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Circulatory Changes During Recovery from Intense Exertion.

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Simultaneous measurements were made of pulse rate (continuous), systolic and diastolic blood pressures (½-minute intervals), pulmonary ventilation, oxygen consumption, and carbon dioxide elimination (10-20 consecutive samples) during the half hour following the fastest possible run upstairs, *viz.*, 17 meters (5 flights) in ½-¾ of a minute. The subjects were 20 young adults and 100 adolescent children—50 boys and 50 girls—and were resting supine while the measurements were made both in basal conditions before and also after the exercise.

Fig. 1 shows the result of a typical experiment. At first the pulse rate and pulse pressure were high and the diastolic pressure usually more or less low. The adults showed a maximum drop of 25 mm.

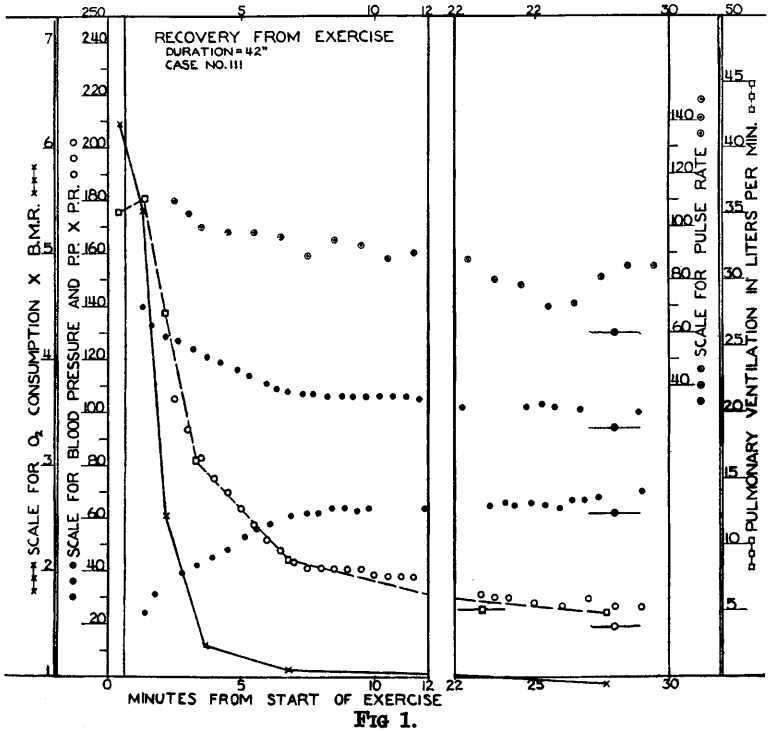

FIG 1.

Hg. and the children showed a maximum drop of 65 mm. Hg. below the basal value. Twenty-two percent of the children showed a drop of more than 25 mm. Hg., which was the greatest drop shown by any adult.

Low diastolic pressure with raised pulse rate and pulse pressure would appear to imply that arterial relaxation has taken place. The ensuing simultaneous decrease of pulse pressure and pulse rate indicates falling cardiac output (a phenomenon measured by Lindhard[1] in similar circumstances), and the simultaneous rise in the diastolic pressure which we observed can only have been accomplished by a vaso-constriction decreasing the peripheral resistance faster than the cardiac output dropped.

Variations in the time and intensity relations of these 2 vascular responses—relaxation followed by constriction—which appear to have been present in every case, can be held to account for all the types of diastolic pressure curves obtained on the basis of the 3 type curves shown in the diagram (Fig. 2). Although for convenience

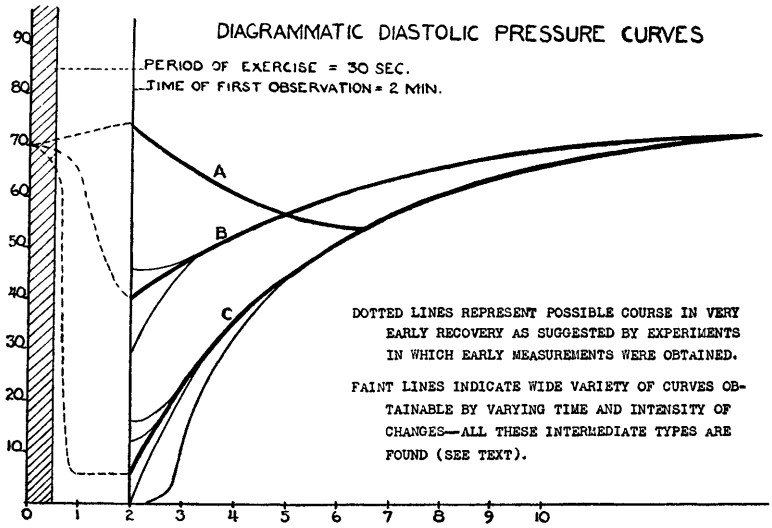

FIG. 2.

of discussion the diagram emphasizes 3 distinct types, all the intermediate varieties of curves were found between these types. All our data may be considered in one or other of these categories as far as the continuous lines are concerned. The dotted lines are hypothetical and suggest possible courses of events in the interval between our resting measurements and our earliest recovery meas-

[1] Lindhard, J., *J. Physiol.*, 1923, **57**, 17.

urements. For the most part, the adults fell into category *B* and the children into *A* and *C*, with a preponderance of boys in *C* and of girls in *A*. This would suggest that the adult vessels relaxed less markedly than those of the children and that among the latter, the boys' arteries reacted more rapidly than the girls'. This may be associated with our observation—to be reported separately—that the boys showed a more rapid rate of recovery of oxygen consumption than the girls. In view, however, of the notorious uncertainty of diastolic pressure measurements, the use of these conceptions in interpreting individual differences in diastolic pressure recovery curves must be reserved until more precise information is available on cardiac output in these circumstances, and until the relative speed of arterial response in these subjects has been measured by other techniques.

Estimates of cardiac output at the very beginning of the recovery from intense exercise have all been indirect. Lindhard showed a continuous diminution of cardiac output following work, but since this first computation depends on an oxygen consumption sample extended over a whole minute, he could not have observed changes in output during this time. Cotton, Rapport, and Lewis,[2] on the other hand, made early and frequent observations of pulse rate and systolic blood pressure from which they concluded that immediately after work the cardiac output fell approximately to its resting value, but mounted again during the ensuing half minute or so. The product of pulse rate and pulse pressure has been regarded[3, 4, 5] as a function of the cardiac output, and although the constancy of this function is uncertain, we believe the data in some experiments in which we obtained early measurements indicate that the cardiac output probably behaves more in accordance with Cotton, Rapport and Lewis' conception than with that of Lindhard, since in the experiments referred to, at the very beginning of recovery the pulse pressure × the pulse rate product is almost constant. However, our evidence was not obtained early enough in recovery to compare strictly with that of Cotton, Rapport and Lewis, and in view of the different varieties of diastolic pressure curves which we found, it would be interesting to see a repetition of their experiments with diastolic pressure measurements included.

2 Cotton, T. F., Rapport, D. L., and Lewis, Thomas, *Heart*, 1915-17, **6**, 269.

3 Liljestrand, G., *Skand. Arch. f. Physiol.*, 1919, **37**, 180.

4 Read, J. M. and Barnett, C. W., PROC. SOC. EXP. BIOL. AND MED., 1934, **31**, 723.

5 And others.

The data from these experiments show also that half an hour after the exercise, when the oxygen utilization of the children approached within 3-5% of its basal level, the pulse rate remained higher than basal and the pulse pressure, though variable, was usually lower than basal. The possibility of these phenomena being correlated with disturbances in the acid-base balance is suggested by the fact that the pulmonary ventilation is often above normal at this time and will be the subject of a later report.

Summary. 1. During recovery from exercise the relaxed arterial tree constricts. 2. The pulse pressure, and even the product of the pulse rate and pulse pressure, are not always decreasing in the first moments of recovery. 3. The basal circulatory equilibrium is not re-established as quickly as is the basal rate of oxygen consumption.

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Resistance of Bacteria and Embryonic Tissue to Germicidal Substances. VI. Iodine Trichloride.

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Iodine trichloride (ICl_3) was first introduced as a germicide by von Langenbach.[1] It was described as a powerful disinfectant and recommended for the sterilization of hands, instruments and other surgical uses.

According to Hailer[2] the chemical is stable in concentrated solutions. In less concentrated solutions the iodine trichloride decomposes into iodine mono-chloride, iodic acid and hydrochloric acid, according to the equation, $2\ ICl_3 + 3\ H_2O \rightarrow HIO_3 + ICl + 5\ HCl$. In more dilute solutions the iodine monochloride decomposes to form iodic acid, free iodine and hydrochloric acid, $10\ ICl + 6\ H_2O \rightarrow 2\ HIO_3 + 8\ I + 10\ HCl$. The effectiveness of the compound is due probably to the amount of free iodine liberated.

In the first paper of this series[3] methods were described for comparing the resistance of bacteria and embryonic chick heart tissue

1 Rideal, Samuel, and Rideal, Eric K., Chemical Disinfection and Sterilization, London, Edward Arnold and Co., 1921.

2 Hailer, E., *Weyls Handbuch der Hygiene,* 1922, **8**, 861.

3 Salle, A. J., and Lazarus, A. S., PROC. SOC. EXP. BIOL. AND MED., 1935, **32**, 665.