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The blood volume in cases of nephritis with edema and low serum protein concentration.

DAN C. DARROW. (Introduced by McKim Marriott).

[*From the Department of Pediatrics of the Boston City Hospital and the Department of Pediatrics, Washington University, School of Medicine and the St. Louis Children's Hospital, St. Louis, Mo.*]

Although a fairly large number of determinations of the blood volume have been made in cases of chronic nephritis with hypertension, very few are reported in cases of parenchymatous nephritis (nephrosis). Plesch,[1] using his infusion method, reported one case in 1909 in which the blood volume was about half the normal amount. Using the carbon monoxide method, Plesch[2] reported in 1922 a less marked decrease in the blood volume in one patient. In this paper, he also reported two cases of chronic nephritis with edema, which showed increasing blood volumes with decreasing edema. Linder, *et al.*,[3] used the dye method on a number of cases of nephritis. They found slightly low blood volumes in two cases of parenchymatous nephritis.

The following cases are reported because of the strikingly low figures found. In all but one case, more than one determination was made.

Blood volumes were determined by the method of Keith, Roun-

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[1] Plesch, J., *Z. fur Klin. Med.*, 1922, xciii, 241.

[2] Plesch, J., *Z. exp. Path. u. Therap.*, 1909, vi, 380.

[3] Linder, G. C., Lundsgaard, C., Van Slyke, D. D., and Stillman, E., *J. Exp. Med.*, 1924, xxxviii, 921.

tree and Geraghty.[4] Three of the cases were typical instances of parenchymatous nephritis in every respect. One case (No. 2) was not entirely typical as the N. P. N. was elevated and blood cholesterol was normal. Otherwise the blood of all the cases showed high cholesterol concentration, and only slight or no elevation of the non-protein-nitrogen. The urine of these patients was concentrated, showed large amounts of albumin, casts and only occasional red blood corpuscles. There was no elevation of blood pressure. Patient No. 2, on admission, was suffering from pneumonia, as well as chronic nephritis. This patient's urine was of high specific gravity, showed large amounts of albumin, but no red blood corpuscles. His whole blood non-protein nitrogen concentration was 115 mg. per 100 mm. and the whole blood cholesterol was 155 mg. per 100 mm. He died during a later attack of pneumonia and no permit for necropsy could be obtained.

The recent studies of Smith[5] have shown that the vital red method of determining blood volumes is reliable for comparative studies. However, the results are not strictly comparable to those obtained by the carbon monoxide method. The latter method apparently gives figures a little too low because of the uneven saturation of the red corpuscles with carbon monoxide, while the former method measures an uncertain amount of lymph. Therefore, the method of Keith, Rountree and Geraghty tends to give slightly high results.

The findings on our cases are given in the accompanying table. From other studies of the blood volume, which are to be reported later, it was found, as would be expected, that the plasma volume is much more constant than the whole blood volume. By the method used, children over 18 months old who have a normal water metabolism, show plasma volumes of approximately 50 mg. per kilogram of body weight. Only in severe anemia does there seem to be any great variation from this figure, unless either dehydration or edema be also present. Adults tend to show the slightly lower figure of 45 mg. per kilogram. However, the results are more convincing when one compares the different figures on the same patient during different states of his water metabolism, as manifested by varying amounts of edema and absence of edema.

[4] Keith, N. M., Rountree, L. G., and Geraghty, J. T., *Arch. Int. Med.*, 1915, xvi, 547.

[5] Smith, H. P., *Bull. J. H. H.*, 1925, xxxvi, 325.

	Wt. kg.	Age Yrs.	N. P. N. mg. per 100 mg.	Tot.W.B. Cholest'l mg. per 100 mg.	Cell Vol. %	Serum Protein % | gm./kg.	Gm. K.	Blood Volume						Edema
								W. B. mg.	Pl. mg.	Cells. mg.	*WB* kg.	*PL* kg.	*Cells* kg.	
IX-25-24 Case I. Parenchymatous nephritis	15.1	2¾		350	28.3	7.09	2.18	649	465	184	43.	31	13	+++
I-9-25 Case I.	15.02	3	40	247	32.7	7.37	2.01	609	410	199	40.5	27	13	+++
I-13-25 Case I.	15.00	3			30.0	7.09	2.2	614	430	184	41.	28	15	+++
V-13-25 Case I.	14.5	3¼	47	250	31.3	8.55	4.26	1054	724	330	72.5	50	22.5	0
XII-2-24 Case II. Subacute nephritis with edema and Ascites	40.45	11	84.5	155	34.4	6.62	2.46	2252	1500	752	55.7	37.2	18.6	++++
XII-18-24 Case II.	39.77	11	115		25.5	6.22	1.85	1586	1182	404	40.0	30	10	++++
IV-4-25 Case III. Parenchymatous nephritis	60.95	39			38.	6.34	2.7	4200	2605	1595	69.	41	26	++
III-9-25 Case IV. Parenchymatous nephritis	33	9			57.7	6.34	1.99	2080	880	1200	63.1	26.6	36.4	+++
IV-22-25 Case IV.	31	9			49.5	5.99	2.38	2437	1230	1207	75.	38.6	39	++
V-5-25 Case IV.	27.7	9			49.3	6.39	3.04	2600	1320	1280	93.8	47.6	46.2	0

Serum protein per cent determined with Abbe refractometer.
Edema ++++ generalized edema with ascites.
Edema +++ generalized edema.
Edema ++ pitting edema of dependent parts and puffiness of face.
Edema 0 no perceptible edema.

All the patients while edematous showed marked decreases in their plasma volumes, and all except patient no. 4 had decreases in the cell volume as well. The low serum protein concentration in this type of case is well recognized, but the low plasma volume, together with the low serum protein concentration, indicates a greater total loss of plasma protein than has hitherto been suspected. The average amount of serum protein per kilogram of body weight, during the stage of edema, was 2.2 gm. This is about half the amount present in normal children, and agrees with the figure of Linder and others.[3] It is to be noted that, with recovery, the plasma volume returns to normal and that there is an absolute decrease in the plasma volume from that found when no edema is manifest. The amount of plasma per kilo is reduced, if one uses the edema-free weight as well as the weight, during the determination. The figures indicate that the patients of this type usually are suffering from an erythropenia far greater than any red cell count or hemoglobin determination could detect.

The methods used in this study do not give any indication as to whether part of the plasma proteins are removed to other tissues, or whether all the loss occurs by way of the urine. These data would suggest a more frequent use of transfusions than is now practiced, to replace both the plasma proteins and the red cells.

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The influence of posture on renal activity.

H. L. WHITE, I. T. ROSEN, S. S. FISCHER and G. H. WOOD.

[*From the Physiological Department of Washington University, St. Louis, Mo.*]

The influence of posture on the renal output of water, bicarbonate, chloride, inorganic phosphate, inorganic sulphate, urea, ammonia, creatinine and titratable acid, on urine pH, on blood pressure, pulse rate, circulation rate and rate of metabolism has been studied. The procedure was as follows: The subject took no