that in every case an active hyperemia is developed during the race, probably due largely to the irritation from the "toxins of fatigue," inasmuch as the blood pressure is not increased. This condition clears up quickly, as albumin and casts had disappeared in all the cases examined one week after the race.

The amount of urine for twenty-four hours is lessened, the color becomes higher, the specific gravity rises and the reaction becomes more intensely acid. Albumin appears in quantities varying from the slightest possible trace to a trace, and in the sediment we find in every instance hyaline and fine granular casts, a few coarse granular and epithelial casts and more or less blood, normal and abnormal, free and on casts. Rare brown granular casts are found in some sediments, and calcic oxalate crystals in the majority.

The urea is not increased after the race, but, on

and a contestant who had run fast for most of the course might slow down at the finish, particularly if he was far ahead of the next runner; his pulse rate would already have diminished materially before the end of the race. The third factor, the time elapsing before the observation, was also important. Two or three minutes are sufficient to change a very rapid to a moderately rapid pulse. This is shown in the following table, which compares the pulse rates after the 1900 race with the race in 1902. It will be seen at a glance that the 1902 average is faster, yet the time of the race and the condition of the men were about equal. The only varying factor was the time which elapsed before counting the pulse. In 1900 two or three minutes elapsed before the runner was stretched upon the table in the examining room; in 1902 the observer was in the elevator, and took the pulses as the men stepped from the street.

PULSE RATES AT FINISH.																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1900 . .	108	120	120	144	108	116	96	88	72	107	100	98	106	88	132	104	128	80	96	104
1902 . .	82	108	126	132	132	96	144	144	160	120	162	136	180	140	160	164	166	146		

the contrary, appears in the majority of cases to be less for the first twenty-four hours following the race than for the last twenty-four hours before the race. By the end of a week, however, it has again risen to normal.

The pulses of the first two men in 1902 were very slow, but, even with these exceptions, the pulses of 1902 were faster than 1900.

The following table compares the pulse rates before and after the race of 1900 :

BEFORE AND AFTER RACE, 1900.																	
1900	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Before	100	80	72	76	84	84	72	104	84	72	80	82	80	86	92	120?	126
After.	108	120	120	144	116	88	100	98	106	98	132	104	80	96	104	134	116

The chlorides are markedly diminished after the race. It is probable that the output of uric acid is diminished, and that of phosphorus increased, but the results vary so much that no definite conclusions can be drawn.

PULSE, WEIGHT AND TEMPERATURE.

BY J. B. BLAKE, M.D., AND D. D. SCANNELL, M.D.

Pulse. — The pulse rate seemed to depend on three factors: First, the condition of the heart itself; second, the character of the exertion, particularly in the last few minutes of the race; third, the time which elapsed between the actual finish and the observation of the pulse. The hearts best prepared for the contest seemed to have the slowest rates. These hearts were always hypertrophied, but were not overworked by excessive training. In each of the three contests, however, occasional slow pulse rates were observed in which the hearts were not in particularly good condition. These we believe to be the exception and not the rule. The second factor influencing the rate was very effective — a man may have covered the entire distance to within half a mile of the end at a slow rate of speed, and may then have run very fast either racing a neighbor or encouraged to make a creditable appearance before the thousands lining the sidewalks — his final exertion would send the pulse rate up enormously; whereas the reverse also occurred,

In this table there are three cases where the pulse at the start was as fast or even faster than at the finish. These men finished slowly, and a few minutes elapsed before the pulse was taken. At the start the men differed much in composure, many even of the veterans being extremely nervous; whereas at the finish, with few exceptions all were stolid with fatigue.

Weight. — These observations were less accurate than those of pulse or temperature, because they were open to the following sources of error: First, difference in scales; second, solids and liquids ingested during the race; third, small articles of clothing. As it is difficult to accurately calculate the first of these, and entirely impossible to estimate the second, it is obvious that the following figures can be accepted as only moderately accurate.

The extremes of one-half pound (one case) and one pound (one case) on the one hand and ten pounds (one case) on the other may be disregarded. Without doubt the first two were much influenced by the above-mentioned source of error. A large majority of the cases would be found to lie within the three- to six-pound limit. This was certainly a moderate loss, and though the time was three times that of a football game, and ten times that of the average four-mile boat race, not only the average but even the maximum loss was less than has been noted in either football or rowing. In general the heaviest men and those who ran fastest lost the greatest amounts, though there were many exceptions to this.

¹ These figures represent the position of the men at the finish.

The heaviest man of whom we have any record during the three years weighed only 166½. He did not finish. The heaviest who completed a race was 155. The lightest starter weighed less than 100. The lightest who finished weighed 104. Obviously, these are not contests for heavy weights.

either between the temperatures before and after the race, or the relation of high or low temperature to loss of weight or extreme fatigue.
The important fact demonstrated by the observations of these three years on 45 men is that the mouth temperature is not a reliable factor. The

Tables of Weights.

1900	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Before	125½	121	130	137½	126	141	124	155	104	124½	123½	131	134½	115½
After	120½	114	124	130½	120	134½	120½	147½	100½	119½	117½	121	133	111½

1901	1	2	3	4	5	6	7	8	9	10	11	12	13
Before	147½	131	110½	152½	134½	111	127	139½	110½	120½	122	139½	130½
After	143½	126½	108	147½	129½	107½	124½	133	107½	116	120	132½	130

1902	1	2	3	4	5
Before	135	130½	114	132	142½
After	127½	124½	100½	126½	137½

Temperature. — These observations were considerably more accurate than those of the weight, and were taken by mouth before the start and by mouth and rectum simultaneously immediately after the finish. The clinical thermometers used were similar to those found in the large Boston hospitals, and were presumably correct to ½ of a degree.

reason is plain. The temperature of the air was colder in 1900 than in the other years; and in 1899, when extreme subnormal mouth temperatures were noted by Williams and Arnold, the air was colder than even in 1900. Every one knows that forced mouth breathing accompanies all severe muscular exercise, unless it be of the

1900	1	2	3	4	5	6	7	8	9	10	11	12
Before — Mouth	98.6°	99.2°	98.0°	100.4°	99.5°	98.6°	99.0°	100.6°	100.4°	98.8°	98.2°	100.4°
After } Mouth	98.3°	99.6°	102.2°	97.4°	99.7°	98.6°	97.6°	97.4°	101.5°	97.2°	99.8°	97.6°
After } Rectum	104.4°	99.4°	104.4°	103.8°	104.0°	98.0°	104.0°	101.0°	103.4°	100.6°	103.0°	102.6°

1900 (continued)	13	14	15	16	17	18	19	20	21	22	23	24
Before — Mouth	100.7°	100.2°	100.0°	99.8°	100.5°	98.2°	. .	. .	. .	. .	. .	. .
After } Mouth	100.2°	100.8°	100.8°	99.6°	99.6°	97.8°	100.2°	98.4°	97.4°	100.4°	98.4°	99.6°
After } Rectum	101.3°	103.0°	102.3°	103.3°	102.0°	102.8°	103.3°	103.8°	99.0°	104.3°	103.3°	103.3°

1901	1	2	3	4	5	6	7	8	9	10
Before — Mouth	99.4°	98.6°	97.2°	98.3°	98.9°	98.9°	98.3°	98.7°	97.1°	98.0°
After } Mouth	98.0°	98.0°	98.2°	. .	97.5°	97.4°	. .	97.8°	98.0°	99.2°
After } Rectum	102.3°	102.4°	104.4°	101.2°	101.4°	100.9°	100.0°	101.3°	96.0°	100.6°

1902	1	2	3	4	5	6	7	8	9	10	11
Before — Mouth	. .	. .	. .	98.6°	99.1°	98.6°	. .	. .	. .	. .	. .
After } Mouth	97.6°	100.6°	99.9°	97.4°	99.4°	97.9°	99.0°	98.8°	97.0°	98.1°	98.8°
After } Rectum	101.7°	102.7°	103.0°	102.0°?	100.7°	100.4°	102.0°	101.0°	102.6°	103.5°	102.0°

These tables show that much more attention was paid to the temperatures in 1900 than in 1901 or 1902. The results are essentially the same, however; the 1900 shows a proportionately higher average both before and after the race. No less than eight out of eighteen examined before the race in this year had a temperature varying from 100° to 100.7°. There is no obvious explanation of this fact. All these men were in good condition and strong enough to finish. They did not have unusually high temperatures at the finish, nor did they show unusual fatigue. In fact, during the entire three years no definite relation could be established

briefest duration. Under the conditions of these races there is no reason why the mouth should not become almost as cool as the surface of the body. For the time being it is no longer a closed cavity. On the other hand, the rectal temperature has invariably raised, the three exceptions being, first, a man who by mistake or intent was dosed with considerable quantities of alcohol; — this man was a teetotaler and supposed he was being given hot beef tea; he was plainly tipsy at the finish; — second, a man who also had a large amount of alcohol and who was so restless that it is questionable if the thermometer really entered the sphincter; third, a

man exhausted more than the average, also overstimulated, the only one of the three whose condition was not as good as the average at the finish. Other contestants may and probably did drink certain amounts of brandy while running, but none showed the effects of it, and no evidence was obtained that a subnormal temperature depends either on overtraining or extreme fatigue.

Forced exertion of this character raises the body temperature. Other agents, acting simultaneously, may cool exposed portions of the body. In rare instances the ingestion of large doses of alcohol seems to prevent the body temperature itself from rising.

REPORT ON PULSE TRACINGS TAKEN FROM THE MARATHON RUNNERS IN THE RACES OF 1900, 1901, 1902.

BY ALLEN CLEGHORN, M.D.

YEAR.	Complete record. (Start and finish.)	Start only.	Finish only.
1900	11	4	9
1901	2	5	4
1902	4	3	5
Totals . . .	17	12	18

THE above table refers to the number of tracings obtained in the different years. From two runners only were complete tracings obtained in these three years, while from five, tracings were taken in two consecutive years, — naturally these tracings are the most valuable. Then follow the *complete* individual records obtained in the different years, and lastly in importance come the “*Start only*” and “*Finish only*” tracings. However, it is possible by combination to make a general comparison between these latter, and they show just as great a difference in the character of the curve as do the “complete records.”

The method employed to obtain the pulse curves was the same that is used in the physiological department of Harvard Medical School. It consisted in placing a glass thistle tube over the right carotid artery at a level with the lower border of the thyroid cartilage. The thistle tube was connected with a very delicate tambour writing on the smoked surface of a revolving drum. The thistle tube was held on the neck of the contestant by the observer, the pressure over the artery being varied until the lever was found to give the greatest incursion when the tracing was recorded. In all cases the subject was seated during the observation. This method was adopted because it could be manipulated with greater ease and speed than either Dudgeon's or Marey's sphygmograph.

The results were uniform; the candidate invariably presented at the start of the race a normal pulse curve, but at the finish the curve was found to be profoundly altered, the tracing pointing to a condition of enormously low arterial tension. In some cases the pulse was extremely dicrotic. In about two thirds of the cases it was also found that the pulse was markedly irregular, but in the

year 1900 no irregularity was noticed in the runners who finished first, second and third.

TYPICAL PULSE TRACINGS.

BEFORE.

AFTER.

Discussion of Results. — These observations open up some interesting points for consideration. All competitors lost considerable weight during the race, presumably by loss of water through sweating, etc. Is the low arterial tension the result of a concentration or lessening of the quantity of the blood circulating in the vessels, and consequently the vessels not being completely filled? Is it due to the action of the “depressor nerve” endeavoring to ease the overworking heart by increasing the caliber of the arterioles, and so lessening peripheral resistance, or is it due to an active dilatation of the arteries caused by the circulation in them of fatigue products, CO₂, etc.? My individual observations do not definitely point to any one of these problematical causes more than another, but, combined with the results of the other observers, would suggest that all these factors are probably concerned in producing this low tension pulse.

BLOOD PRESSURE.

Twice, during the three years occupied by this series of investigations, were attempts made to measure the blood pressure of the various contestants, both at the beginning and at the finish of the race. These experiments were made in the years 1900 and 1902.

In the former year a modified form of Mosso's apparatus was used. It was found troublesome to transport and to work; it consumed too much time in adjusting, and in obtaining the graphic record, etc., serious defects when celerity was required at the finish. In the latter year another form of tonometer was employed. This instrument is considerably less in bulk, fitting an ordinary pocket, and is much simpler to apply than the former, but on investigation it was found to be measuring the peripheral (capillary) circulation and not the arterial pressure. Consequently both methods, although the best we could devise, were unsatisfactory.

In the results obtained by these two methods the individual variation in pressure was so great that it was deemed best to reject them, only one point being as a rule maintained throughout; that is, in the majority of cases the blood pressure, as measured by Mosso's apparatus, and the peripheral pressure, as measured by the tonometer, were, in the various contestants tested, usually lower at the finish of the race than at the start.