Intensive exercise training during bed rest attenuates deconditioning

ABSTRACT

A 30-d 6° head-down bed rest project was conducted to evaluate variable high-intensity, short-duration, isotonic cycle ergometer exercise (ITE) training and high-intensity intermittent resistive isokinetic exercise (IKE) training regimens designed to maintain peak VO$_2$ and muscle mass, strength, and endurance at ambulatory control levels throughout prolonged bed rest. Other elements of the deconditioning (adaptive) syndrome, such as proprioception, psychological performance, hypovolemia, water balance, body composition, and orthostatic tolerance, were also measured. Major findings are summarized in this paper. Compared with response during bed rest of the no exercise (NOE) control group: the ITE training regimen (a) maintained work capacity (peak VO$_2$), (b) maintained plasma and red cell volumes, (c) induced positive body water balance, (d) decreased quality of sleep and mental concentration, and (e) had no effect on the decrease in orthostatic tolerance; the IKE training regimen (f) attenuated the decrease in peak VO$_2$ by 50%, (g) attenuated loss of red cell volume by 40% but had no effect on loss of plasma volume, (h) induced positive body water balance, (i) had no adverse effect on quality of sleep or concentration, and (j) had no effect on the decrease in orthostatic tolerance. These findings suggest that various elements of the deconditioning syndrome can be manipulated by duration and intensity of ITE or IKE training regimens and that several different training protocols will be required to maintain or restore physiological and psychological performance of individuals confined to prolonged bed rest.

The mechanism for short-term adaptation to prolonged bed rest with the body in the horizontal or slightly head-down position has not been fully elucidated. Short-term adaptation refers to integrated physiological changes during bed rest in a controlled laboratory setting. Deconditioning, one facet of bed-rest adaptation, refers specifically to deterioration of physical fitness. Understanding this mechanism requires study of not only individual physiological system responses (neuroendocrine, musculoskeletal, and cardiovascular), but also of their integration. While investigation of the deconditioning mechanism is important and will continue, many practical problems concerning medical prescription of bed rest have received little attention. For example, there are essentially no data differentiating physiological responses during bed-rest deconditioning from those occurring concomitantly with the healing process from an illness or injury; but early ambulation, with its increased hydrostatic pressure and exercise, appears to be better than continuing with bed rest (6). Will moderate exercise (training), which appears to stimulate the immune system in healthy people (16,21), enhance recovery if performed by injured or diseased bed-ridden patients? Interestingly, studies of bed-rest deconditioning have not been performed to any great degree by the medical profession to enhance clinical treatment.
To facilitate rehabilitation, an optimal exercise training program should not only assist in counteracting bed-rest deconditioning, but it should also be efficient in time and energy utilization (8,11,12). Maintenance of aerobic work capacity, strength, and endurance during prolonged bed rest may be attained best by exercise regimens requiring development of maximal muscular tension intermittently rather than performance of longer duration sub-maximal exercise continuously as reported in ambulatory subjects (22,26). But, with one possible exception (24), no exercise-training protocol tested has been able to maintain muscular strength or aerobic work capacity at ambulatory-control levels during prolonged bed rest (15,18,25). Kakurin et al. (24) reported that performance of a variety of isometric, isokinetic, and isotonic exercise regimens "... preserved the strength of the flexor and extensor muscles (10 groups of muscles were tested), as well as physical fitness of all subjects according to the test on a bicycle ergometer," but no data were presented.

Therefore, a major 30-d bed-rest project (9) was conducted at Ames Research Center in 1986 to evaluate high-intensity and relatively short duration, alternating, high- and low-intensity cycling isotonic exercise (ITE) and intermittent resistive isokinetic exercise (IKE) training regimens that were designed to maintain ambulatory aerobic (peak oxygen uptake) capacity (11), muscle mass (5,17), and muscular strength and endurance (10) in men during prolonged bed-rest deconditioning. A secondary purpose was to determine the effect of these training regimens and no exercise (NOE) on post-bed-rest proprioception (2,3), psychological performance and mood (4), vascular volume, and water balance (19), and orthostasis (20). This paper discusses salient findings from this bed-rest project.

METHODS

Subject selection. Candidates had to: (a) be male, 32-42 yr old; (b) be a nonsmoker for at least 10 yr and no history of nonmedical drug use; (c) pass a comprehensive medical examination that included their history, blood and urine analysis, and a treadmill test; (d) be at least moderately physically fit, i.e., a maximal aerobic capacity of at least 35 ml O₂·min⁻¹·kg⁻¹ body wt; and (e) be psychologically fit as determined by the screening process described below. The subjects provided informed consent, and the project was approved by the Human Research Institutional Review Board at Ames Research Center. Over 2,000 applicants responded by telephone to a newspaper advertisement requesting volunteers for a NASA study. Over 500 candidates were interviewed by two experienced personnel specialists for a healthy and physically fit appearance, friendliness, good social skills, self-reliance, good sense of humor, and a high degree of motivation. The men, with a few exceptions, were selected immediately after their interview and most rejections resulted from a candidate’s decision to withdraw. Twenty-seven candidates participated in the orientation (training) phase of the study and only 19 entered and completed bed rest. Personal interview and observation were more reliable indicators of adaptability to these bed-rest studies than standard personality tests, which were not used.

Nursing staff selection and duties. A head nurse and two nursing aides worked each 8-h shift. The nursing staff was responsible for transporting subjects to test sites, the horizontal shower, and telephone; maintaining hygiene; providing food, massage, and medical care; and supporting subjects’ needs within the constraints of the protocol. The nursing staff was the primary source of social contact between others and the subjects who were supervised 24 h⁻¹.

Human research facility (HRF). This study was conducted in the Ames Research Center’s 12-bed HRF. While in bed each subject was provided with reading material (books, magazines, and newspapers), games, AM/FM radio, and videocassette movies via color television mounted on the ceiling; remote controls and headphones permitted privacy and individual selection of radio and TV reception.

Subject group allocation. The nineteen men, aged 32-42 (36± SD 4yr) were allocated selectively into three treatment groups (Table 1): no exercise training control (NOE, N=5), isotonic exercise training (ITE, N=7), and isokinetic exercise training (IKE, N=7) on the basis of age, height, weight, peak oxygen uptake, and isokinetic knee strength, in that order of priority. Testing was done in two phases that began June 30, 1986 (4 NOE, 4 ITE, and 4 IKE subjects), and August 18, 1986 (1 NOE, 3 ITE, and 3 IKE subjects).

TABLE 1. Anthropometric and physiologic baseline data for the three groups.

| Diet, body weight, and vital signs. The diet of fresh and frozen foods consisted of 17 different daily menus which provided 113 ± SE 2 g(20%) protein, 362 ± 7g (62%) carbohydrate, and 101 ± 2 g (18%) fat (19). Mean (± SD, N=19) daily consumption of some basic minerals during the 7-d ambulatory and 30-d bed-rest periods were: Ca (1,288 ± 53 and 1,296 ± 75 mg·d⁻¹), P (1,137 ± 53 and 1,856 ± 104 mg·d⁻¹), Na (5,626 ± 172 and 5,442 ± 495 mg·d⁻¹), respectively. The mean daily intake of these dietary components was not significantly different but was varied: calcium (1,000-1,900 mg·d⁻¹), phosphorus (1,450-2,700 mg·d⁻¹), respectively, and, near the end of bed rest, sodium intake was reduced to slightly less than 5 g for 2 d. The planned caloric intake was 2,800 kcal·d⁻¹ for the NOE control group, and 3,100 kcal·d⁻¹ for the ITE and IKE groups; but the measured mean± SE daily caloric consumption was 2,678 ± 75 kcal·d⁻¹ (NOE), 2,833 ± 82 kcal·d⁻¹ (ITE), and 2,890 ± 75 kcal·d⁻¹ (IKE), which resulted in mean± SE weight change during bed rest of -1.01 ± 0.81 kg, -0.85± 0.59 kg, and 0.00 ± 0.52 kg, respectively. |
| Experimental protocol. The wide range of tests. During bed rest the two exercise groups participated in the twice-daily 30-min exercise-training regimens. All three groups underwent maximal isokinetic (ITE) and isokinetic (IKE) exercise testing once per week and had weekly blood sampling and cardiac output and ultrasound measurements. During pre- and post-bed-rest periods all subjects underwent measurement of posture, equilibrium, gait, orthostatic tolerance, body density via water immersion, and arm and leg P-31 magnetic resonance spectroscopy (University of California-San Francisco Medical School), leg magnetic resonance imaging (University of California-San Francisco Radiology Imaging Laboratory), and radius and lumbar spine density (Diagnostic Nuclear Medicine Clinic, San Francisco). All subjects received 15-min psychological performance and mood tests at least once each day throughout the 41.5-d.

| The subjects were restricted to the horizontal or 6° head-down position during bed rest for testing, excretory functions, and showering; they were allowed one pillow, lateral and rolling movement, and to rise on one elbow to eat. They interacted freely with staff, investigators, and visited other subjects via gurney. Recreational activities (e.g., hobbies, stereo, playing musical instruments) were permitted. |
| Peak oxygen uptake. Peak oxygen uptake (·VO₂max) was measured six times before the ambulatory control test on day 6 and four times during bed rest at weekly intervals with an abbreviated protocol to minimize training effects (11). |
| Isokinetic exercise training protocol and testing. Subjects in the ITE group exercised in the supine position for 30 min in the a.m. and p.m. (11). The daily supine isokinetic cycle ergometer exercise training (Quinton model 846T, Seattle WA) consisted of 7-min warm-up at 40% of peak oxygen uptake followed by 2 min of exercise at 60%, 70%, 80%, 90%, and 80% and loads with each separated by 2-min at the 40% load. The ambulatory control exercise loads were used throughout bed rest. |

| Isokinetic exercise testing involved five maximal leg flexions and extensions through a 90° to 100° arc performed in 10 s (velocity 100°·s⁻¹) followed by 50-s rest for a total of 10 sets in 10 min for each leg. The weekly peak test was one set. Shoulder/arm peak strength and endurance using abduction and adduction toward the sagittal plane were measured weekly (10). Peak isokinetic testing was performed weekly (days 6, 13, 20, 28) during bed rest in all three groups. |
| Isokinetic proprioceptive and training testing. The 2.5-min warm-up and cool-down periods for isokinetic exercise were devoted to proprioceptive training (PT) with both extension and flexion of the right knee with only the IKE group (2). The other two groups performed this 2.5-min routine weekly as a test during the warm-up period of the muscular
Orthostatic (tilt-table) tolerance. Orthostatic testing was performed on ambulatory control day -7 and bed-rest day 30[20]. This was the first occasion the subjects were upright (head-up) after bed rest. The protocol consisted of 45 min in the horizontal supine position before the pre-bed-rest tilt test, and the subjects were in the 6° head-down supine position before the post-bed-rest test. They were tilted 60° head up within 10-15 s, remained in that position for 60 min or until onset of presynopal signs and symptoms (e.g., nausea, dizziness, sweating, lightheadedness, or tunnel vision), and had at least 10 min of recovery in the 6° head-down position. An antecubital vein was catheterized 45 min before tilt. Plasma volume was measured between -15 and -5 min of the control period with a standard Evans blue dye (T-1824) dilution technique[13]. When tilted, the subject stood on a pillow placed on a 7-cm foam cushion on the footboard. The subject, under constant observation, was instructed to remain quiet and relaxed without overt muscular contraction. Heart rate and blood pressures were taken periodically during the control and tilting periods.

Rest and submaximal isotonic exercise metabolism and cardiac output. These two variables were measured in the same testing session in supine postabsorptive subjects after 30 min rest. Rest oxygen uptake and cardiac output (\(\dot{V}O_2\)) were determined in all groups on ambulatory control day -2 and bed-rest day 25. Submaximal exercise metabolism and \(\dot{V}O_2\) were measured in all test groups on control day -2, but only in the two exercise groups on bed-rest days 4, 11, and 25 so as to not further compromise the control status of the no-exercise group. (The NOE group performed peak isotonic and peak isokinetic exercise only weekly during bed rest). The submaximal exercise load was established during the 20-min exercise period on ambulatory control day -2 in the exercise groups and used thereafter; the mean relative oxygen uptake on day -2 was 62 ± SE 2% (ITE) and 60% ± 3% (IKE). Cardiac output was measured in quadruplicate from 10-15 min of submaximal exercise with the indirect Fick \(\dot{CO}_2\) rebreathing method[23].

Statistical analysis. Statistical tests used and additional information are given in the published papers[2-5,10-12,14,17,19,20].

RESULTS

Basal vital signs were normal and virtually unchanged during bed rest: blood pressure averaged about 118/80 mm Hg, pulse rate 60 beats·min\(^{-1}\), respiratory rate 12 br·min\(^{-1}\), and oral temperature 36.3° C (Fig. 1).

Mean absolute and percent change (ambulatory control to the end of bed rest) of all major tests and measurements for the three groups are presented (Table 2).

TABLE 2. Mean absolute and percent change (end bed rest vs. ambulatory control) in physiological, performance, and mood variables for the three groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ambulatory Control</th>
<th>Bed Rest</th>
<th>Percent Change</th>
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<tbody>
<tr>
<td>Anthropometry</td>
<td>Decreased lean body mass (Table 2) was accompanied by increased fat mass with NOE and IKE; both lean body and fat mass tended to decrease with ITE probably as a result of the increased exercise metabolism (19).</td>
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<tr>
<td>Fluid volumes</td>
<td>The normal decrease of plasma, red blood cell, and total blood volumes after bed rest was greatly attenuated (<em>P &lt; 0.05</em>) with ITE training when compared with the response of NOE and IKE training (Table 2, Fig. 2). Voluntary fluid intake varied from 1.6 to 2.2 l·24 h(^{-1}) among the three groups; NOE was lowest (%(DELTA) = 2.4%) while IKE and ITE were higher (%(DELTA) = 8.1 and 9.8%, respectively) presumably to replace exercise sweat and respiratory water loss (Table 2). The increased fluid intake and attenuated urinary output with isokinetic exercise resulted in a greater positive water balance throughout bed rest when compared with the lesser positive IKE balance and the negative NOE balance (Fig. 3). The positive water balance in all groups in the first 3 d of ambulatory recovery indicated replacement of lingering fluid deficit, partially from bed rest, and also from assumption of the upright posture with increased fluid filtration into the interstitial space of the lower extremity (19).</td>
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<tr>
<td>Metabolism</td>
<td>Rest metabolic rate varied from -0.3 to 0.1 l·min(^{-1}) (NS) and rest heart rate varied from 2 to 6 beats·min(^{-1}) (NS); both ranges were within the error of measurement (Table 2). Rest (\dot{V}O_2) was unchanged during bed rest with NOE and IKE, but it was reduced by 1.27 l·min(^{-1}) with isotonic exercise (Table 2, Fig. 4).</td>
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Figure 1-Mean daily resting vital signs for the three groups during ambulatory control (AC), bed rest (BR), and ambulatory recovery (AR) periods. From reference 11: Greenleaf, J. E., E. M. Bernauer, A. C. Ertl, T. S. Trowbridge, and C. E. Wade. Work capacity during 30 days of bed rest with isotonic and isokinetic exercise training. J. Appl. Physiol. 67:1820-1826, 1989.

Figure 2-Mean (±SE) percent change in plasma, red cell, and total blood volumes for the three groups during AC (day-7) and BR (day 8 and 30) periods. *P < 0.05 from zero. From reference 19: Greenleaf, J. E., J. Vernikos, C. E. Wade, and P. R. Barnes. Effect of leg exercise training on vascular volumes during 30 days of 6° head-down bed rest. J. Appl. Physiol. 72:1887-1894, 1992.

Figure 3-Mean daily body weight and daily fluid balance (fluid intake minus urinary volume) for the three groups during AC, BR, and AR periods. Body wt: solid line is mean (\(N = 19\) weight). Fluid balance: dashed line and solid horizontal lines (other than zero lines) represent mean level for that period. *P < 0.05 from ambulatory control day-1; † \(P < 0.05\) from bed rest day 30. From reference 19: Greenleaf, J. E., J. Vernikos, C. E. Wade, and P. R. Barnes. Effect of leg exercise training on vascular volumes during 30 days of 6° head-down bed rest. J. Appl. Physiol. 72:1887-1894, 1992.
Submaximal exercise oxygen uptake was depressed by 7-10% with the two exercise regimens (14), which was accompanied by corresponding reduction in $Q_c$ of 15-20% (Table 2, Fig. 4).

Peak oxygen uptake was maintained during bed rest with isotonic exercise, while it decreased ($P < 0.05$) on bed-rest day 29 by 18% (7.9 ml·kg$^{-1}·$min$^{-1}$) with NOE and by 9% (4.1 ml·kg$^{-1}·$min$^{-1}$) with IKE (Table 2, Fig. 5). The elevated peak heart rate and trend toward increased peak exercise load (Table 2) and peak oxygen uptake of 4% on bed rest day 29 (Fig. 5), together with the 18% reduction in peak oxygen uptake with NOE, indicates a restoration (increase) of about 22% in peak oxygen uptake after 29 d of bed rest with intensive daily isotonic exercise training (11).

**Muscular strength.** There was no significant change in shoulder or knee flexion and extension strength (peak torque) during bed rest although the increase in isokinetic exercise knee extension torque of 10% was greater than that with ITE (%$\Delta$ = -2%) but not with NOE of -10% (Table 2). Isotonic leg exercise training appeared to provide for some strength maintenance of the knee extensor muscles during bed rest. Shoulder peak torque tended to increase (NS) in all groups by 13-22% (10).

**Muscular endurance.** Shoulder and knee flexion endurance (total work) were unchanged during bed rest although the change in isokinetic exercise knee flexion total work of 6% was less than that with ITE (%$\Delta$ = -13%) or NOE of -19% (Table 2). Leg extension endurance was increased by 27% ($P < 0.05$) with isotonic exercise and decreased by 5% with ITE and by 16% with NOE (Table 2). Again, isotonic leg exercise training attenuated loss of knee flexion and extension endurance when compared with comparable NOE endurance. Shoulder total work tended to increase in all groups by about 8% (10). Thus, normal use of the arms during bed rest in healthy subjects probably maintained shoulder muscular strength and endurance.

**Muscle thickness and volume.** Thickness (from ultrasonography) of the two-joint rectus femoris muscle decreased by 10% with NOE and was unchanged with both ITE and IKE (Table 2). Vastus intermedius (one-joint) muscle thickness decreased by 18% with NOE and by 13% with IKE but was unchanged with isotonic exercise. Thickness of the posterior leg muscle group (soleus, flexor hallucis longus, tibialis posterior) decreased by 9-13% in all groups (Table 2). Thus, isokinetic leg knee exercise attenuated only rectus femoris atrophy, but not atrophy of the vastus intermedius or posterior leg groups, while isotonic leg exercise training attenuated atrophy of both rectus femoris and vastus lateralis muscles, but not the posterior group (5). Therefore, different types of exercise can change specific muscle group strength and endurance responses during bed rest.

Volume of a somewhat expanded posterior leg muscle group (now comprising the soleus, flexor hallucis longus, tibialis posterior, lateral and medial gastrocnemius, and flexor digitorum longus), measured with magnetic resonance imaging, decreased similarly in all groups from 4 to 8% (Table 2). Posterior leg muscle volume (pixels) was correlated highly with thickness (cm) with ITE ($r = 0.79$, $P < 0.05$), but not with IKE ($r = 0.27$, NS) or with NOE ($r = 0.63$, NS) (17).

**Orthostatic tolerance.** Average orthostatic (60° head-up tilt) tolerance decreased by 19-43% ($P < 0.05$) among all groups (Table 2, Fig. 6). There was no effect of the exercise-training regimens or no exercise on the characteristic reduction in orthostatic tolerance after bed-rest deconditioning in spite of plasma volume maintenance in the isotonic exercise group (20).

**Proprioception.** Knee flexion and extension proprioception scores for both exercise groups were increased by 4-7% ($P < 0.05$) after bed rest; those with NOE were unchanged (Table 2). The isokinetic group practiced the proprioception test during bed rest while the other groups did not.

**Performance.** Test subject self-rated performance and composite performance test proficiency increased in all groups, while individual test performance increased in 7 of 10 tests (a-e, g, i) during bed rest (Table 2, Fig. 7). There were no consistent differences between the three groups, but reasoning (REASON) accuracy with NOE was greatly elevated over those of IKE and ITE (Fig. 7). Other exceptions were no change in (f) Sternberg short-term memory (NOE), no change in (h) two-finger tapping (ITE, IKE), and no change in (j) simple reaction time (ITE, IKE). Number of sleep awakenings was increased ($P < 0.05$) in all groups (Fig. 8), but more with isotonic exercise (48% increase) when compared with NOE or IKE (4).

| Table 2 | Fig. 7 | P < 0.05 from zero; $\dagger P < 0.05$ from corresponding NOE change; $\ddagger P < 0.05$ from corresponding ITE change. From reference 14: Deroshia, C. W. and J. E. Greenleaf. Performance and mood-state parameters during 30-day 6° head-down bed rest with exercise training. Aviat. Space Environ. Med. 64:522-527, 1993. |
DISCUSSION

Intensive, intermittent exercise training is not a new concept(22,26), but it does not appear to have been used in prior, prolonged bed-rest studies(15,18,25). Only Kakurin et al.(24) commented that muscular strength and physical fitness (presumably aerobic capacity) were "preserved" on a 3-d exercise and 1-d rest cycle during a 49-d 4° head-down bed-rest study; but no data were given.

The basic premise for the design of the present exercise training regimens was that muscular contraction and accompanying increased metabolism induced stimulation for the adaptation (training) effect that occurred in the recovery intervals during the exercise periods and between the two 30-min daily exercise sessions. The sessions were designed to be of near maximal intensity and were to provide optimal stimulation while allowing sufficient recovery intervals to obviate excessive fatigue and injury. Only two subjects in the middle of bed rest had alterations in their prescribed exercise program because of muscular problems: one ITE subject reduced his training intensity to 40% of peak O2 uptake on three consecutive sessions because of calf muscle strain, and one IKE subject canceled two consecutive sessions because of leg muscle pain(11). The decreased ability to concentrate and reduction in sleep quality in the isotonic group suggested some chronic fatigue. Thus, it appears that the ITE subjects and some IKE subjects were near their limit of effective physiological training performance, which was a design criterion. Clearly, these various physiological and psychological findings apply mainly to middle-aged (32-42 yr old) men.

The new findings were that intermittent, high-intensity, isotonic lower extremity exercise training maintained aerobic capacity and plasma volume at pre-bed rest control levels, but had no effect on the usual significant reduction in orthostatic tolerance after prolonged bed rest exhibited by all three treatment groups in which two had aerobic capacity and plasma volume reduced significantly. This suggests that neither intensive training nor maintenance of plasma volume alone has a significant effect on orthostatic tolerance after bed rest. It appears that maintenance of orthostatic tolerance cannot be attributed to any single variable and is likely multifactorial. But in ambulatory subjects, total body dehydration and accompanying hypovolemia have been associated with lower orthostatic tolerance, and level of aerobic capacity is not always associated with the level of orthostatic tolerance(7).

The isotonic training regimen without proprioceptive practice provided for some maintenance of leg proprioceptive response and knee extension muscular strength and endurance, probably from the isometric-isokinetic component at the higher intensities which should facilitate reambulation immediately after bed rest(2,3). However, it is clear that specific isokinetic and proprioceptive training were better for maintaining and increasing muscular strength and endurance and proprioceptive response as would be expected. As with normal ambulatory exercise training programs, the physiological responses are exercise specific, but there was more crossover with the isotonic regimen which would make it the training regimen of choice if only one mode of exercise were available.

The exercise training regimens used in this study represent an upper adaptive limit during the deconditioning of bed rest. They may not be ideal for use with hospitalized patients in this form, but the basic concept of intensity and intermittency may be useful to save patients from hours of boring exertion. There have been few if any controlled bed rest studies using injured or diseased patients. The effect of bed-rest deconditioning without and with moderate exercise training on immune system function is virtually unknown(16).

When appropriate data from these patients become available, it will be possible to prescribe definitive exercise and orthostatic (body tilting) regimens that should not only enhance normal ambulatory exercise training programs, the physiological responses are exercise specific, but there was more crossover with the isotonic regimen which would make it the training regimen of choice if only one mode of exercise were available.

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ISOTONIC EXERCISE; ISOKINETIC EXERCISE; PLASMA VOLUME; ORTHOSTATIC TOLERANCE; METABOLISM; PSYCHOLOGICAL PERFORMANCE

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The resultant deconditioning caused by bed rest can be independent of the primary disease and physically debilitating in patients who attempt to reambulate to normal active living and working. A challenge to clinicians and health care specialists has been the identification of appropriate and effective methods to restore physical capacity of patients during or after restricted physical activity associated with prolonged bed rest. The examination of physiological responses to bed rest deconditioning and exercise training in healthy subjects has provided significant information to develop effective Deconditioning: the consequence of bed rest. Objectives. Look at the patient lying alone in bed. What a pathetic picture he makes. The blood clotting in his veins. The lime draining from his body. Deconditioning: A Clinical Entity. Adverse Clinical Manifestations. Levels of Deconditioning. Staircase to dependence. Common Causes of Immobility. Intensive exercise training during bed rest attenuates deconditioning. Article. Mar 1997. These findings suggest that various elements of the deconditioning syndrome can be manipulated by duration and intensity of ITE or IKE training regimens and that several different training protocols will be required to maintain or restore physiological and psychological performance of individuals confined to prolonged bed rest.