabolism under conditions of simulated weightlessness (Osnovnoi obmen v usloviakh imitatsii nevesomosti). In: Problems of cosmic biology. 16: (A71-42789 22-05), p. 41-46. Moscow, Izdatel'stvo Nauka, 1971. 21 refs. In Russian.

A71-42794

Subjects were kept immersed in water, or restricted to bed rest for 24 hr on the same diet in a study of basic metabolic processes and external respiration under such conditions. Oxygen requirement, carbon dioxide discharge, pulmonary ventilation, and the oxygen consumption coefficient were higher in immersed subjects than in subjects with be rest.

SOKOLOV, N.L., Yu.G. NEFEDOV, V.P. SAVINA, and V.Ye. RYZHKOVA. 1971.
Study of the composition of air exhaled by man exposed to some extremal
factors.
Space Biology and Medicine 5(1):86-90.

[Article by N. L. Sokolov, Yu. G. Nefedov, V. P. Savina and V. Ye. Ryzhkova;
Moscow, Kosmicheskaya Biologiya i Meditsina, Russian, Vol 5, No 1, 1971,
pp 57-60, submitted for publication 27 August 1970]

Abstract: This paper presents the results of an analysis of
contaminants present in the air exhaled by human subjects
exposed to different stress effects (20-day bed confinement
20-day starvation, 120-day diet of lyophilized foods, high
temperature and humidity). The colorimetry, nephelometry and
gas chromatography methods were used. The most significant
air changes were detected during exposures to prolonged
starvation and high temperature (40°C).

ACCESS. NO. 26, 389

FORM: _____ AUTHOR: DRILL: RCP

A71-28412 # Study of the composition of air exhaled by
humans exposed to certain stress effects (Issledovanie sostava
vydykhaemogo chelovekom vozdukh pri deistvii nekotorykh ekstre-
mal'nykh faktorov). N. L. Sokolov, Yu. G. Nefedov, V. P. Savina, and
V. E. Ryzhkova. Kosmicheskaya Biologiya i Meditsina, vol. 5,
Jan.-Feb. 1971, p. 57-60. In Russian.

DOCUMENT NO.: A71-28412

DESCRIPTORS: Analysis P/2, Atmosphere W/70, Bed rest GY/39, Chromatography P/10, Food Deprivation GY/77, Human
BL/72, Relative Humidity Y/27, Respiratory System R/21, Stress GY/76, Temperature Y/25, USSR GR-3.
1971.

ABSTRACT:

Results of qualitative and quantitative studies of the gaseous
microimpurities contained in air exhaled by humans subjected to
certain stress factors (20-day bed rest, 20-day starvation, 120-day
feeding with lyophilized diets, high temperature and humidity).
Using the methods of colorimetry, nephelometry, and gas chroma-
tography, it is found that the most significant changes detected in
exhaled air occur during exposure to prolonged starvation and high
temperature (40 C). A.B.K.

249

SOROKIN, P.A., V.V. SIMONENKO, and B.A. KOROLEV. 1970.

Clinical observations in 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. 15-25. [NASA-TT-F-639].

The results of clinical observations on the state of 16 subjects over 70 days of bed rest are reported. The psychological effects of prolonged hypodynamia are analyzed and data on the pathology of the subjects during the experiments are presented. Author

ACCESS. NO. 19,708

FORM: AUTHOR: DRILL:

A70-24668 # Clinical observations during prolonged hypodynamia (Klinicheskie nabludeniia pri dlitel'noi gipodinamii). P. A. Sorokin, V. V. Simonenko, and B. A. Korolev. 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. 24-34. 27 refs. In Russian.

DOCUMENT NO.: A70-24668

DESCRIPTORS: Bedrest GY/39, Disease GY/40, Human BL/72, Immobilization GR/62, Immunology GY/64, Medicine GY/36, Psychology GY/68, Symptom GY/54, USSR GR/3. 1969.

ABSTRACT:

Results of clinical observations from five series of experiments conducted with 16 healthy young (21 to 23 years of age) men confined to bed for a 70-day period. It is shown that prolonged hypodynamia has specific psychological effects. Certain subjects exhibited an 'expectancy neurosis' toward the end of the experiment; however most subjects maintained a will to complete the entire test period, and only one had to be removed due to psychoneurotic reactions. Prolonged inactivity had harmful physical effects, and data show a clearly disturbed gastroenteric function. A serious deterioration of the organism's immunobiological properties is evident, and data are given for the occurrence of various illnesses.

T.M.

250

SOROKIN, P.A., A.M. GENIN, M.I. TISHCHENKO, P.V. VASIL'EV, R.I. GISMATULIN,
and I.D. PESTOV. 1969.

Organizational and methodological principles for the conduct of prolonged
hypodynamia researches.

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. 8-14. [NASA-TT-F-639].

The influence of prolonged hypodynamia on the human
organism was investigated under clinical conditions in five series
of experiments in which 16 subjects spent 70 days confined to
bed. Series 1 was the control (pure hypodynamia), consisting of
4 subjects. Series 2 through 5 imposed hypodynamia together with
various combinations of prophylactic measures on 12 subjects. The
most general methodological approaches to study of the effects of
hypodynamia and evaluation of the effectiveness of various
prophylactic measures are characterized. Author

ACCESS. NO. 20,005

FORM: AUTHOR: NP DRILL: NP

A70-24667 # Organizational and methodical principles of
conducting investigations during prolonged hypodynamia (Organi-
zatsionno-metodicheskie printsipy provedeniia issledovaniia pri dlitel'-
noi gipodinamii). P. A. Sorokin, A. M. Genin, M. I. Tishchenko, P. V.
Vasil'ev, R. I. Gismatulin, and I. D. Pestov. 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. 16-23. In Russian.

DOCUMENT NO.: A70-24667

DESCRIPTORS: Bedrest GY/39, Human BL/72, Immobilization GR/62, Medicine GY/36,
Technique P/1, USSR GR/3. 1969.

ABSTRACT:

Clinical study of the influence of prolonged hypodynamia on
the human organism in five series of experiments conducted with 16
subjects subjected to 70 days of bed confinement. The first series
involved four control subjects who were exposed to pure hypo-
dynamia. Twelve remaining subjects participated in the other four
experiments which differed by the prophylactic measures applied to
the subjects. General methodological principles which should be
followed are outlined. T.M.

Spealman, C. R., Bixby, E. W., Wiley, J. L., and Newton, M.: Influence of Hemorrhage, Albumin Infusion, Bed Rest, and Exposure to Cold on Performance in the Heat. *J. Appl. Physiol.* 1: 242, 1948.

1. The ability of 4 young men to perform in the heat (33°C , D.B., $28-29^{\circ}\text{C}$, W.B.) certain simple physical tasks (active and passive standing, pedalling a bicycle ergometer) was tested following short (24 hours) periods of bed rest, venesection of 500 cc., exposure to cold (20°C , D.B., 18°C , W.B.) and in control experiments. In all cases, subjects remained in the controlled temperature room for 24 hours prior to testing. The subjects were partially but incompletely acclimatized to the testing temperature by the summer weather and by the short periods of exposure to the higher temperatures of the room. In somewhat similar experiments, the effects of infusing serum albumin and of hemorrhage on performance ability in the heat were studied using 4 other men as subjects.

2. Removal of 500 cc. of blood (venesection) resulted in an immediate and marked decrease in ability to carry out physical activities (active and passive standing, exercising on bicycle ergometer) in the heat. Several days elapsed before control level of performance was attained again. Performance was affected adversely, but to a lesser degree, following removal of 200 cc. of blood. Subjects also performed poorly following confinement to bed and exposure to cold. Infusion of serum albumin in quantity equivalent to 500 cc. of blood plasma improved performance.

3. These various procedures also altered the level of hemoglobin concentration (increase in concentration following experiments on bed rest and exposure to cold; decrease following venesection and albumin infusion) and blood volume. Performance in these experiments correlates well with estimated levels of blood volume, but there is not any consistent relationship between performance and hemoglobin concentration.

SPEARS, W.R., K.H. HYATT, W.R. VETTER, and R.W. SULLIVAN. 1973.
Decreased Myocardial Contractility as a Result of Simulated Weightlessness.

In: Preprints of the 1973 Annual Scientific Meeting, Aerospace Medical Association, Las Vegas, Nevada. p. 102-103.

Since bedrest is nearly uniformly accompanied by decreases in plasma volume, measurement of the myocardial contractile state requires an index unaffected by left ventricular filling or pre-loading effects. Because of its close association to $R-dP/dt$ (R to peak velocity of the left ventricular pressure rise), $R-dA/dt$ appears quite a suitable non-invasive means to this end (4). The use of PEP/LVET as an index of contractility is advantageous because of its well known close correlation to ejection fraction and independence of changes in heart rate.

Both the ACG and the STI data in our studies showed changes in the direction of diminished myocardial contractility during bedrest, lasting significantly longer than the fluid volume

changes. Both the $R-dA/dt$ and PEP/LVET parameters showed increases which were manifest soon after initiation of bedrest, and which followed a trend of slight progressive worsening throughout bedrest. The ACG data suggest that as much as three weeks is required for ventricular function to recover from the influence of bedrest; the STI data indicate that perhaps an even longer period is necessary. These findings may help clarify the basis for the disparity between time to recovery of fluid volumes from bedrest effect, and the time to recovery of exercise performance.