and vice versa; yet the fallacy of this generalization is but too often misleading, and it would seem but a poor makeshift to depend on the varying accompaniments of a condition when the condition itself may be determined. Pulse rate undoubtedly often affords a good index of pulse force, but a blood pressure reading is the pulse force. The use of a certain remedy in anemia would gain small credence to-day if cases were reported when the color improved after three days' treatment, while if the hemoglobin increased regularly in that time 40 per cent., it would certainly carry weight. Similarly it would seem almost negligent to *think* a certain treatment lowered the tension in a case of uremia or aneurism, or to give an infusion in shock and be content with *thinking* the pulse felt stronger. The time can not be far distant when operator and anesthetist will keep closer watch of difficult cases by blood pressure observations on the table, when routine blood pressure charts are kept as clinical aids to diagnosis and treatment in hospital wards, when careful case synopses contain blood pressure estimates, and when the general practitioner really *knows* the arterial tension of his patients.

Progress in medicine, as in the other component branches of advancing civilization, is not gradual and imperceptible, but is marked definitely by improvements and new departures from the old régime. It would seem that few individual medical advances would be more far reaching or more productive of real benefit than the substitution of precision for vagueness in the estimation of arterial tension.

FURTHER OBSERVATIONS ON INCREASED BLOOD COUNTS DUE TO HIGH ALTITUDE.*

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That altitude produces an increase in the number of red corpuscles in the blood is a principle very generally accepted. The work of a number of investigators appears to show that the increase is directly proportional to the altitude. At sea level we have, according to Laasche, a blood count of 4,974,000 cells which is by many considered normal.† At an altitude of 9,500 feet Egger found a count of 7,000,000 cells; while Viault, who worked in the Cordilleras of South America at an altitude of 14,400 feet, found the high count of 8,000,000 cells. All these counts refer to human subjects.

As a result of these and similar studies the principle of high blood counts in high altitudes is regularly found in our works on hematology, and is regularly taught in the medical schools. Further, more or less elaborate theories have been based on it to account for the beneficial effects ascribed to high altitudes. There appears to have been but little question as to whether the increase in the number of red corpuscles was permanent or merely temporary.

When our first investigations were undertaken, some two years ago, the above principle was naturally accepted; but, after a number of observations had been made, numerous remarkable exceptions were noted. How to explain these observations soon became the leading problem. From a number of blood counts which were made in order to test the accuracy of the altitude hypothesis it was found that in the case of persons resorting to a higher altitude for a short period of time that an increase in the number of red corpuscles usually resulted; but that cases residing regularly at high altitudes showed counts substantially normal. When common white rabbits were transferred to higher altitudes a similar increase followed. The increase was gradual and continued for several weeks, after which the number of cells began to decline. But these experiments were not of sufficient duration to determine whether the blood count would return to normal or remain permanently at a higher figure. The evidence, however, seemed to indicate a return to normal.

In our climatologic investigations it seemed desirable to have this problem definitely solved. For, if no permanent increase in the number of cells occurred then the beneficial effects ascribed to altitude must either be temporary or of a different character. In order to settle this point, at least in our own minds, our observations were continued; a number of animal experiments were also made to bear directly on this problem. The results of these observations and experiments are presented in this paper.

Among a considerable number of cases examined three bear more particularly on this problem and the data taken are therefore given in full.

Case 55 resides regularly in Albuquerque, but while he was spending the summer in a mountain resort, at an altitude of 7,000 feet, we were enabled to make a series of examinations of his blood. He was enjoying excellent health at the time. The period spent in the mountains was 48 days, and although not as long as could be desired, the decrease in the cell count followed the characteristic increase. The counts, together with other data, are embodied in Table 1:

TABLE 1.—BLOOD COUNTS OF SPECIAL CASES AT HIGH ALTITUDES.

Date.	Time.	Weight.	Sp. Gr.	Hemoglobin (per cent.).	Red Cells (per c.m.m.).	Colorless Cells (per c.m.m.).	Time in High Altitude (days).
Case 55..							
7/24/02	10:30	125	1.060	..	5,573,000	12,000	8
7/28/02	10:00	...	1.060	85	6,155,000	12,000	12
7/31/02	2:30	...	.....	..	6,431,000	12,000	15
9/ 4/02	3:00	...	.....	..	5,791,000	11,000	48
12/10/02	10:00	123	1.060	87	5,395,000	14,000	..
Case 75..							
9/20/02	3:00	150	1.061	84	5,093,000	6,000	4
1/27/02	11:30	...	1.061	..	5,382,000	10,000	11
10/ 3/02	11:30	...	.....	..	5,777,000	14,800	17
10/21/02	11:30	...	.....	..	5,928,000	14,800	35
10/31/02	11:30	...	1.062	78	6,280,000	13,000	45
11/20/02	10:00	...	1.063	88	5,591,000	6,000	65
12/11/02	3:45	155	1.061	82	5,218,000	6,000	86
Case 74..							
9/20/02	10:30	177	1.060	82	5,915,000	8,600	4
9/27/02	10:30	...	1.061	..	5,844,000	8,600	11
9/30/02	10:30	...	.....	..	5,564,000	7,400	14
10/ 6/02	11:00	...	.....	..	5,862,000	5,000	20
10/27/02	10:00	...	.....	..	6,271,000	15,000	41
11/21/02	10:00	...	.....	..	5,951,000	9,500	66
12/13/02	11:00	172	1.064	90	6,235,000	6,500	88
12/19/02	11:00	...	1.064	93	6,600,000	.....	94

It is seen that after staying in the mountains eight days the blood count was slightly above normal as indicated by previous examinations. It is also seen that a considerable rise in the number of corpuscles took place and that this occurred rapidly during the early part of

* For carrying out the researches embodied in this paper aid was received from the Elizabeth Thompson Science Fund, which is hereby gratefully acknowledged.

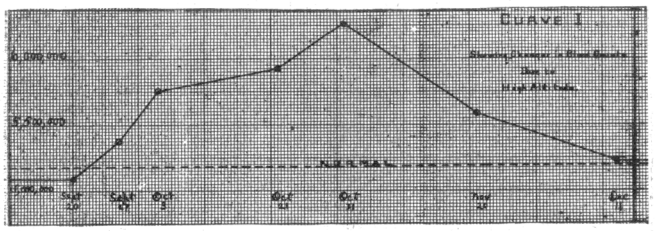
† In this paper 5,500,000 red corpuscles is assumed to be normal for man and 5,000,000 for woman.

his stay. Immediately after returning from the mountains the blood count shows a decrease to practically the original count.

Case 75 was a young man, 22 years of age, who came from the Mississippi valley at an altitude of 900 feet, to Albuquerque at 5,000 feet. The summer had been spent on a farm and the subject enjoyed excellent health. On entering the university as a student regular blood counts were made; the results are given in Table 1. It is seen that the counts increase regularly from 5,093,000 to a maximum of 6,280,000 cells, when a decrease set in and the blood returned practically to the first figure. The difference between the first and last counts, which is slight, can be readily accounted for by the seasonal variations due to temperature. It should, perhaps, be added that this case was particularly free from disturbing factors, which we have found enter largely in much of our work with human subjects. The relation between time spent at the higher altitudes and the number of red corpuscles is shown graphically by Curve 1.

To illustrate the above mentioned fact that external factors may retard, or perhaps even obliterate the effects of altitude, Case 74 is here introduced.

This is a male subject, 30 years of age, and in perfect health. The conditions attending this case are almost identical with those of No. 75. The summer, however, had been spent in recreation, his duties being assumed at about the time the blood counts were begun. These



Curve 1.—Showing changes in blood count due to high altitude.

duties were of such a nature as to cause considerable mental anxiety. Undoubtedly this factor, with his resumption of work, had much to do in modifying the usual blood phenomena due to increased altitude. After several weeks the mental strain was largely removed, and, as is seen in Table 1, the characteristic increase followed; but this was after a period of gradual decrease. In other words, there was a decrease when there should have been an increase, and the latter occurred only after a considerable period of time. The case has evidently not yet run its complete course.

In order to meet the conditions of the problem more closely than could be done with human subjects, animal experiments were made. For this purpose four healthy white female rabbits were selected and blood counts made. They were then sent to Ellis' mountain resort (altitude 8,000 feet) and the blood examined after five or six days had elapsed. The animals were allowed to remain at the higher altitude for a period of seventy-two days, when they were returned to the laboratory and again examined. The final count was made after the animals had been kept at the laboratory for one month.

Since changes in physical conditions, such as the character of the food, the amount of floor space, etc., are apt to produce important changes in the blood and so obscure the true phenomena, especial care was exercised in carrying out this experiment. The rabbits were fed on alfalfa, wheat, bran mash and a few vegetables during the time they were under experimentation. The floor space was also kept constant and comprised about 50 square feet. The animals were kept in the open air with an abundance of sunlight. Adequate protection was also given them. The fact that they gained in weight continually while under experiment shows that they were well cared for. Certainly they appeared to be in perfect health.

So far as the writers are aware the only disturbing factor entering into the experiment was involved in the transportation. The greatest care was given them during this time, and it is not believed that the animals could have been materially influenced by it, as the cage was large and the time relatively short.

Rabbit 17 was injured before the end of the experiment, and this affected the counts so as to render them worthless; they are, therefore, excluded. The counts for the other three, together with other valuable data, are included in Table 2:

TABLE 2.—BLOOD COUNTS OF RABBITS AT HIGH ALTITUDES.

Date.	Time.	Weight.	Sp. Gr.	Hemoglobin (per cent.).	Red Cells (per c.mm.).	Colorless Cells (per c.mm.).	Days in Mountains.	Days After Return to Albuquerque.
Rabbit 16.		Lbs.						
8/21/02	9:30	4½	1.056	78.0	6,666,000	4,000	....	....
8/28/02	3:00	....	.....	....	7,742,000	13,000	5	....
11/ 8/02	1:00	5¼	1.060	86.0	6,671,000	8,500	72	....
12/ 5/02	1:30	6¼	1.058	86.0	6,786,000	2,500	....	27
Rabbit 18.								
8/21/02	1:45	6¼	1.057	73.0	5,849,000	9,000	....	....
8/29/02	10:30	....	.....	....	5,875,000	14,000	6	....
11/ 8/02	3:30	7¼	1.058	85.0	7,760,000	7,500	72	....
12/ 6/02	3:30	8	1.056	84.0	7,391,000	4,000	....	28
Rabbit 19.								
8/21/02	3:00	3¼	1.058	73.0	6,022,000	10,000	....	....
8/29/02	9:20	....	.....	....	6,929,000	11,000	6	....
11/ 8/02	11:00	5¼	1.061	80.0	6,835,000	7,000	72	....
12/ 4/02	2:45	5.6	1.060	81.0	6,702,000	6,500	....	26
Rabbit 24.		Gms						
11/29/02	1:30	2240	1.053	82.0	5,742,000	11,000	....	....
12/11/02	11:40	2470	1.058	86.0	6,083,000	7,000	....	19
Rabbit 25.								
11/29/02	3:00	2332	1.052	80.0	6,211,000	8,300	....	....
12/19/02	11:30	2500	1.057	78.0	6,249,000	7,500	....	20
Rabbit 26.								
11/29/02	4:00	2371	1.059	85.0	8,084,000	11,000	....	....
12/18/02	2:30	2672	1.059	91.0	8,716,000	7,000	....	19

It is observed in rabbits 16 and 19 that the blood counts were very nearly the same on returning as when sent to the mountains; that the intervening blood count was higher; and that the last count, after remaining for one month at the lower altitude, did not differ materially from the one made on returning from the mountains.

Rabbit 18 shows a comparatively low count before being sent to the mountains, while the two final counts are decidedly higher. It is probable that improvement in some physiologic condition occurred, and that this may account for the divergence. The final count is slightly lower than the one made when brought from the mountains, but the fall is not at all in proportion to the fall in altitude. If, then, we take the results as a whole, they agree very well with those shown in Curve 1.

A second experiment with rabbits was carried out, but this varied in a number of details. Three common rab-

bits were purchased in Las Vegas (altitude 6,500 feet) and sent to the laboratory in Albuquerque. It is seen that one transportation and one change of masters were thus avoided. The rabbits were sent by express and could not have been materially affected by the trip. They were received from Las Vegas in the evening and the examinations made on the following day. The rabbits were in good condition, but were not fat. The results of both examinations are given in Table 2.

In none of the rabbits is there a decrease in the final counts; two agree very well, while the third shows an increase. These data are in harmony with those of the previous experiment, and refute the supposition that high altitudes produce abnormally high blood counts.

To prove that subjects in high altitudes have a blood count substantially normal, it appeared desirable to make examinations of a number of cases who had resided at an increased elevation for varying periods of time. The mountain resort, Camp Whitcomb, at an altitude of 7,000 feet, furnished opportunities for obtaining a number of such cases. The results of these examinations appear in Table 3.

From the table it is seen that these cases do not vary decidedly from the normal. A larger number fall below

TABLE 3.—BLOOD COUNTS OF CASES RESIDING AT HIGH ALTITUDES.

No. of Case.	Date.	Time.	Weight in Lbs.	Age.	Sex.	Condition of Subject.	Altitude.	Time in Albuquerque. Altitude 5000.	Time in Mountains.	Sp. Gr.	Hemoglobin, per cent.	Red Cells per c.mm.	Colorless Cells, per c.mm.	Red Cells. Above Normal.	Red Cells. Below Normal.
56	7/24/02	2:30	....	22	M	Normal.	7000	30 days	1 day	1.062	80.0	6,911,000	14,800	1,411,000	.....
57	7/24/02	3:45	....	39	F	Normal.	7000	11 years	7 days	.....	....	5,351,000	15,000	351,000	.....
58	7/25/02	10:30	....	34	F	Tuberculous.	7000	1½ years	13 days	.....	....	5,275,000	19,000	275,000	.....
59	7/25/02	11:30	150	33	M	Tub. (no bacilli).	7000	35 days	21 days	1.062	85.0	5,679,000	11,000	179,000	.....
60	7/25/02	4:00	175	47	M	Tub. (cured).	7000	8 years	1 day	1.060	....	5,186,000	12,000	.....	314,000
61	7/26/02	11:45	106	42	F	Normal.	7000	18 years	1 year	1.058	....	4,440,000	9,000	.....	560,000
62	7/26/02	3:00	125	26	F	Normal.	7000	35 days	22 days	1.062	....	4,770,000	13,000	.....	230,000
63	7/27/02	10:30	140	45	M	Tuberculous.	7000	6 years	45 days	1.056	....	5,160,000	16,000	.....	340,000
63	7/31/02	10:30	140	45	M	Tuberculous.	7000	6 years	49 days	.....	....	5,130,000	10,000	.....	370,000
64	7/27/02	4:20	125	25	M	Tuberculous.	7000	60 days	30 days	1.062	77.0	5,720,000	13,000	220,000	.....
65	7/28/02	2:45	148	19	M	Normal.	7000	105 days	5 days	1.063	75.0	5,293,000	11,000	.....	207,000
66	7/28/02	11:45	140	19	M	Normal.	7000	18 years	46 days	1.060	83.0	5,440,000	9,000	.....	60,000
67	7/28/02	5:30	131	32	M	Normal.	7000	6 years	10 days	1.060	....	5,093,000	9,000	.....	407,000
68	7/29/02	10:30	120	28	F	Normal.	7000	6 years	42 days	1.060	75.0	4,773,000	10,000	.....	227,000
69	7/29/02	5:00	135	52	F	Normal.	7000	60 days	32 days	1.062	....	5,391,000	10,000	391,000	.....
70	7/30/02	10:00	104	40	F	Normal.	7000	2 days	25 days	1.061	78.0	4,942,000	10,000	.....	58,000
71	7/31/02	4:15	145	32	M	Normal.	7000	6 years	8 days	1.062	81.0	5,581,000	12,000	81,000	.....
72	8/26/02	4:00	115	30	F	Normal.	8000	9 years	60 days	.....	....	5,782,000	11,000	782,000	.....
73	8/29/02	11:30	120	56	M	Normal.	8000	.....	9 years	.....	....	5,417,000	7,000	.....	83,000

than above, and this notwithstanding the fact that several must have been influenced by a temporary rise due to the increased elevation of 2,000 from Albuquerque to Camp Whitcomb.

Several of the above cases require comment. Case 56 has been at the higher altitude only thirty days, and therefore had not had sufficient time to pass through the altitude phenomena and return to normal. Cases 57, 58, 59, 62, 64, 67 and 70 were also at the increased elevation during the periods varying from 8 to 30 days, and would likewise be affected by the temporary increase due to a change of altitude. Five of the above cases show blood counts above normal, as was to be expected. It may be mentioned that five of the total number of cases were tuberculous, two of which, however, showed no bacilli. Such cases frequently vary from the normal in their blood counts. They should, however, be affected by the altitude factor in the same way as healthy subjects. If, then, the cases be taken as a whole, they show a substantially normal condition, and support the view that high altitudes have no permanent effect on the number of red corpuscles.

The factor of temperature change has not yet been considered in this discussion. As has been indicated elsewhere,[1] this factor plays an important part in the altitude phenomena as related to the blood. It is there shown that a fall in temperature produces the same effect as an increase in altitude; also, that winter counts are, as a rule, higher than counts made in summer.

If the above data are viewed in the light of these results, it becomes evident why the rabbits taken from a higher altitude did not show a fall in the number of red corpuscles when transferred to lower levels. In both these experiments it happened that when the animals were taken to the lower altitude a considerable fall in the temperature took place; this made the temperature conditions nearly the same in both places, with probably a fall at the lower altitude. Likewise, in the examinations of human subjects recorded above, the temperature factor plays an important rôle. The counts in Table 3 were all made during the warm months of July and August, and therefore show figures lower than would have been obtained during the winter months. They are therefore lower than might have been expected from a consideration of the altitude principle as shown in Curve 1.

From the data presented here we may conclude that the increase in the number of red corpuscles due to an increase in altitude is temporary, and that after the lapse of several weeks the blood counts again become normal. It is believed that the temporary increase is due very largely to the change in the temperature factor, and not to the diminished barometric pressure, as is generally held.

1. Paper to appear in the American Journal of the Medical Sciences.

AMERICAN TRAVELING MEDICAL SCHOOLS.—After referring to the traveling post-graduate schools, which we have recently mentioned as being a feature in Germany, the *Medical Standard* says: "In America we already have hundreds of traveling medical 'schools.' Here the practitioner's school is the medical society, which is multiplying with astonishing rapidity. Few medical men are outside of the influence of one or more of these organizations. The county and district societies are frequently attended and addressed by our most distinguished physicians, who often seize these opportunities to demonstrate their clinical methods. In this manner the country practitioner is kept in close touch with the leaders in the profession."