

For newborn infants the corrected formula is as follows:

$$A = W^{.425} \times H^{.725} \times 78.50,$$

or

$$\log A = \log W \times .425 + \log H \times .725 + 1.895.$$

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On the relation of blood-volume to the nutrition of the tissues.

I. The effects of hemorrhage and intravenous injections of gum-saline on the response to the administration of a mixture of carbon dioxide and room air, and of room air alone.

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At the last meeting of the American Physiological Society some experiments were reported on the effects of hemorrhage on the response to a gradual reduction in the percentage of oxygen in the respired air. These experiments were performed on the normal unanesthetized dog connected by means of a mask with a rebreathing apparatus arranged to absorb the carbon dioxide of the expired air as the oxygen was consumed. The purpose of the experiments was to determine the detrimental effects of hemorrhage and the subsequent effects of replacing the lost blood with a gum-saline solution.

We reasoned that if a normal percentage of hemoglobin and a normal flow of blood are essential for a normal gaseous exchange, that the response of an animal to a reduction in the percentage of oxygen in the respired air would be altered by hemorrhage; and further that if the intravenous injection of gum-saline accelerated the volume-flow of blood out of proportion to the accompanying dilution, the reduced tolerance to low pressures of oxygen would be improved.

To our surprise we were unable to detect, with the methods employed, any decrease in tolerance after hemorrhage amounting to 3 per cent. of the body weight. We do not attempt to definitely explain these results as yet, but wish to point out a striking effect

of hemorrhage. It invariably produced a quieting effect upon the dogs accompanied by a softness of muscle indicative of a marked reduction in muscular tonus. It is possible that the decreased demand for oxygen on the part of the tissues partly explains our data.

When carbon dioxide was allowed to accumulate in the re-breathing apparatus as the oxygen percentage of the respired air decreased, hemorrhage produced a definite decrease in tolerance to the combined changes in carbon dioxide and oxygen. But the restlessness of the animals under these conditions contraindicated an effort at quantitative results without anesthesia.

We have recently conducted a series of experiments on the dog under morphine-ether, and morphine-urethane anesthesia. In these experiments we compared the ventilation during the administration of a mixture of carbon dioxide and room air with that of room air—first with a normal blood volume, second after hemorrhage, and third after the replacement of the blood with gum-saline. Consistent results were obtained in 10 experiments. The administration of a 5 per cent. mixture of carbon dioxide in room air invariably increased the ventilation over that of room air alone. The increase in ventilation was markedly augmented by hemorrhage. In some cases the augmentation was excessive. Subsequent injections of gum-saline reduced the response almost to that obtaining before hemorrhage. Striking augmentation of response to carbon dioxide mixtures resulted from hemorrhages amounting to 1 per cent. of the body weight and less. In some experiments changes in respiration were associated with the administration of carbon dioxide alone. In other experiments the ventilation of room air was increased by hemorrhage, and decreased by injection as well.

These experiments, we believe, demonstrate that hemorrhage amounting to 1 per cent. of the body weight or less may, under the conditions employed in these experiments, produce a detrimental effect upon the volume flow of blood, and that the injection of an inert solution improves the circulation in such a way as to enhance the gaseous exchange.