WADD TECHNICAL REPORT 61-257

PHYSIOLOGIC EFFECTS OF A HYPODYNAMIC ENVIRONMENT SHORT TERM STUDIES

Duane E. Graveline, Capt., USAF MC
George W. Barnard, Capt., USAF MC

Biomedical Laboratory
Aerospace Medical Laboratory

MARCH 1961

WRIGHT AIR DEVELOPMENT DIVISION
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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NOTICES

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Task No. 71745

WRIGHT AIR DEVELOPMENT DIVISION
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FOREWORD

This study was performed under Project Number 7222, "Biophysics of Flight," Task Number 71745, "Psychophysiology in Flight," by the Psychophysiologic Stress Section, Biophysics Branch, Biomedical Laboratory. This study began in November 1960 and was completed in January 1961.

ABSTRACT

By a technique involving complete immersion in water, a hypodynamic situation was produced in which normal weight sensations were altered and movement was relatively effortless. Four subjects were evaluated after 6, 12, and 24 hours of this envionment. Tilt table, centrifuge, and heat chamber studies demonstrated significant cardiovascular deterioration even after the 6-hour runs, becoming progressively more severe with the 12- and 24-hour experiments. Pertinent psychomotor evaluations, anthropometric measures, and urine and blood studies also were done. The results of this study indicate that the cardiovascular adaptation to a hypodynamic environment of this type occurs early and the deterioration from even a 6-hour exposure is readily apparent.

PUBLICATION REVIEW

E. L. deWilton

E. L. deWILTON, CAPT, MC, USN
Acting Chief, Biomedical Laboratory
Aerospace Medical Laboratory

PHYSIOLOGIC EFFECTS OF A HYPODYNAMIC ENVIRONMENT SHORT TERM STUDIES

INTRODUCTION

Man having been accustomed to the gavitational field of the Earth will find that the muscular efforts, consciously or subconsciously needed in normal life, will be greatly reduced in a weightless existence. Muscular tone previously required to maintain, for instance, the erect posture in a 1-g environment will be diminished considerably. Although a certain amount of energy will be expended in manipulating controls and overcoming inertial effects, the energy expenditure will be much less than similar activity under normal gravitational conditions. Under these conditions, it is probable that muscular hypotonicity and atrophy will occur. Also, certain cardiovascular changes due to both lack of normal muscular tone and altered hydrostatic influences may become evident. Such changes could seriously interfer with man's ability to tolerate reentry stresses.

The study of hypodynamics deals with the metabolic and functional responses of the body to a state of relative muscular inactivity first by assessing qualitatively and quantitatively these responses, then by evaluating various preventive measures designed to protect the body against these debilitating adaptative changes.

This study involved the use of water immersion to approximate some of the hypodynamic effects of weightlessness. Supported by water, normal weight sensation is altered and movement is relatively effortless. That component of muscular activity previously used to compensate for one gravity is no longer actively utilized. Previous research in this area has evaluated the effects of similarly induced hypodynamic periods of 2 and 7 days duration on one subject (ref. 1). Marked debility was apparent after both time periods upon emersion from the hypodynamic environment and return to a normal gravitational situation. It is now timely and important to try to establish how long this type of environment can be tolerated before significant deconditioning occurs.

In this study, four subjects have been evaluated after 6, 12 and 24 hours of water immersion induced hypodynamics. Functional studies included tilt table and heat chamber tests, as well as to headward acceleration tests. Pertinent psychomotor tests and evaluations of muscle strength also were included.

METHODS

A tank was constructed to allow immersion of a subject in a semireclining position. Installation of a form-fitting couch insured a stable position to which the subject, if he so desired, could attach himself using a seat belt. The water was maintained at a constant temperature of 33.5 degrees C. The subject, clad in a rubber suit of conventional SCUBA design and wearing a modified partial pressure type helmet, was completely immersed in the water to a depth of approximately 18 inches. A pressure regulator was installed in the outflow line of the helmet air and was adjusted so that respiration was optimally balanced. With the resultant specific gravity of the subject being very close to 1, movements of the trunk and extremities were relatively effortless. Modifications in the suit and helmet permitted ad lib liquid intake and continuous urine collection.

Four healthy male subjects were used ranging in age from 23 to 33 years and in state of physical conditioning from a very well conditioned athlete (subject No. 1, mile time was 4 minutes 32 seconds) to a sedentary mildly obese type with slight to no participation in strenuous sports (subject No. 4).

Functional studies before and after the 6-, 12-, and 24-hour periods of water immersion included heat tolerance, response to headward acceleration and orthostatic tolerance studies. Heat tolerance was assessed using the heat chamber at 71.1 degrees C., 10-mm. Hg. vapor pressure water for 1 hour or until a critical pulse rate of 150 beats per minute was reached. Measures of orthostatic tolerance were obtained using the tilt table with a 90-degree tilt for 12 minutes. During this time a standard three lead ECG was obtained and blood pressure values were recorded at minute intervals. Psychomotor measures consisted of a stylus-in-hole type of task done under varying degrees of headward acceleration. The accelerative profile during these performance runs began with 1-radial g for 1 minute, then immediately to 1-1/2-radial g for 1 minute, etc., up to 3 g. During this time the subject was responding to a randomly administered signal light by inserting a metal stylus into a metal receptacle located on the control panel at arms length. In this manner both response times at each g level and error signal (contact with sides of the receptacle) were obtained to allow some estimate of arm strength and coordination under dynamic conditions. During all centrifuge runs continuous ECG values were obtained. In addition to the performance profile, a blackout run was made on each subject using 0.1 g per second rate of onset and response to center light as the end point.

In order to objectively assess any changes that might occur in the contractile strength of selected muscle groups, a series of seven-strength tests were administered during the course of this investigation. The tests were grip strength, hip extension, hip flexion, trunk extension, neck extension, knee extension, and knee flexion. These tests include the main anti-gravity groups of muscles. The S. A. M. (School of Aviation Medicine) Complex Coordinator also was used as an indicator of overall neuromuscular coordination. Additional studies included complete blood count (CBC), hematocrit, urine volume and urine specific gravity determinations.

After the subject emerged from the tank, five cc of blood were drawn and the various functional tests were administered in the following sequence:

1. Tilt table test
2. Headward acceleration response test
3. Heat tolerance test
4. Muscle strength measurements
5. SAM complex coordination test

the sequence remained the same throughout this study.

RESULTS

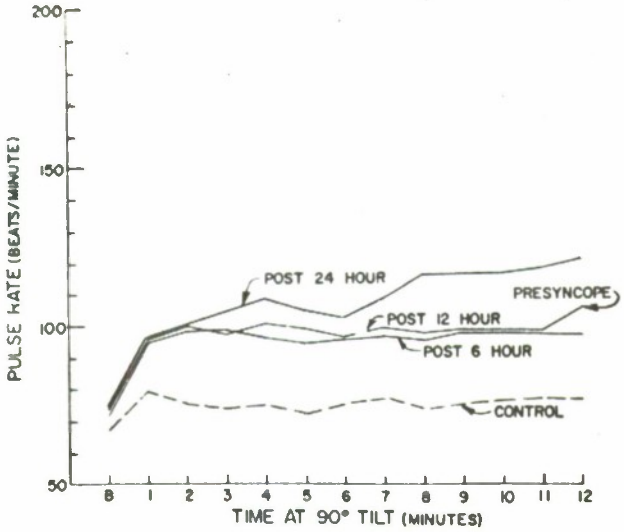
Cardiovascular System

The pulse rate response to tilt table testing are shown in figure 1. After 6-hour run, a considerable increase in pulse rate reflecting altered response to orthostasis was apparent in all four subjects. The tachycardia was progressively more severe following the 12- and 24-hour experiments.

The blood pressure responses of the four subjects to tilt table testing are shown in figure 2. The decreases in pulse pressure secondary to decreases in the systolic level and/or increases in the diastolic level were readily apparent even after the 6-hour stuides. Following the 24-hour runs, these decreases were quite extreme, with pulse pressures in the range of 2 to 6 mm. Hg. The standard clinical auscultatory technique of blood pressure determination was used throughout this study. Following the 24-hour run, Subject No. 1 experienced syncope at the 10th minute of the tilt table test with a pulse rate of 184 and blood pressure of 98/96.

These pulse rate and blood pressure responses reflected significant alteration in those cardiovascular reflexes necessary for adequate circulation in the erect posture.

Although all subjects show the same general pattern of response, individual differences were noted especially with regard to subject No. 3. This individual did not participate in strenuous sports or in programmed exercises, but is of a hyperkinetic nature and had what appears to be a bradycardia reflecting considerable vagal activity. The control cardiovascular stress tests induced unusually small heart rate increases. in the subject. Assuming cardiac output was maintained, it must be primarily through increasing stroke volume with less input from heart rate increases than was seen in the other more typical subjects.



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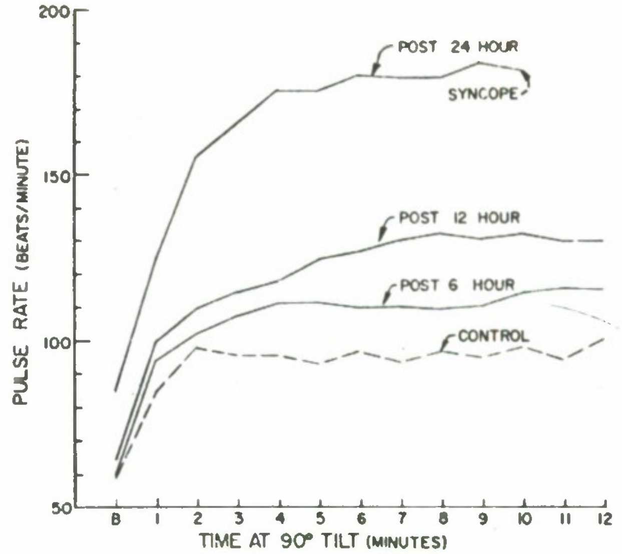

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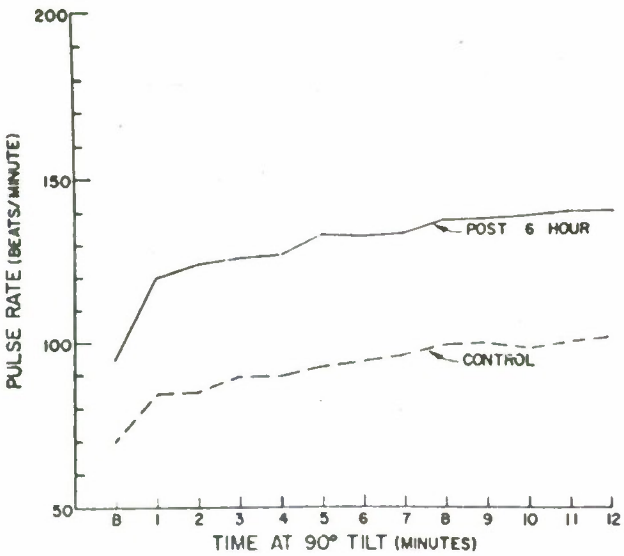

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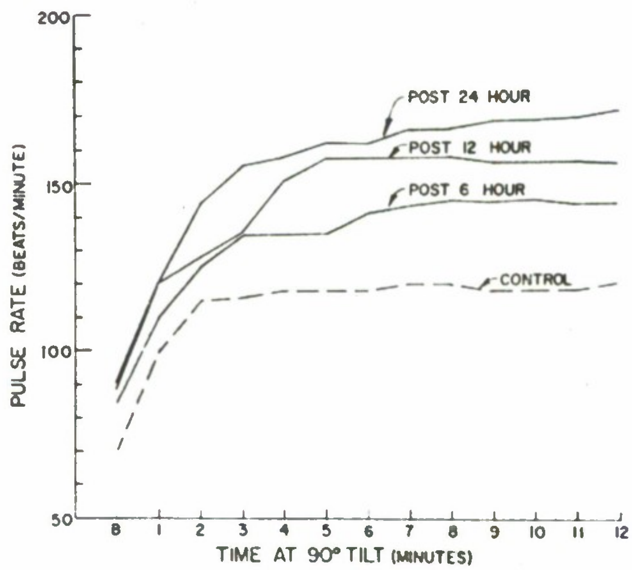
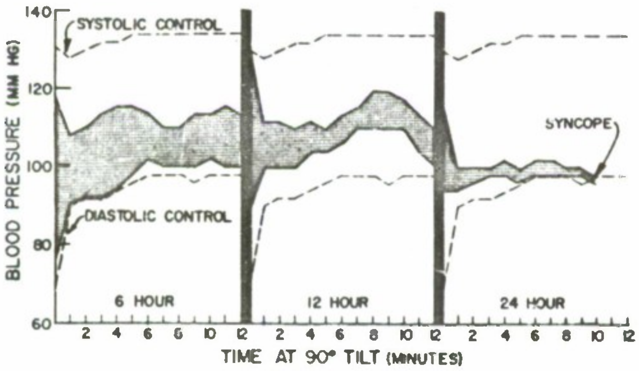


Subject 4

Figure 1. Pulse Rate Response to Tilt Table Testing. Baseline Rate B is Obtained While the Table is Horizontal, Before Being Tilted to 90 Degrees.

The pulse rate responses to heat chamber tests is shown in figure 3. A rate of 150 beats per minute was chosen as the critical cutoff at which point the run would be terminated. Prior to the hypodynamic deconditioning, all subjects found the 50 to 60 minute control runs readily tolerable with moderate pulse rate increases. Heat intolerance expressed as increased pulse rate response to the same heat stress was evident in all subjects after the 6- hour studies and became progressively more apparent with the 12- and 24-hour runs.



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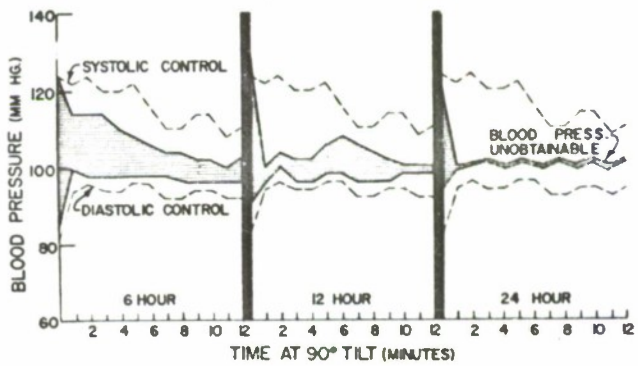

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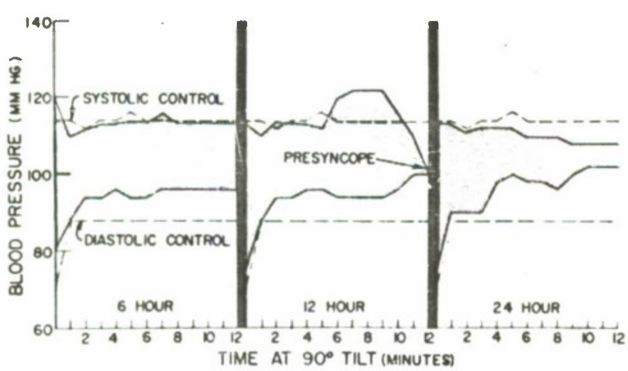

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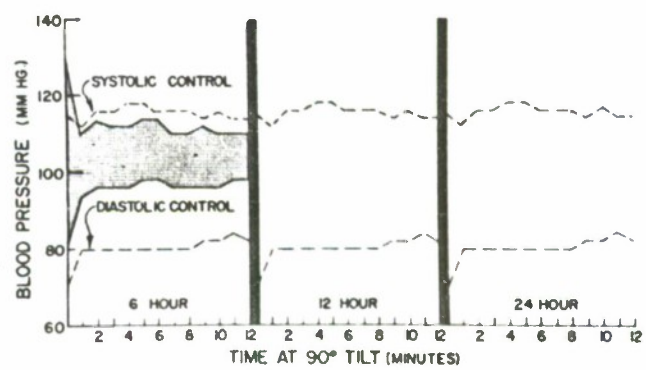
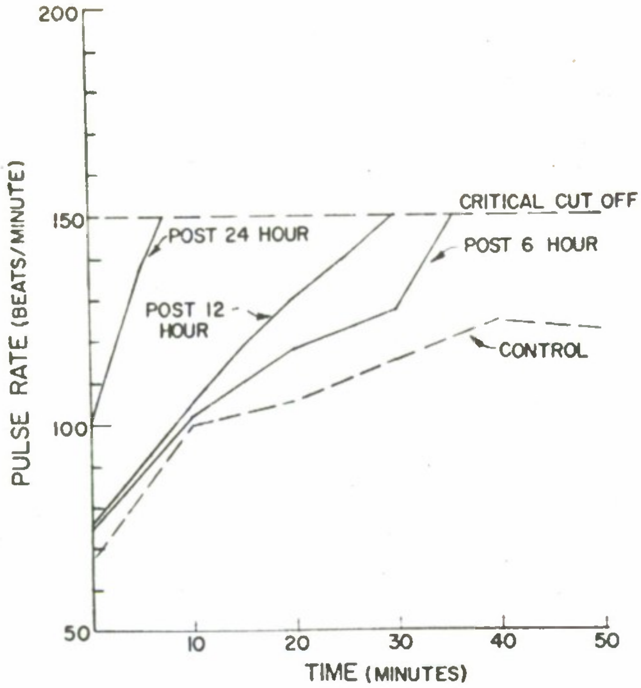


Subject 4

Figure 2. Blood Pressure Response to Tilt Table Testing Demonstrating the Decrease from Control Systolic Pressures (top dotted line) and/or Increase over Control Diastolic Pressures (bottom dotted line)



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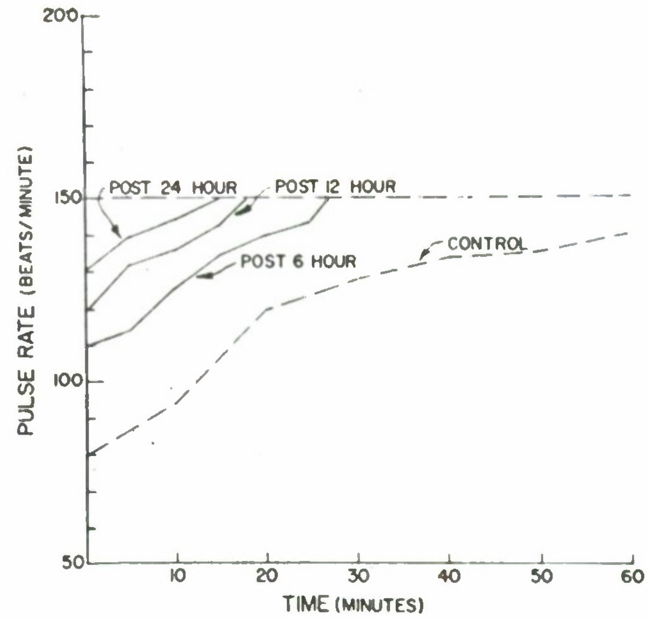

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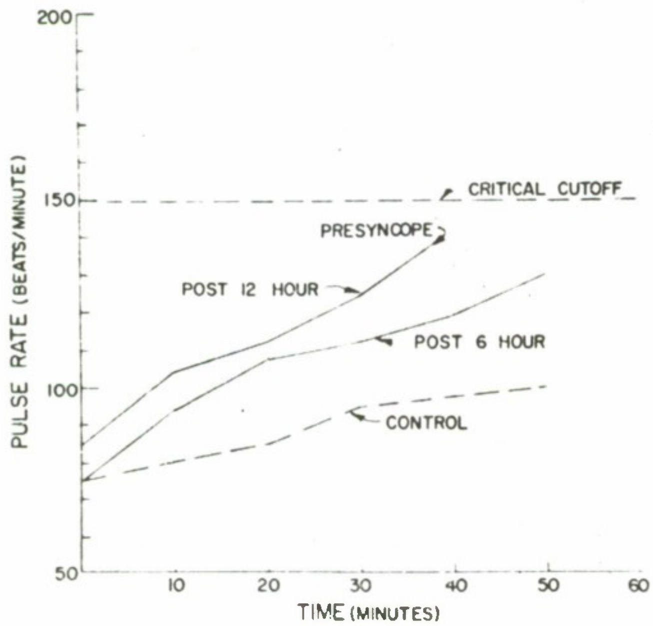

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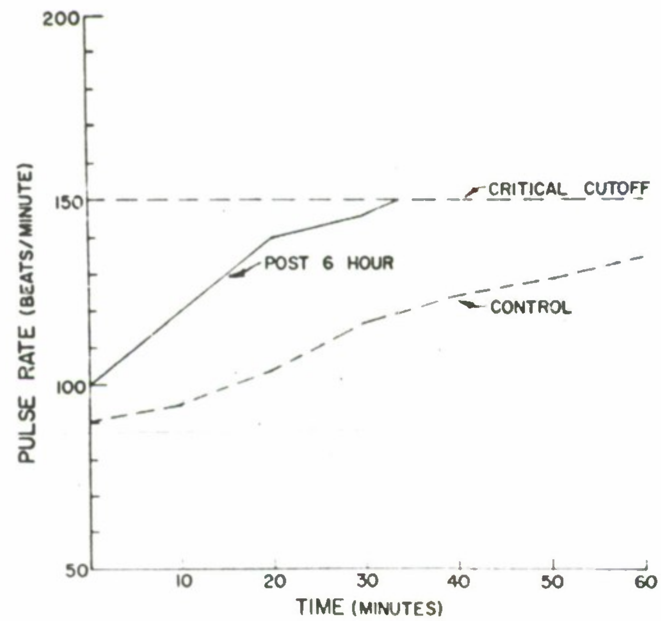

Subject 4

Figure 3. Pulse Rate Response to Heat Chamber Testing Demonstrating the Progressively Increased Rates Over Control Rates (dotted line) for the Same Heat Stress

Table I records the pulse rate response to headward acceleration. These rates were taken from a modified Lead II ECG, which monitored each subject continuously during centrifugation. After hypodynamic deconditioning, the pulse rate response to the higher g loads was much greater than the control values. This altered response was apparent even after the 6-hour studies and reflects decreased capacity for adequate cardiovascular support during accelerative stress.

PULSE RATE RESPONSE TO HEADWARD ACCELERATION AFTER THE 6-, 12- and 24-HOUR STUDIES

Subject		Constant g Runs					Blackout Runs	
		1 g	1.5 g	2.0 g	2.5 g	3.0 g	2 g	4 g
1	control av.	113	87	100	105	105	136	154
	post 6 hr.	96	88	108	116	132	104	152
	post 12 hr.	112	108	124	144	160	136	168
	post 24 hr.	112	112	116	156	164	120	152
2	control av.	108	108	117	125	140	136	168
	post 6 hr.	-	-	-	-	-	126	150
	post 12 hr.	108	116	124	148	176	128	152
	post 24 hr.	116	132	148	173	184	128	154
3	control av.	96	96	96	106	112	112	137
	post 6 hr.	98	112	112	120	152	132	161
	post 12 hr.	110	110	112	134	152	121	144
	post 24 hr.	-	-	-	-	-	-	-
4	control av.	96	96	96	112	116	120	152
	post 6 hr.	111	112	120	134	154	134	158
	post 12 hr.	-	-	-	-	-	-	-
	post 24 hr.	-	-	-	-	-	-	-

The blackout point of each subject during headward acceleration showed no significant change from control run values despite the presence of marked cardiovascular deterioration as evidenced by other more sensitive tests. Apparently blackout point alone is a fairly gross indicator of cardiovascular capability and from the results it may be inferred only that central arterial pressure was maintained. The reader must remember that approximately 35 minutes elapsed from emersion until centrifugation actually took place. During this time the subject was undergoing tilt table testing. Recent research into the hypodynamic area at Johnsville Naval Development Center indicated that immediate centrifugation after similar time periods of water immersion significantly decreased the level at which blackout occurred.

The electrocardiographic changes noted on subjects No. 2 and No. 4 upon emersion after just 6 hours of hypodynamic deconditioning are shown in figure 4. These were recorded during the 10th minute of tilt table testing and have been included to demonstrate rather interesting changes, which are of a transient nature and of no apparent clinical significance. In addition to orthostatic T wave changes, shifts in the QRS loop with the terminal electrical events directed more towards the right, and accentuation of the P waves which were noted in all subjects, subjects No. 2 and No. 4 demonstrated ST segment depression. Although these are of an obvious junctional nature in some leads, in others such as lead III, the configuration is that of a plateau-type depression which easily could be misinterpreted.

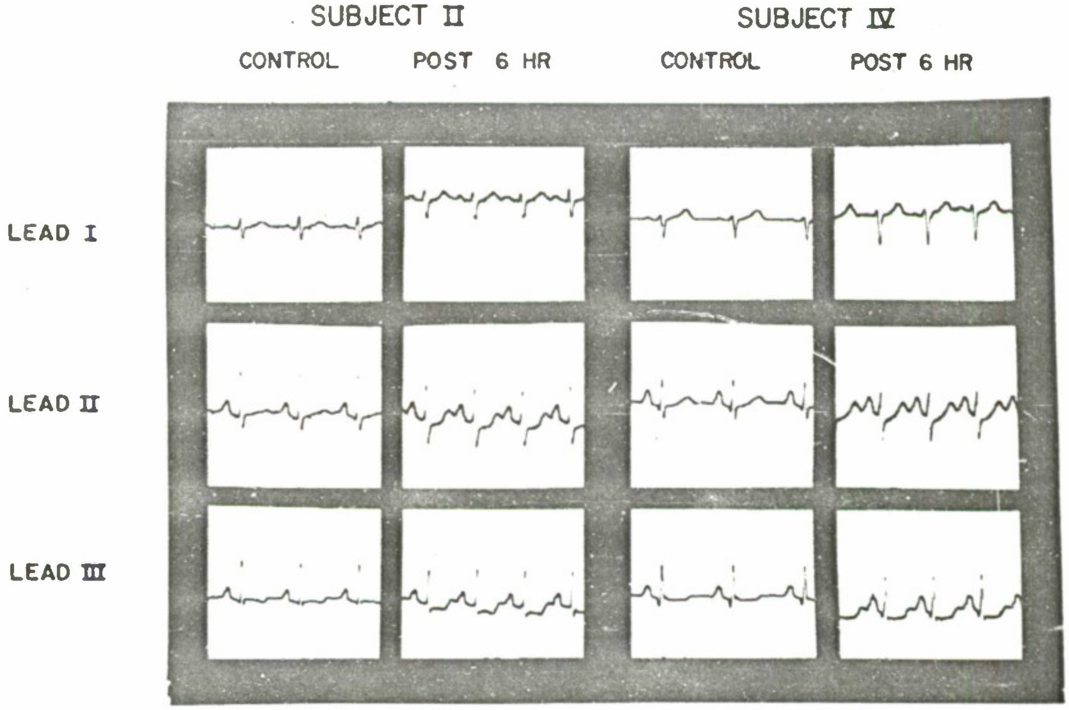

Figure 4. Electrocardiographic Changes Recorded During the Tenth Minute of Tilt Table Testing Demonstrating the Sinus Tachycardia, Alteration in the QRS Axis, Increased Amplitude of the P Waves, T Wave Changes and ST Segment Depression

Neuromuscular System

Although it was hypothesized that no significant changes in muscular strength would be revealed due to the relatively short periods of decreased muscular activity, slight trends were evident. For both subject No. 1 and No. 2, the results of the strength tests showed a progressive decrease in strength of some of the muscle groups as the duration of the water immersion periods increased; however, these changes were not statistically significant. Significant decrements in muscular ability may be revealed after longer exposures to a hypodynamic state.

The SAM Complex Coordination tester was used to evaluate the overall neuromuscular coordination of the subjects. It is a light matching task utilizing a control stick and rudder pedals so that simultaneous use of both upper and lower extremities is required to match the roll, pitch, and yaw lights. No evidence of significantly altered general coordination could be demonstrated by this test even after the 24-hour runs. The capability for neuromuscular performance of this type was maintained throughout the time periods used in this study, despite other evidences of general debility.

The more dynamic test of neuromuscular coordination, the "stylus in hole" task designed to evaluate upper extremity strength and coordination under gradually increasing g loads, showed only slight changes from control values. These small increases in response times and error signals noted on the high g loads especially after the 24-hour runs, although apparent in all subjects, were not of a sufficient degree to be significant. In general, the results of this test indicate that minimal, if any, performance decrement for this type of task resulted following the hypodynamic periods used.

Hematologic Findings

The red blood count and hematocrit showed considerable departure from control values in a response pattern similar for all four subjects. The blood drawn immediately upon emersion from the 6-hour runs showed significant decrease in these values. For example, subject No. 1 with control hematocrits of 44, 44, and 45 decreased to 37 with parallel red blood cell (RBC) changes. Subject No. 2 decreased from a control range of 47, 47, and 48 to 39 with parallel RBC changes, Following the 12-hour runs, the hematocrit values and RBC's of all subjects were in the control range. Following the 24-hour runs, the hematocrits values of all subjects were increased considerably with subject No. 1 rising to 53 and subject No. 2, to 55 with parallel RBC changes. In general, the blood picture of all subjects was that of an early hemodilution progressing to a terminal hemoconcentration.

Urinary Findings

All subjects had low specific gravity polyuria during the various water immersion periods; however, pronounced diurnal variation was evident. The experiment was designed so that all runs terminated at 0800 hours so that all functional testing was given at the same time of day. The 6-hour runs, therefore, began at 0200 hours; the 12, at 2000 hours the previous day and the 24-hours at 0800 the previous day. The urine output of all subjects during the nocturnal 6 hour runs was quite small, in the range of 300 to 600 cc with specific gravities of 1.003-1.007. Yet the outputs of these same subjects during the diurnal 6-hour periods were large, in the range of 1000 to 1400 cc with specific gravities of 1.001 to 1.003. This unexpected association with the normal diurnal variation in urine output was consistent for all subjects.

DISCUSSION

The results of this study demonstrate that even relatively short exposures to a hypodynamic environment of this type result in significant deconditioning. Evidence of cardiovascular deterioration readily apparent after the 6-hour tests became progressively more severe with longer exposure.

The physiologic adaptive processes leading to the observed deteriorative changes occurred early. It would be of interest to evaluate even shorter time periods than the 6-hour runs used in this study to determine the earliest point at which these debilitating changes can be demonstrated. After the initial phase, the rate of change slows, becoming more gradual. The cardiovascular changes observed after the 24-hour tests were comparable in degree to those resulting from the 7-day experiment (ref. 1).

If the obvious inferences of this type of hypodynamic deconditioning can be extended to the zero gravity environment, then man must be adequately protected even in orbital flights of only a few hours duration. The unprotected astronaut will adapt to the new set of environmental demands, and it is man's capacity for such adaptation which will compromise his biodynamic potential for reentry stresses.

Unusual urinary and hematological changes occurred. Because respiration was balanced to a very narrow range from optimal to a few millimeters Hg. positive pressure, it may be assumed that negative pressure breathing was not a causal factor. That the diuresis is somehow a function of ambient water pressure does not adequately explain the diurnal variation. More study is needed to clarify these areas.

REFERENCES

1. Graveline, D. E., E. Duane, and B. Balke, The Physiologic Effects of Hypodynamics Induced by Water Immersion, USAF School of Aviation Medicine Report 60-88, School of Aviation Medicine, Brooks Air Force Base, Texas, September 1960.

ADDITIONAL REFERENCES

1. Balke, B., Correlation of Static and Physical Endurance, Part I. A Test of Physical Performance Based on the Cardiovascular and Respiratory Response to Gradually Increased Work, USAF School of Aviation Medicine Project 21-32-004, Report No. 1, School of Aviation Medicine, Brooks Air Force Base, Texas, April 1952.

2. Deitrick, J.E., G.D. Whedon, and E. Shorr, "Effects of Immobilization Upon Various Metabolic and Physiologic Functions of Normal Men," Am. J. Med., 4: 3-36, January 1948.

3. Hartman, B., R.E. McKenzie, and D.E. Graveline, An Exploratory Study of Changes in Proficiency in a Hypodynamic Environment, USAF School of Aviation Medicine Report 60-72, School of Aviation Medicine, Brooks Air Force Base, Texas, July 1960.

4. Hartman, B., R.E. McKenzie, and D.E. Graveline, An Exploratory Study of Sleep Characteristics in a Hypodynamic Environment, USAF School of Aviation Medicine Report 60-68, School of Aviation Medicine, Brooks Air Force Base, Texas, October 1960.

5. Taylor, H. L., A. Henschel, J. Brozek, and A. Keyes "Effects of Bed Rest on Cardiovascular Function and Work Performance," J. Appl. Physiol., 2: 223-239, November 1949.

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Aerospace Medical Laboratory, Wright Air Development Division, Wright-Patterson Air Force Base, Ohio.
PHYSIOLOGIC EFFECTS OF A HYPODYNAMIC ENVIRONMENT SHORT TERM STUDIES, by D.E. Graveline, Capt., USAF, MC, and G.W. Barnard, Capt., USAF, MC. March 1961. 14pp. incl. illus., 1 table, and 1 ref. and 5 additional refs. (Proj. No. 7222; Task No. 71745)   Unclassified report.

By a technique involving complete immersion in water, a hypodynamic situation was produced in which normal weight sensations were altered and movement was relatively effortless. Four subjects were evaluated after 6,

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12, and 24 hours of this environment. Tilt table, centrifuge, and heat chamber studies demonstrated significant cardiovascular deterioration even after the 6-hour runs, becoming progressively more severe with the 12- and 24-hour experiments. Pertinent psychomotor evaluations, anthropometric measures, and urine and blood studies also were done. The results of this study indicate that the cardiovascular adaptation to a hypodynamic environment of this type occurs early and the deterioration from even a 6-hour exposure is readily apparent.

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