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The effect of hemorrhage on the blood after removal of the liver.

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The principal factors determining the distribution of fluid between the blood and tissue spaces seems to be the filtering pressure of the blood in the capillaries tending to force fluid out, and the greater osmotic pressure of the colloids of the blood tending to pull fluid in. Normally, these two factors balance one another and the concentration remains fairly constant. As far as experiments go, the capillaries seem to be readily permeable to most crystalloids, especially salts.

The balance described above, however, is easily upset. Thus a rise of capillary pressure leads to a concentration of the corpuscles in the blood due to the filtering out of fluid (Scott[1]). Starling[2] showed the capillaries in the liver are the most permeable to colloid, the percentage of protein in liver lymph being practically that of the plasma. Histologists almost describe the capillaries in the liver as being devoid of a wall but they are not clear as to the origin of the lymphatics in that organ. With this very permeable membrane the influence of filtration should therefore be most marked in that organ, and this has been shown to be the case (Scott[1], Lamson and Roca[3]). The opposite conditions occur when capillary pressure is lowered; that is, the osmotic pressure of the colloid gains the upper hand, fluid is pulled into the vessels and the blood diluted (Scott[1]). The fluid which is pulled in is in all probability nearly pure salt solution, that is, it contains only a little colloid (Scott[4]). Seeing that the liver capillaries are so permeable to colloid, one would not expect the colloids of the blood to exercise much osmotic effect in that organ, but it was decided to test the point.

The easiest method of lowering capillary pressure is by hemorrhage. The great vaso-constriction produces a fall of capil-

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1 Scott, F. H., *Am. J. Physiol,* 1917, xliv, 298.

2 Starling, E. H., *J. Physiol.,* 1894, xvi, 224.

3 Lamson, P., and Roca, J., *J. Pharm. and Exp. Ther.,* 1921, xvii, 481.

4 Scott, F. H., *J. Physiol.* 1915, l, 128.

lary pressure and the blood becomes diluted. One cannot predict with certainty just how much dilution of the blood will occur in an animal for a given hemorrhage. The figures given below, however, will compare with the effects of hemorrhage in intact animals. Cats were used and anesthetized with chloroform followed by ether. A cannula was inserted into the carotid artery for taking samples of blood. After the cannula was inserted the abdomen was opened and the portal vein and hepatic artery identified just as they entered the liver. Clamps were then adjusted, but not tightened. The first sample of blood was then taken, the clamps then tightened and hemorrhage made. After a few minutes a second sample of blood was taken by allowing enough blood to escape to wash the cannula. This procedure, which not only excludes the liver but also the intestines, was followed in the first three experiments listed below. In the fourth experiment listed below, the intestines and liver were removed from the animal before the hemorrhage. In doing this, a considerable accidental hemorrhage occurred and it was not possible to make a large hemorrhage. However, the effect is very evident. The blood was kept from coagulating by means of oxalate and the hemoglobins compared as acid hematin in a Duboscq colorimeter, samples being prepared as described in previous papers.

The hemoglobin in the first sample is considered 100.

Expt. I. Cat 2600 gm. hemorrhage 38 cc. hemoglobin red. to 87 in 3 min.
Expt. II. Cat 5090 gm. hemorrhage 80 cc. hemoglobin red. to 86 in 5 min.
Expt. III. Cat 2795 gm. hemorrhage 40 cc. hemoglobin red. to 93 in 2 min.
Expt. IV. Cat 3470 gm. hemorrhage 7 cc. hemoglobin red. from 75 to 70 in 2 min.
(The accidental hemorrhage caused the reduction from 100 to 75.)

The above results show that hemorrhage is about as effective in causing a dilution of the blood when the viscera are out of the circulation. This from the above considerations is what one would expect.