

Behaviour of Isotonic and Hypertonic Solutions in Blood Stream of Normal and Dehydrated Animals.

HARRY A. DAVIS.* (Introduced by L. R. Dragstedt.)

From the Department of Surgery, The University of Chicago.

The mode of regulation of the blood volume remains still an unsolved problem in spite of the efforts of many investigators.¹⁻⁴ It has been pointed out recently that the blood stream does act to some extent as a reservoir in the normal animal.⁵ This study was undertaken to evaluate the rôle played by this reservoir action in the regulation of the blood at a constant volume and the effects of dehydration and protein loss. The investigation was divided into 2 parts, the first dealing with effects produced by isotonic solutions introduced in large amounts into the blood stream of normal and dehydrated animals. The second part concerns the results produced by hypertonic solutions.

The effects of isotonic solutions.

Material used—10 normal healthy dogs. Five dogs were used as controls and were allowed free access to water and food. Five were dehydrated by deprivation of water for a standard period of 10 days but food was permitted freely.

Method. 970-980 cc. of 0.9% sodium chloride solution or of 5% glucose solution were injected into the blood stream at a constant rate of 330 cc. per 5 min. Five cc. of blood were withdrawn from the femoral vein before and immediately after injection and at intervals of 15, 60, 180, and 300 minutes. The hemoglobin was determined by the Newcomer method, the plasma volume by the hematocrit method and erythrocyte counts were performed.

Results. The blood vascular system does act as a reservoir, the blood remaining diluted for a period of 5 hours, at which time it has almost returned to its normal state. With isotonic glucose solutions,

* Jessie Horton Koessler Fellow in Experimental Surgery.

¹ Bogert, L. J., Underhill, F. P., and Mendel, L. B., *Am. J. Physiol.*, 1916, **41**, 189.

² Smith, A. H., and Mendel, L. B., *Am. J. Physiol.*, 1920, **53**, 323.

³ Chanutin, A., Smith, A. H., and Mendel, L. B., *Am. J. Physiol.*, 1924, **68**, 444.

⁴ Erlanger, J., *Physiol. Rev.*, 1921, **1**, 177.

⁵ Calvin, D. B., Smith, A. H., and Mendel, L. B., *Am. J. Physiol.*, 1933, **105** 135.

the blood dilution shows a progressive diminution to the normal, *i. e.*, there is a uniphasic response. With isotonic sodium chloride solutions, the response is polyphasic, *e. g.*, the maximum dilution may not be reached until one hour after the injection or the initial dilution is followed by concentration and later by a further dilution. The blood of the normal animal retains sodium chloride solutions better than glucose solutions. Dehydration definitely increases the ability of the blood to hold both isotonic sodium chloride and isotonic glucose. Animals, which, by repeated bleedings, have been rendered anemic, as indicated by a definite lowering of the amount of hemoglobin in the blood, are unable to hold water in the blood vascular system even when severely dehydrated. In the normal animal the changes in blood dilution follow closely the changes in urinary secretion. In dehydration, however, following an injection, the blood dilution continues to diminish even although no urine is being excreted, indicating the passage of fluid into the tissues. This study seems to indicate that the major site of electrolyte action is in the extravascular tissues rather than in the blood, and that the blood colloids play a greater rôle than do electrolytes in the maintenance of a constant blood volume: whereas, in the tissues, water storage seems to depend to a greater extent upon electrolyte action.

Effects of hypertonic solutions.

Material—20 dogs. 10 dogs were used as controls and 10 were dehydrated.

Method. Both femoral veins or external jugular veins were exposed under local anesthesia. Morphine hydrochloride was administered before each experiment. The standard injection was 50 cc. of 25% sodium chloride solution. Five cc. of blood were withdrawn from opposite vein before, and at intervals of $\frac{1}{2}$ minute, 3, 7, 10, 15, and 30 minutes following injection. Hemoglobin determination by Newcomer method. Red blood cell count and plasma volume by hematocrit method.

Results. The effect of the injection is instantaneous and results in an increase in the volume of circulating blood. This increase varies from 15.2% to 38.9% according to hemoglobin dilution measurements. The volume increase is of short duration and the norm is reached within 20-30 minutes. In the dehydrated animal the blood volume increase is just as great as in normal animals. Often the response is even greater in the dehydrated state. In dehydration the return of the diluted blood to normal is definitely slower. Repeated hemorrhages leading to a loss of the cellular and protein content of the blood results in a considerable diminution in the response to the standard injection.