THE EFFECT OF INTRAVENOUS INJECTION OF SOLUTIONS OF DEXTROSE UPON THE VISCOSITY OF THE BLOOD.[1]

By R. BURTON-OPITZ.

(From the Physiological Laboratory of Columbia University, at the College of Physicians and Surgeons, New York.)

The viscosity of the blood is expressed in this paper in terms of the coefficient K, obtained by calculation from the following known factors: the quantity of blood collected during a definite period, its specific gravity, the blood pressure, and the length and internal diameter of the capillary tube through which the blood is allowed to flow. When this coefficient has been compared with K for distilled water at 37° C., the value of which has been proved by Poiseuille to be 4700, it is possible to express the viscosity of the blood in terms of multiples of the viscosity of distilled water, heated to the temperature of 37° C. The method by means of which the aforesaid factors were obtained has been fully described by Hürthle.[2]

In the experiments now to be recorded, I have made use of four capillary tubes, numbered II, III, IV, and V. Tube No. II was used in Experiments 3, 4, 5, and 6; No. III in Experiment 1; No. IV in Experiment 2, and No. V in Experiment 7. The accuracy of each capillary was tested beforehand by a series of experiments with distilled water. Their dimensions were as follows:

[1] This study has been conducted under a grant from the Rockefeller Institute for Medical Research.

[2] Hürthle, *K. Arch. für die ges. Phys.*, 1900, lxxxii, 415.

Capillary	Length	Diameter
	mm.	mm.
II	213.0	0.6636
III	245.5	0.6636
IV	299.2	0.4100
V	331.7	0.7150

The experiments were performed upon dogs under light ether narcosis. The method remained the same in all cases. The normal viscosity having been tested by a number of determinations, a certain quantity of a concentrated solution of dextrose, heated to body temperature, was slowly injected into the facial vein. After an interval lasting from ten to fifteen minutes three or four additional determinations were made, fifteen minutes apart.

The details of the experiments with the concentrated solution of dextrose are given in Table I. In Experiments 1 and 2 only 5 c. c. of the solution were injected, while in the last two, 50 and 100 c. c. respectively were administered. The determinations in each experiment fall into two groups, which show respectively the normal viscosity and the viscosity prevailing after the injection.

On comparing the coefficients of the viscosity with one another, it is found first of all that their value does not remain constant. In the first two experiments, K became smaller after the injection, but in the third and fourth experiments larger than normal. As the actual change in the viscosity is inverse to the numerical change in the coefficient, these facts imply that the viscosity of the blood is increased by small and decreased by large quantities of the solution. The increase which occurred when the quantity of solution injected was small is only a moderate one, and is entirely in accord with the fact[3] that small amounts of pure distilled water, even when used alone, render the blood slightly more viscous. Larger quantities of the solution of dextrose, on the other hand, produced an im-

[3] Burton-Opitz, R., *Jour. of Phys.*, 1904, xxxii, 8.

TABLE 1.

THE VISCOSITY OF THE BLOOD AFTER INTRAVENOUS INJECTION OF DEXTROSE.

Number of exp. and weight of dog		Deter. No.	Quantity of sol. inj. c. c.	Time elapsed since inj. min.	Temperature of animal °C.	Specific gravity of blood	Quantity mg.	Time sec.	Pressure mm. Hg.	Viscosity coefficient K	Difference between K of same group	Mean value of K	Change in K equals
Exp. 1 13.0 K.	Normal	1	—	—	36.8	1.0547	2615.1	18.24	179.8	957.24	59.46	986.97	103.70
		2	—	—	"		1865.2	14.31	153.9	1016.70			
	After inj.	3	5	15	"	1.0564	2092.7	16.71	174.2	861.60	51.70	883.27	
		4	—	30	"		2510.4	20.53	167.5	874.93			
		5	—	45	"		2374.4	18.30	170.2	913.30			
Exp. 2. 17.5 K.	Normal	1	—	—	36.5	1.0589	233.7	22.22	138.1	761.56	29.86	746.63	37.70
		2	—	—	"		250 9	24.74	138.6	731.70			
	After inj.	3	5	15	"	1.0594	168.8	22.53	106.8	701.14	15.59	708.93	
		4	—	30	"		200.3	22.31	125.2	716.73			
Exp. 3 12.0 K.	Normal	1	—	—	37.0	1.0522	2662.9	17.46	154.8	1028.42	77.03	1035.69	51.24
		2	—	—	"		2130.8	14.90	138.5	1077.85			
		3	—	—	"		2568.0	18.60	144.0	1000.82			
	After inj.	4	50	15	"	1.0504	2896.5	16.25	159.6	1167.80	146.35	1086.93	
		5	—	30	"		3007.4	19.32	151.9	1071.54			
		6	—	45	"		2686.3	20.25	135.8	1021.45			
Exp. 4 13.0 K.	Normal	1	—	—	36.8	1.0544	1915.0	20.07	115.4	861.26	41.83	851.14	95.92
		2	—	—	"		2016.3	19.84	122.1	867.00			
		3	—	—	"		1685.9	18.41	115.6	825.17			
	After inj.	4	100	10	"	1.0519	2471.7	21.54	121.1	989.38	79.28	947.06	
		5	—	20	"		2724.7	25.43	118.8	941.70			
		6	—	30	"		2362.7	23.53	115.2	910.10			

mediate decrease corresponding to the amount of solution injected. The specific gravity of the blood pursued, in these experiments, a course parallel to the vicosity.

It is also to be noted that the viscosity did not retain its new value for any length of time, but assumed with each successive determination a value closer to the normal. The greatest change was observed, therefore, shortly after the injection, while thirty to forty-five minutes later, when osmotic interchanges between the blood and the tissues had taken place, the difference had become much less evident.

Three additional experiments were performed with a view to determine the viscosity during hyperglycæmia, this condition having been brought about by painting the surface of the pancreas with a solution of adrenalin. A number of determinations of the viscosity were made before as well as after the adrenalin had been applied. In all three cases traces of sugar were found in the urine after the completion of the last determination. The details of these experiments can be readily obtained from Table II.

It is clearly brought out in the foregoing table that the viscosity of the blood during hyperglycæmia is somewhat greater than normal; however, the increase did not amount to more than seventy points in the experiments now recorded. Thus, if Experiment 7 be taken as an example, we find that the viscosity, which was in this case 6.6 times as great as that of distilled water at 37° C., became 7.0 times as great after the use of the adrenalin. Corresponding changes were noted in the specific gravity of the blood.

TABLE II.

THE VISCOSITY OF THE BLOOD AFTER APPLICATION OF ADRENALIN TO PANCREAS.

Number of exp. and weight of dog		No. of determ.	Temp. of animal	Specific gravity of blood	Quantity mg.	Time sec.	Pressure mm. Hg.	Viscosity coefficient K	Difference between K of same group	Mean value of K	Change in K equals:
Exp. 5	Normal	1	36.5	1.0488	1333.4	13.94	96.1	1042.35	39.85	1062.95	53.48
		2	"		1853.2	15.54	115.4	1082.20			
		3	"		1672.3	14.51	113.4	1064.32			
9.5 K.	After applic. of adrenalin	4	"	1.0494	1778.7	16.15	113.5	1015.60	16.50	1009.47	
		5	"		2338.8	17.94	134.6	1013.72			
		6	"		128.59	15.83	85.1	999.10			
Exp. 6	Normal	1	36.5	1.0610	1900.9	14.37	171.1	800.32	22.05	801.83	47.37
		2	"		2269.6	14.96	189.5	813.62			
		3	"		1632.0	15.18	140.6	791.57			
10.0 K.	After applic. of adrenalin	4	"	1.0614	1462.7	12.08	165.4	757.55	6.17	754.46	
		5	"								
		6	"		1482.0	12.20	167.3	751.38			
Exp. 7	Normal	1	36.9	1.0559	1100.5	16.54	111.1	719.85	14.87	710.02	66.32
		2	"		1344.5	18.31	125.2	704.98			
		3	"		1631.6	13.40	207.5	705.23			
9.5 K.	After applic. of adrenalin	4	"	1.0573	1511.2	15.84	183.8	623.11	34.43	643.70	
		5	"		1582.1	15.99	182.6	650.46			
		6	"		1399.1	16.64	153.5	657.54			