

MEDICAL RESEARCH DEPARTMENT



U. S. Submarine Base
New London

THE EFFECT OF INCREASED ATMOSPHERIC PRESSURE ON BLOOD PRESSURE

First and Final

Report
on
Bureau of Medicine and Surgery
Research Project
X-595
(Sub. No. 127)

Prepared by
Comdr. Mark H. Young, (MC) USN
and
Lieut. W. E. Cook, USN

1 March 1946

APPROVED FOR PUBLIC
RELEASE - DISTRIBUTION
UNLIMITED

APPROVED: Captain C. W. Shilling, (MC) USN, Medical-Officer-in-Charge

LIBRARY

MEDICAL RESEARCH LABORATORY

ACCESSION NO. FILE COPY #2

THE EFFECT OF INCREASED ATMOSPHERIC PRESSURE
ON BLOOD PRESSURE.

Final Report
on
Bureau of Medicine and Surgery
Research Project X-595
(Sub No.127)

Prepared by
Comdr. Mark H. Young, (MC) USN
and
Lieut. W. E. Cook, USN

1 March 1946

APPROVED: Captain C. W. Shilling, (MC) USN, Medical Officer-in-Charge

SUMMARY

Preliminary uncontrolled observations on thirty students at the School for Second Class Divers, U.S. Submarine Base, New London, Connecticut, showed an apparent drop of blood pressure during the four-weeks course. On the basis of these observations, an attempt was made to demonstrate, under controlled conditions, the effect on blood pressure of exposure to increased atmospheric pressures.

Experimentally, a total of sixty subjects were exposed to increased atmospheric pressure under controlled conditions.

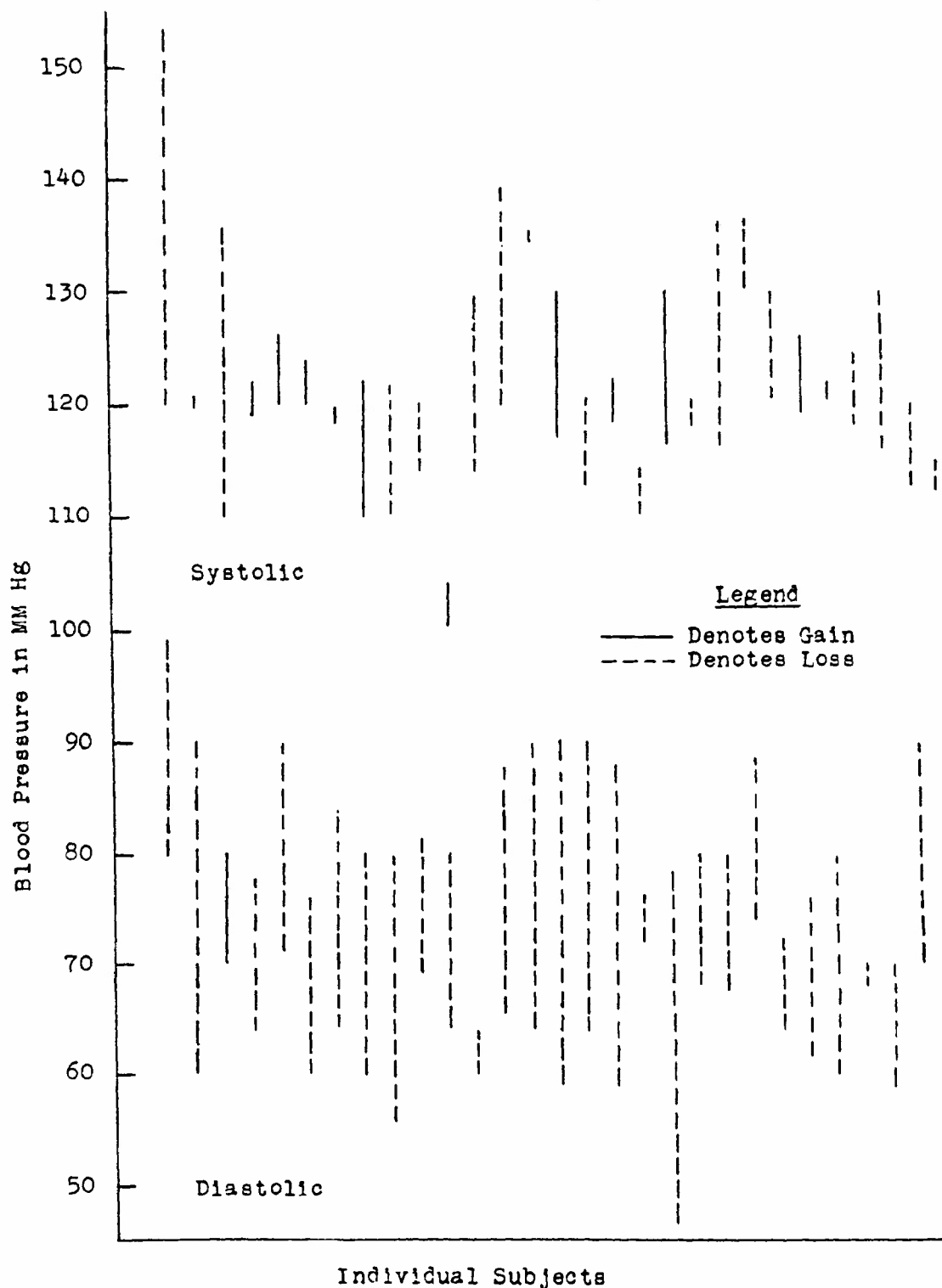
Under the conditions described, no appreciable, lasting effect of increased atmospheric pressure on blood pressure was demonstrated.

It is felt that further experimentation on the subject may be justified using different conditions. It is possible that submersion under actual diving conditions and extending over a much longer period of time may demonstrate a lasting effect on blood pressure.

INTRODUCTION

The results of routine blood pressure examinations, taken before and after attendance at the School for Second Class Divers at the U.S. Submarine Base, New London, Connecticut, seemed to indicate a definite lowering of blood pressure. During the course at the Diving School, the students were exposed to varying amounts of pressure up to ninety feet.

The results of these two sets of readings are shown in Figure 1. It will be seen that there was an average loss of 3.9 mm. of mercury, systolic pressure, and an average loss of 16.5 mm. diastolic pressure. This observation seemed to warrant a controlled study to determine any causal relationship that might exist between lowering of blood pressure and exposures to increased air pressure. Such a study was undertaken as Bureau of Medicine and Surgery Research Division Project X-595 (Sub No. 127), entitled, "A Study of the Effect of Increased Atmospheric Pressure on Blood Pressure", which was approved as of 2 June 1945.



Shows Change in Blood Pressure after
Increased Atmospheric Pressure

Fig. 1

PREVIOUS WORK

Earlier investigators have demonstrated that increased air pressure, as used in the recompression chamber, has an effect on blood pressure. Shilling, et al (1) showed that, during the application of pressure, blood pressure dropped from an average systolic of 115.2 to 107.96; and that pulse pressure showed a similar decline from 49.31 to 34.4 mm. while under increased pressure.

Katsutaka Kato (2) showed that in rabbits, under increased pressure, the minute and stroke volume were decreased. The minute volume decreased from 307 cc to 205 cc, while stroke volume decreased from 1.3 cc to 0.86 cc.

Van der Aue, et al(3) more recently have demonstrated the variations of blood pressure in increased atmospheric pressures, with the predictability of the incidence of bends.

The study described in this report was undertaken to determine whether any permanent effect on blood pressure was produced by the intermittent application of increased barometric pressure.

EXPERIMENTAL PROCEDURE

In an attempt to obtain basal blood pressure readings, sixty subjects were observed at five o'clock in the morning, before they had arisen. Readings were obtained on three different days, but were so completely at variance with themselves that this method was abandoned in favor of the method to be described.

Experimental subjects were available for only two weeks, in groups of thirty each.

Daily blood pressure readings were taken at 1:00 P.M. Prior to the readings, subjects were soaked for 15 minutes, were urged to "relax", and were not permitted to smoke. Other than this 15-minute period, no attempt was made to regulate the activities of the subjects. However, all of them were in the same liberty section and were generally under the same routine.

Blood pressure was recorded while the subject was seated. The cuff was at heart level on the left arm. The same mercury manometer was used throughout, and readings were carefully recorded by an M.D. Diastolic blood pressure was recorded at the point of major change in tone.

Blood pressure was determined for three days on the first group of thirty subjects in the manner described above. Following this, the group was split into two unselected halves. Group "A" was exposed to pressure in the Recompression Chamber to a simulated depth of 50 feet of sea water, taking four minutes to reach the depth. The subjects remained for 3 minutes, were decompressed to ten feet, remained for 5 minutes, and then surfaced. This procedure was repeated on each of eight days; thus, a total of thirteen daily blood pressure readings were obtained.

Group "B" of fifteen subjects, served as controls; undergoing the same routine, but omitting the application of increased pressure.

RESULTS

Results are shown in Figure 2. Although the average blood pressure of Group "A", "treated," changed from 122/74 to 107/63, an almost identical change occurred in the control group.

These results might be attributable to the application of too little pressure for too short a time.

A second group of 29 subjects was treated like the first, being split into Groups "A" and "B", of 15 and 14 subjects each.

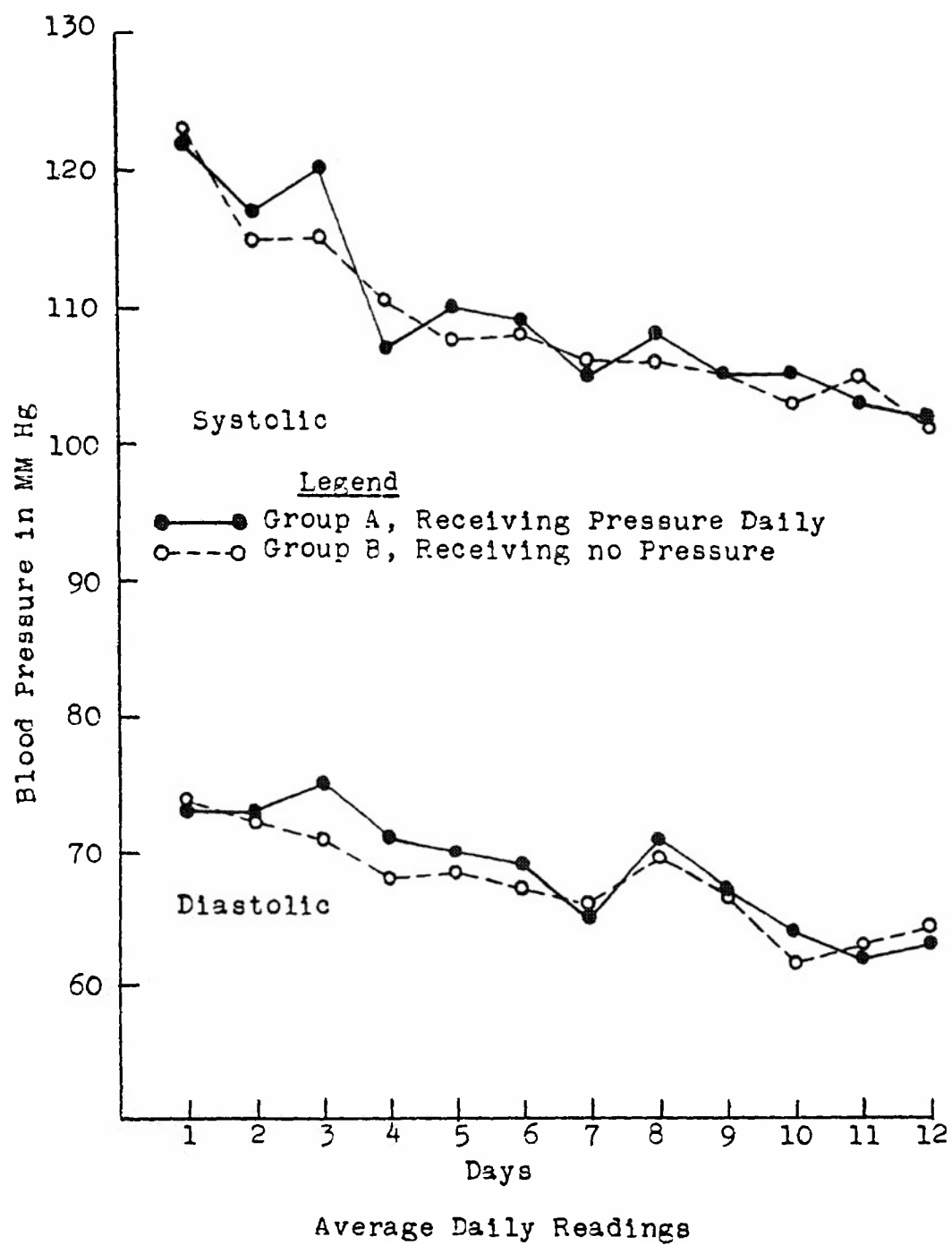


Fig. 2

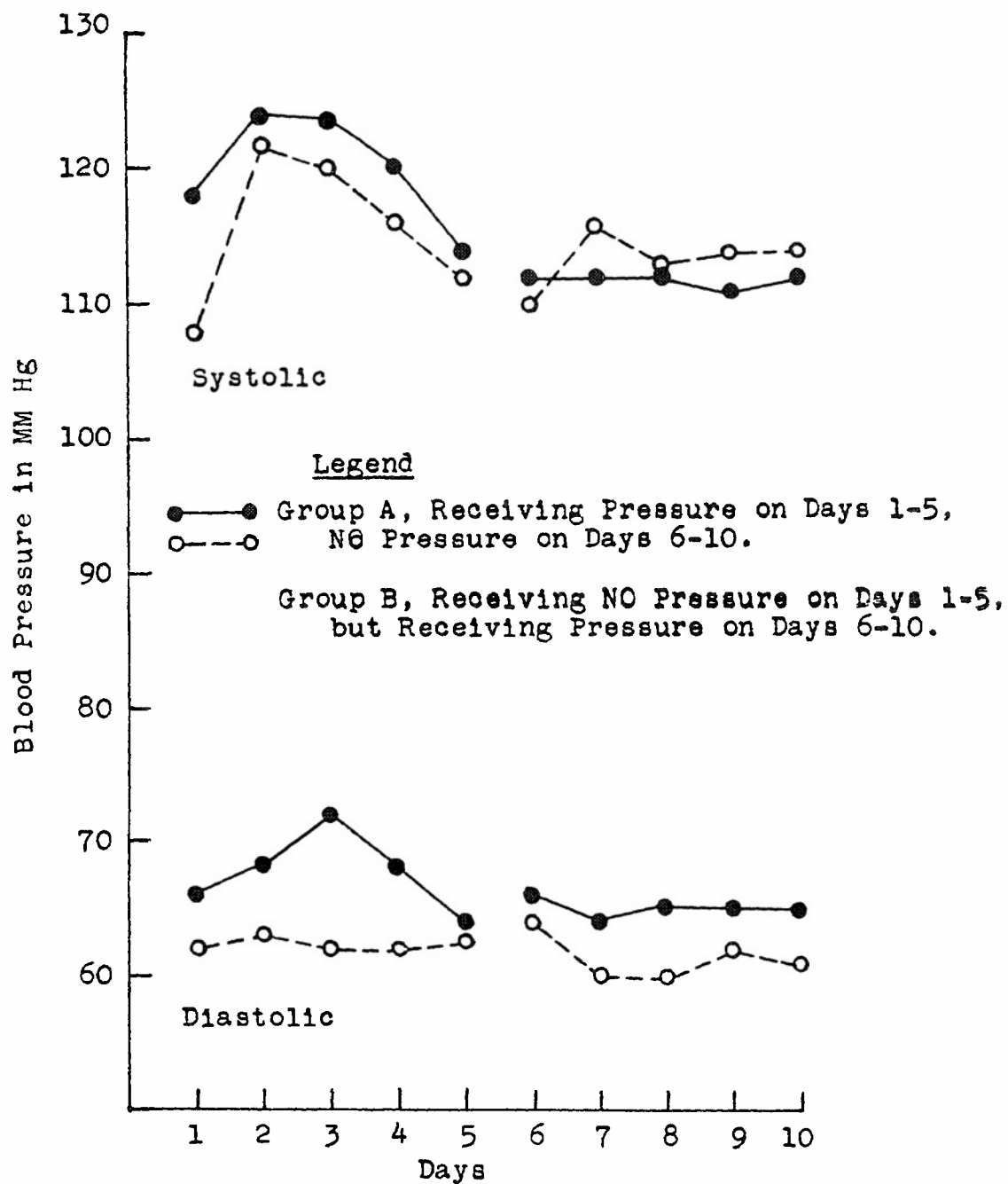
During "treatment" these groups were exposed to pressures equivalent to 100 feet for ten minutes, decompressed to 10 feet for ten minutes, to 5 feet for five minutes, and then surfaced.

Group "A" was treated for 5 days, with Group "B" serving as controls, and then the groups were reversed, with Group "A" serving as controls. This reversal was intended to further test any differences in blood pressure.

Results are shown in Figure 3. There were no appreciable differences demonstrated.

During all the procedure, a known hypertensive individual (McL) was followed. He took the same "pressure treatment" as all the other subjects, at the same time, but was followed separately. His blood pressure was 156/94; his final reading was 150/90. The highest reading was 170/98 and the lowest 148/86. It is interesting to note that his blood pressure was the only one of all the subjects which did not show any decline.

A further attempt was made to correlate blood pressures with temperature and humidity during the period. There was no apparent relationship demonstrated.



Average Daily Readings, with Reversal
of Treatment on Day 6

Fig. 3

BIBLIOGRAPHY

1. Shilling, C. W., Hawkins, J. A., Hansen, R. A., and Everley, I.A.
"The Influence of Increased Barometric Pressure on the Pulse
Rate and Arterial Blood Pressure". U.S.Naval Medical Bulletin
34:39-47;1936.
 2. Katsutaka Kato "Changes in Minute Volume and Stroke Volume of
Heart Following Respiration of Compressed Air". Tohuku J.
Experimental Medicine, 16:189-196; August 1930.
 3. Van der Aue, O. E., Report on Project X-476, entitled "Variations
of Pulse and Blood Pressure in Increased Barometric Pressure".
Deep Sea Diving Unit, Washington, D.C.
-