of perfusion, the sample of secretion corresponding to this period does not show an especially marked increase of Cl concentration.

For all these reasons it seems adequate to assume that the normal pH shift from an alkaline to an acid reaction is due to the localized reabsorption of HCO_3. This will bring about a pH shift from 7.4, corresponding to the normal pH of the blood and of our perfusion fluid, to pH 4.8, equal to our perfusion fluid without HCO_3 and equal to the lowest pH value of frog's urine.[6] This reabsorption can be looked upon as being causally related to the catalyzing effect of carbonic anhydrase.

Summary. Following the addition of sulfanilamide and of sulfonamides having an unsubstituted SO_2NH_2 group to the Ringer-phenol red perfusion fluid of an isolated frog kidney, the reaction of the secretion turns from acid to alkali, as indicated by the color of the indicator. This effect is reversible. Reasons are proposed for the assumption that the change of reaction is due to the inhibitory action of the sulfonamides upon carbonic anhydrase and that this enzyme is involved as a catalyzer in the reabsorption of bicarbonate by the kidney.

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Renal Physiology in Infants and Children. II. Inulin Clearances in Newborn Infant with Extrophy of Bladder.

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(Introduced by Jean V. Cooke.)

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Interest in the renal function of newborn infants has been aroused by recent studies which indicate that the glomerular filtration rate is relatively low during the newborn period. The application of a method devised by one of us[1] to 7 apparently normal full-term infants ranging in age from 4 to 9 days suggested glomerular filtration rates between 20 and 40% of the average normal adult values. McCance and Young[2] have since published an extensive study of renal function of newborn infants, in which are included observations on inulin clearances in 3 infants, aged 6 to 13 days, with meningoceles. Urine collections were made by means of catheterization, and the determined inulin clearances were of the order of 43% of the average adult value. These workers pointed out that the inulin clearances varied considerably with the minute urine volumes. In addition, they observed corresponding changes in urea clearances. Gordon, Harrison, and McNamara,[3] determining urea clearances in premature and full-term infants ranging in age from 7 to 70 days, also obtained values considerably below the normal adult levels. They did not find increases in the urea clearances when the flow of urine, initially 0.05 to 0.20 cc per minute or 0.4 to 1.0 cc per square meter per minute, increased by 25 to 100%.

The observations reported here were made on a 24-hour-old infant, weighing 2100 g, who was admitted to the St. Louis Children's Hospital on July 18, 1941, because of an extrophy of the bladder. The 2 ureteral orifices were visible and readily accessible. Ureteral catheters were inserted easily and a steady flow of urine was obtained. Blockage necessitating irrigation of the catheters was not encountered during the period of the studies to be described and it was felt that accurate collections were made with a minimum of manipulation. Some blood, very probably the result of trauma, appeared in the urine from the right ureter on the first day of study. On the second day of observation gross hematuria was not observed. Two groups of data were obtained: the first dealing with clearances following a single injection of inulin; the second with clearances during a sustaining infusion.

On July 18, 1941, 315 mg of inulin in the form of a 10% solution were injected intravenously and the urine was collected separately from each ureter for 3 consecutive 45-minute periods beginning 90 minutes after the injection. Blood samples were obtained at the middle of each period, and the volume of urine from each catheter was measured. During the period of the test, the patient received subcutaneously approximately 70 cc of Ringer's solution per hour. Inulin concentrations in the blood and urine were determined by a modification of the method of Corcoran and Page.[4] On July 19, after a priming dose of 1.2 cc of 10% inulin, a continuous infusion of 1.8 cc of 10% inulin in 200 cc of normal saline was given intravenously during which inulin clearances were determined for 6 consecutive 45-minute periods. The fluid intake by vein during this period was approximately 60 cc per hour. In Table

[1] Barnett, H. L., PROC. SOC. EXP. BIOL. AND MED., 1940, **44**, 654.

[2] McCance, R. A., and Young, W. F., *J. Physiol.*, 1941, **99**, 265.

[3] Gordon, H. H., Harrison, H. E., and McNamara, H., *Am. J. Dis. Child.*, 1941, **62**, 894.

[4] Corcoran, A. C., and Page, I. H., *J. B. C.*, 1939, **127**, 608.

I are shown the data obtained for all of the periods, together with the calculated clearances. In Fig. 1 is shown the relationship between the rate of urine flow from each ureter and the inulin clearance for the corresponding kidney. The total inulin clearance for the 2 kidneys ranged from 7.30 to 21.23 cc per square meter of body surface per minute and averaged 14.17, a figure which is much lower than the average adult value of 76 cc per square meter per minute.[5] It is apparent that the inulin clearances varied considerably with the minute urine volumes, which, for the 2 kidneys, ranged from 0.078 to 0.467 cc per minute or 0.52 to 3.11 cc per square meter per minute. Although these observations are in general accord with the findings of McCance and Young,[2] the magnitude of change in clearance with change in urine flow observed by us cannot be compared directly with that observed by them since their figures for inulin clearances as related to urine flow are not corrected for surface area.

TABLE I.

Observations on Inulin Clearances for Separate Kidneys in Newborn Infant with Extrophy of the Bladder.

Period	Inulin adminis-tration	Actual urine vol. cc per min			Actual urine vol.* cc/m2/min			Inulin conc. mg%			Inulin clearances cc/m2/min		
									Urine† (diluted to 10 cc)				
		R	L	Total	R	L	Total	Plasma	R	L	R	L	Total
7-18-41													
I	Single	.049	.036	.085	.327	.240	.567	24.61	41.8	63.0	2.51	3.79	7.30
II	injection	.036	.042	.078	.240	.280	.520	18.46	44.4	104.2	3.56	8.38	11.94
III		.076	.078	.154	.507	.521	1.028	17.11	52.0	78.0	4.50	6.75	11.25
7-19													
I	Sustaining	.122	.111	.233	.814	.740	1.554	30.0	117.0	152.0	5.78	7.50	13.28
II	infusion	.178	.207	.385	1.188	1.381	2.569	25.6	137.5	153.3	7.96	8.88	16.84
III		.191	.276	.467	1.273	1.840	3.113	19.2	124.5	150.6	9.61	11.62	21.23
IV		.178	.211	.389	1.188	1.408	2.596	21.5	104.0	132.5	7.17	9.14	16.31
V		.187	.187	.374	1.248	1.248	2.496	23.7	113.5	126.5	7.10	7.91	15.01
VI		.187	.244	.431	1.248	1.629	2.877	23.3	104.0	125.0	6.62	7.94	14.56

*The value for surface area, as obtained from the nomogram[6] constructed by Hannon from the formula of DuBois and DuBois, S.A. = $Wt^{0.425} \times Ht^{0.725} \times 71.84$, was 0.15 square meters. The factor for correcting the urine volumes in cc per minute to cc per square meter per minute was, therefore, 1 ÷ 0.15 or 6.67.

†Each collection period covered 45 minutes, and each urine specimen was originally made up to 10 cc before the determination of the inulin concentration was undertaken. (Urines III L and VI L of 7-19-41 were diluted to 20 cc and the inulin concentrations corrected to 10 cc.) The diluted urine volume corrected for surface area and for time was, therefore, 10 ÷ 45 × 6.67 or 1.481 cc per square meter per minute. This figure was used for V in the formula, UV/B, for the calculation of each of the inulin clearances.

[5] Goldring, W., Chassis, H., Ranges, H. A., and Smith, H. W., *J. Clin. Invest.*, 1940, **19**, 739.

[6] DuBois, E. F., *Basal Metabolism in Health and Disease*, p. 124, Lea & Febiger, Philadelphia, 1927.

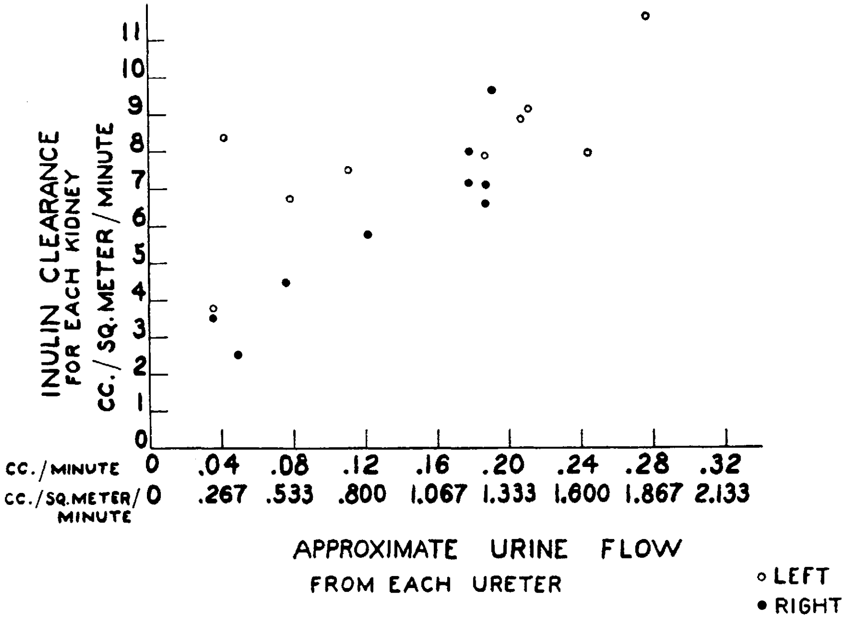

FIG. 1.

Relation between rate of urine flow from each ureter and the inulin clearance for the corresponding kidney.

These observations on a 24-hour-old infant with extrophy of the bladder* offer further evidence that the inulin clearance in newborn infants is considerably lower than in adults. In general, throughout the range of urine flow observed, the inulin clearances varied directly with the minute urine volumes.

* An autopsy on July 22, 1941, revealed that the extrophy of the bladder was accompanied by congenital defects of other organs, but the kidneys and urinary tract showed no other anomalies.