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THE INFLUENCE OF INCREASED BAROMETRIC PRESSURES ON THE BLOOD CE--ETC(U)
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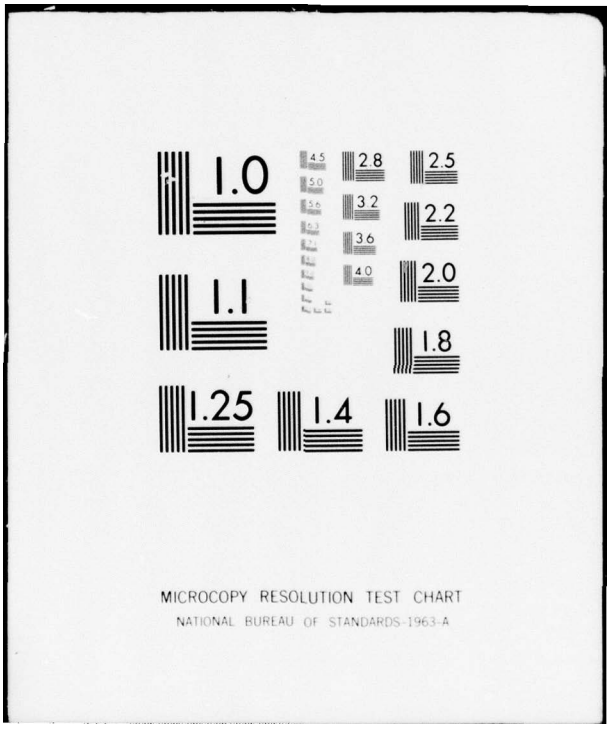
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NAVY EXPERIMENTAL DIVING UNIT

(6) THE INFLUENCE OF INCREASED BAROMETRIC PRESSURES ON THE BLOOD CELL COUNT AND HEMATOCRIT READINGS OF DIVERS.

Report No. 3-45

(11) September 1945

(14) NEDU-3-45

(10) Otto E. Van Der Aue,
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EXPERIMENTAL DIVING UNIT

Navy Yard

Washington, D. C.

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THE INFLUENCE OF INCREASED BAROMETRIC PRESSURES ON THE BLOOD CELL COUNT AND HEMATOCRIT READINGS OF DIVERS.

PROJECT X-476 (Sub. No. 98) Report No. 3

SEPTEMBER, 1945

OBJECT

To determine if high barometric pressures altered the blood count or hematocrit reading and whether these findings could be used to prognosticate the onset of compressed air illness.

SUMMARY

1. Comparative blood examinations were made on twenty five subjects before and immediately after completing 282 dives of various depths, exposures and diving procedures. Resulting from these dives were 27 cases of compressed air illness requiring treatment by recompression and 25 cases of mild compressed air illness not requiring recompression.

2. A slight decrease in the red blood cell count was found following most dives. In the greater majority of dives there was a moderate but consistent leukocytosis following the dive. A higher white count was found in subjects who made working dives than those who made resting dives. The white cell differential count showed a slight but consistent increase in the polymorphonuclear cells with a corresponding decrease in round cells; these slight changes were within the range of normal laboratory error. The hematocrit readings showed no significant change.

3. No prognosis as to the onset of compressed air illness could be made from these findings.

INTRODUCTION

The literature contains very few reports regarding variations in the blood cell count of man after exposures to high barometric pressures. In a comprehensive review of the literature by Stadie (1), changes have been reported where human subjects breathed pure oxygen at high pressures. In most instances a decrease in the red cell count and a mild leukocytosis with no change in the differential was found.

It is generally thought that there is some degree of hemoconcentration and capillary stagnation in conjunction with compressed air illness. If this is present, then the hematocrit and blood counts should be of some prognostic value as an indication of bubble formation. In all dives where the barometric pressure is increased the high oxygen tension in the blood

may bring about a physiological reduction in the red cell count. A leukocytosis may be present in man as a result of strenuous exercise (2) and possibly develops as the result of an increased circulatory rate and volume through the lymphatic tissues and probable contraction of the spleen. In these dives we are dealing with the physiological effects of increased oxygen tension and exercise. Even the "resting" dives, made in a standard deep sea diving dress, curtail the expenditure of a considerable amount of energy which should increase the number of white cells above normal values.

PROCEDURE

Blood studies were made in conjunction with all dives reported on in Report I, of Project X-476 (3). Blood counts and differentials were made preceding and succeeding each of a total of 282 dives while hematocrit readings were taken in 90 dives.

Twenty five subjects were used in this project of whom twenty one were first class divers and the remainder second class divers. All divers were in good physical condition with body specific gravity ranges from 1.100 to 1.054 and cardiovascular scores with ranges from 51 to 81.

The dives made in this project were of the following types:

102 dives at 100 feet for 85 minutes.

59 work dives (in dry chamber, surface decompression procedure (21)
in wet tank, surface decompression procedure (20)
in wet tank, standard decompression procedure (18)

43 rest dives (in dry chamber, surface decompression procedure (22)
in wet tank, surface decompression procedure (21)

66 dives at 130 feet for 55 minutes (all in wet tank

44 work dives (Standard decompression procedure (22)
Surface decompression procedure (22)

22 rest dives (Surface decompression procedure (22)

61 dives at 150 feet for 38 minutes (all in wet tank)

41 work dives (Standard decompression procedure (21)
Surface decompression procedure (20)

20 rest dives (Surface decompression procedure (20)

53 dives at 170 feet for 30 minutes (all in wet tank)

35 work dives (Standard decompression procedure (20)
35 work dives)Surface decompression procedure (15)
18 rest dives (Surface decompression procedure (18)

Blood counts were made in the Levy Counting Chamber with double Neubauer ruling, using capillary blood from the finger tip. Differential counts were made from a Wright stain blood smear. Hematocrit readings were taken from lcc Wintrobe hematocrit tubes containing heparinized venous blood centrifuged at 3000 RPM for a period of 30 minutes.

RESULTS

The results are tabulated in Tables I to VIII (inclusive) for each of the depth and time limits described under procedure.

In Table IX, all dives have been condensed and subdivided into work and rest dives with subclassification into the three groups of normal dives, "mild bends" and "bends". The red blood cell count showed a slight but consistent decrease for all groups with no significant variation between work and rest dives. The average white blood count increased for all dives made. Work dives resulted in a greater increase than the resting dives. No appreciable difference was found between the normal dives and the dives resulting in "bends". The average differential counts show interesting findings. Even though the changes noted were not above laboratory error, there was a small but consistent increase in the percentage of polymorphonuclear cells and a resultant decrease in lymphocytic cells.

Table X summarizes all dives into the three groups of normal dives, "mild bends" and "bends". These findings are of no value in prognosticating the onset of compressed air illness.

COMMENT

The authors realize that this report consists mainly of negative findings, however, due to the lack of literature on this particular phase of investigation, these data are submitted for future reference.

The slight but fairly consistent decrease in the RBC can probably be explained as a normal physiological reaction to the increased partial pressure of oxygen.

The consistent rise in the WBC is undoubtedly due to work while making the dive (2). Even in resting dives, there is considerable energy expended. The small increase in polymorphonuclear cells cannot be explained satisfactorily.

ACKNOWLEDGEMENTS

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2. Osgood, E. E.: A Textbook of Laboratory Diagnosis - Edition III, 235-236. 1940.

3. Van Der Aue, O. E., Brinton, E. S., and Kellar, R. J. Surface Decompression, Derivation and Testing of Decompression Tables with Safety Limits for Certain Depths and Exposures. Report No. I, Research Project X476 (Sub. No. 98) Experimental Diving Unit, U. S. Navy Yard, Washington, D. C., September, 1945.

TABLE I.

Average Hematocrit, RBC, WBC and Differential Counts on divers developing no bends, mild bends or bends following a 100 ft. work dive of 85 minutes duration.

	On 36 Uneventful Dives.					
	Hematocrit* S.	L.	RBC	WBC	POLY. %	LYMS. %
Before Initial Dive	49.1	50.9	4,969,301	6,847	64.4	35.6
After recompression period.	48.1	51.9	4,790,723	8,849	68.3	31.7
DIFFERENCE	-1.0	+1.0	-178,578	+2,002	+3.9	-3.9

	On 7 dives causing Mild Bends.					
	Hematocrit* S.	L.	RBC	WBC	POLY. %	LYMS. %
Before Initial Dive	50.5	49.5	5,083,974	6,678	64.2	35.8
After recompression period.	50.2	49.8	5,000,000	9,135	67.5	32.5
DIFFERENCE	-.3	+.3	-83,974	+2,457	+3.3	-3.3

	On 16 Dives causing Bends.					
	Hematocrit* S.	L.	RBC	WBC	POLY. %	LYMS. %
Before Initial Dive	50.3	49.7	5,124,975	7,196	63.0	37.0
After recompression period	50.7	49.3	5,098,593	8,567	68.5	31.5
DIFFERENCE	+.4	-.4	-26,382	+1,371	+5.5	-5.5

*Hematocrits were done on 27 uneventful dives; 4 dives causing mild bends; 16 dives causing bends.

TABLE II.

Average Hematocrit, RBC, WBC and Differential Counts on Divers developing no bends, midl bends or bends following a 100 ft. resting dive of 85 minutes duration.

	On 35 Uneventful Dives					
	Hematocrit S.	Hematocrit L.	RBC	WBC	POLY. %	LYMS. %
Before Initial Dive	48.9	51.1	4,950,570	7,493	65.0	35.0
After recompression period.	49.1	50.9	4,949,710	8,224	66.3	33.7
DIFFERENCE	+.2	-.2	-860	+731	+1.3	-1.3

	On 5 Dives causing Mild Bends.					
	Hematocrit S.	Hematocrit L.	RBC	WBC	POLY. %	LYMS. %
Before Initial Dive	48.8	51.2	4,970,000	6,990	63.8	36.2
After recompression period.	49.4	50.6	4,884,000	7,200	66.4	33.6
DIFFERENCE	+.6	-.6	-86,000	+210	+2.6	-2.6

	On 3 Dives causing Bends.					
	Hematocrit S.	Hematocrit L.	RBC	WBC	POLY. %	LYMS. %
Before Initial Dive	50	50	5,290,000	6,413	57.3	42.7
After recompression period.	49.3	50.7	4,786,666	7,433	60.3	39.7
DIFFERENCE	-.7	+.7	-503,334	+1,020	+3.0	-3.0

TABLE III.

Average RBC, WBC, and Differential Counts on Divers developing no bends, mild bends or bends following a 130 ft. work dive of 55 minutes duration.

	On 38 Uneventful Dives.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	4,959,147	6,763	63.9	36.1
After recompression.	4,853,745	7,448	67.9	32.1
DIFFERENCE	-105,402	+685	+4.0	-4.0

	On 3 Dives causing Mild Bends.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	4,906,666	7,583	63.3	36.7
After recompression.	4,830,000	8,700	66.3	33.7
DIFFERENCE	-76,666	+1,117	+3.0	-3.0

	On 3 Dives causing Bends.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	5,000,000	8,033	63.0	37.0
After recompression.	5,230,000	8,033	73.3	26.7
DIFFERENCE	+230,000	00	+10.3	-10.3

TABLE IV.

Average RBC, WBC and Differential Counts on divers developing no bends, mild bends or bends following a 130 ft. resting dive of 55 minutes duration.

	On 22 Uneventful Dives.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	5,053,630	6,295	62.9	37.1
After recompression.	4,995,454	7,261	64.5	35.5
DIFFERENCE	-58,176	+966	+1.6	-1.6

On 3 Dives causing Mild Bends.

TABLE V.

Average RBC, WBC and Differential Counts on Divers developing no bends, mild bends or bends following a 150 ft. work dive of 38 minutes duration.

	On 33 Uneventful Dives.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	5,069,086	6,194	62.5	37.5
After recompression.	5,017,489	6,966	65.4	34.6
DIFFERENCE	-51,597	+772	+2.9	-2.9

	On 4 Dives causing mild bends.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	5,145,000	6,325	67.2	32.8
After recompression.	4,982,500	6,975	65.1	34.9
DIFFERENCE	-162,500	+650	-2.1	+2.1

	On 4 Dives causing Bends.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	4,715,000	6,900	69.5	30.5
After recompression.	4,440,000	6,540	73.7	26.3
DIFFERENCE	-275,000	-360	+4.2	-4.2

TABLE VI.

Average RBC, WBC and Differential Counts on divers developing no bends, mild bends or bends following a 150 ft. resting dive of 38 minutes duration.

	On 19 Uneventful Dives.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	5,014,730	6,637	63.6	36.4
After recompression.	4,975,780	7,065	66.0	34.0
DIFFERENCE	-38,950	+428	+2.4	-2.4

	On 1 Dive causing Mild Bends.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	5,660,000	7,700	71	29
After recompression.	5,490,000	6,750	78	22
DIFFERENCE	-170,000	-950	+7	-7

No dives causing Bends.

TABLE VII.

Average RBC, WBC and Differential Counts on Divers developing no bends, mild bends or bends following a 170 ft. work dive of 30 minutes duration.

	On 31 Uneventful Dives			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	4,967,383	5,720	63.2	36.8
After recompression.	4,882,538	6,270	64.1	35.9
DIFFERENCE	-84,845	+550	+.9	-.9

	On 4 dives causing Mild Bends.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	4,975,000	6,699	66.5	33.5
After recompression.	4,844,950	7,299	67.2	32.8
DIFFERENCE	-130,050	+600	+.7	-.7

TABLE VIII.

Average RBC, WBC and Differential Counts on divers developing no bends, mild bends, or bends following a 170 ft. resting dive of 30 minutes duration.

	On 16 Uneventful Dives			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	5,001,250	6,056	62.3	37.7
After recompression.	4,896,870	6,225	63.7	36.3
DIFFERENCE	-104,380	+169	+1.4	-1.4

	On 1 dive causing Mild Bends.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	4,920,000	5,550	60	40
After recompression.	4,730,000	8,300	79	21
DIFFERENCE	-190,000	+2,750	+19	-19

	On 1 dive causing Bends.			
	RBC	WBC	POLY.%	LYMP.%
Before Initial Dive.	4,500,000	6,300	68	52
After recompression.	3,350,000	5,550	68	52
DIFFERENCE	-150,000	-750	0	0

TABLE IX.

Average gain or loss of RBC, WBC and Differential Counts for all depths and exposures tested (work and rest dives separately).

	RBC	WBC	POLY.%	LYMP.%
Bends:				
Work - 23 Dives	-36,178	+893	+5.9	-5.9
Rest - 4 Dives	-140,000	+575	+2.22	-2.22
Mild Bends:				
Work - 18 Dives	-101,944	+1,468	+1.46	-1.46
Rest - 7 Dives	-110,000	+ 407	+5.55	-5.55
Normal Dives:				
Work - 138 Dives	-108,123	+984	+2.0	-2.0
Rest - 92 Dives	- 40,437	+624	+1.72	-1.72

TABLE X.

Average gain or loss of RBC, WBC and Differential Counts for all depths and exposures tested (work and rest dives combined).

	RBC	WBC	POLY.%	LYMP.%
Bends: 27 Dives	-51,559	+845	+5.55	-5.55
Mild Bends: 25 Dives	-104,119	+1,171	+2.58	-2.58
Normal Dives: 230 Dives	-81,048	+342	+1.88	-1.88

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THE INFLUENCE OF INCREASED BAROMETRIC PRESSURES ON THE BLOOD CELL COUNT AND HEMATOCRIT READINGS OF DIVERS

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13. ABSTRACT

To determine if high barometric pressures altered the blood count or hematocrit reading and whether these findings could be used to prognosticate the onset of compressed air illness.

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Diving						
Hyperbaric Environments						
Blood Cell Count						
Hematocrit						
Hyperbaric Medicine						
Hyperbaric Physiology						