brings about. Under the circumstances, it is necessary to conclude that the effect on the refractory period is the more important. It is also a matter of interest that the dogs are not affected uniformly by the drug. It is to be recalled that a similar lack of uniformity in action exists in patients. We have, as yet, no explanation of this phenomenon. Muscular irritability is a third factor which must be considered in this connection, but a discussion of this, as well as of the details of the experiments now described and of those formerly reported, we reserve for the full account of our studies.

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The acid base equilibrium of the blood following vigorous muscular exercise.

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Immediately following short periods of vigorous muscular work, there is a marked reduction in the bicarbonate content of the blood, a phenomenon observed by Christianson, Douglass and Haldane in 1914.[1] The initial purpose of the present investigation has been to discover what changes in the reaction and the CO_2 tension of arterial blood accompany the diminution in bicarbonate. For this purpose, four individuals without demonstrable organic defects but of varying grades of apparent fitness were selected for experiment. Each did on a Krogh bicycle ergometer a standard amount of exercise which consisted of the performance of approximately 3,500 kilogrammeters of work in three and a half minutes. The method employed upon the blood is that introduced by Henderson and Haggard[2] and consists in the simultaneous determination of the carbon dioxide absorption curve of blood at body temperature and the carbon dioxide content of the arterial blood as it occurs in the body. The reaction of the arterial blood is calculated from the $H_2CO_3/BHCO_3$ ratio after the formula of Hasselbalch. Arterial blood was drawn from the brachial or

[1] Christianson, J., Douglass, C. G., and Haldane, J. S., *Jour. Physiol.*, 1914, xlviii, 244.

[2] Henderson, Y., and Haggard, H. W., *J. Biol. Chem.*, 1919, xxxix, 163.

radial artery immediately before the exercise while the patient was resting and three minutes after the exercise had ceased. In one individual a third sample was taken eight minutes after the work was stopped.

In all cases there was a striking reduction in the bicarbonate content of the blood, varying in the different individuals from 10.5 to 18.8 volumes per cent. of CO_2. The CO_2 tension of the arterial blood was always lower after exercise. The diminution varied from 1.5 to 12.0 mm. The reaction of the blood was always less alkaline, in one instance assuming the very low figure of P_H 7.02, practical neutrality. The reduction of P_H varied from 0.09 to 0.27 in the different subjects. In the one observation eight minutes after cessation of work, the reaction of the blood, which at the end of three minutes had been P_H 7.15, had resumed its original alkalinity of P_H 7.30. The bicarbonate content of the blood, however, had not regained its original level and the return to normal alkalinity had been accomplished by a further reduction in CO_2 tension.

The effects of exercise are summarized in the table.

SUMMARY OF EFFECTS OF EXERCISE.

Subject.	Time.	CO_2, Capacity of Blood at 40 mm. CO_2 Tension Vol. %.	CO_2, Content Arterial Blood Vol. %.	CO_2, Tension Arterial Blood mm. Hg.	P_H, Arterial Blood.	Remarks.
N. P. L. .	Before exercise.....	45.5	48.10	45.5	7.27	Athletic subject in excellent physical condition
	3 min. after exercise	34.9	34.66	39.5	7.18	
J. McL...	Before exercise.....	48.0	50.48	45.0	7.30	Athletic subject in excellent physical condition
	3 min. after exercise	32.3	32.23	39.5	7.15	
	8 min. after exercise	42.5	41.02	36.6	7.30	
J. E.....	Before exercise.....	41.1	43.84	43.5	7.25	Normal subject with alcoholic habits
	3 min. after exercise	26.8	23.01	31.5	7.10	
P. R.....	Before exercise.....	44.4	45.75	41.5	7.29	Acute tonsillitis, 3 days afebrile
	3 min. after exercise	25.6	25.84	40.0	7.02	