agglutinated by any dysentery, paradysentery, or metadysentery serum except in a dilution of 1 to 20: it does not absorb the agglutinins of any of the dysentery, paradysentery and metadysentery sera tried. For purposes of reference I propose calling it *B. ceylonensis* A, strain S, the name of the patient from whom it was recovered beginning with S.

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Correlation of Urinary Findings and Renal Pathology in Experimental Streptococcal Nephritis.

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The relation of the urinary to the kidney changes in experimental nephritis is of particular interest since in man, with few exceptions, we have been unable to do more than conjecture the cause of the different stages of nephritis, and to assume that in certain infections the concomitant acute nephritis lays the foundation for chronic diffuse renal disease months and years afterwards. Likewise, in human nephritis it is very difficult to compare any particular derangement of kidney function with the structural renal changes incident thereto.

This paper reports upon the sequence of the structural renal changes in correlation with the abnormal urinary findings in dogs in whom nephritis has been induced with the toxic product of *Streptococcus scarlatinae*. The results are especially noteworthy inasmuch as the kidney changes were produced with a nephritic agent that commonly causes nephritis in man, and a closer analogy could be drawn with the human disease than is possible where improbable excitants of human nephritis, like uranium nitrate, have been employed. The experiment has also afforded the opportunity to study the relation and sequence of the renal changes, and to trace the progress of their anatomical development.

Since nephritis frequently occurs spontaneously in the dog, we have used only young animals whose urine over a period of 10 days to 2 weeks was free from albumen, casts and other abnormalities; and whose kidney function, as determined by the phenolsulphenolphthalein test, was within the normal limits. During the period of observation the animals were kept in metabolism cages to facilitate

TABLE I.

Dog 14. Fatal *Single* Intravenous injection. Urinary findings in experimental nephritis induced with Streptococcal "Lysate".

Date	Volume of Urine Excreted in 24 hours	Intravenous Injection Streptococcus "Lysate"	Albumen	Blood	Bile	Casts			Phenolsulphonphthalein % Excreted in 2 Hours	Remarks
						Hyalin	Fine Granular	Coarse Granular		
Apr. 6	500	12 cc.	0	0	0	0	0	0	84	1st injection.
7	400		++	+	+	++	++	++		Marked evidence of nephritis
8	340		++	+	+	+	+	+		Animal very sick.
9	500		+	0	+	+	+	0		Animal improved.
14	200		+	0	++	+	0	+		
22	210		+	+	++	+	+	+		Animal not eating.
24	300		++	++	+	++	++	+		Severe diarrhea.
25	200		++	+	++	++	++	++	62	Very weak and sick.
27										Animal found dead in cage.

Autopsy: Acute hemorrhagic glomerulo-nephritis.

TABLE II.

Dog 6. *Single* non-fatal intraperitoneal injection. Urinary findings in experimental nephritis induced with Streptococcal "Lysate".

Date	Volume of Urine Excreted in 24 hours	Intraperitoneal Injection Streptococcus "Lysate"	Albumen	Blood	Bile	Casts			Phenolsulphonphthalein % Excreted in 2 Hours	Remarks
						Hyalin	Fine Granular	Coarse Granular		
Feb. 22	600	10 cc.	0	0	0	0	0	0	76	1st injection; vomited immediately.
23	500		0	0	0	0	0	0		
24	200		+++	+	+	+	+	+		Animal very sick.
25	230		+++	0	+	+	+	+		
26	530		++	0	+	+	+	+		Animal eating again.
Mar. 3	375		+	0	+	+	+	+		
4	300		+	+	+	+	0	+		
9	170		+	+	+	0	0	0		
16	210		+	0	+	+	+	+	64.5	
26	210		0	0	0	0	0	+		
28	90		+	0	+	0	0	0		
April 8	200		+	0	+	+	+	0		
15	185		+	0	+	+	+	+		
22	300		+	0	+	+	+	+	61.7	P S P Test shows reduced function.
28	280		+	0	+	+	+	+		
May 10	300		+	0	+	+	+	+		
20	330		++	0	+	++	++	++		
22	290		++	0	+	++	++	+		
28	180		+	0	+	++	++	++		
June 2	380		++	0	0	++	++	++		Evidence of Chr. Nephritis.

Animal killed November 20, six months after inoculation, at the time apparently in good health.
Autopsy: Chronic interstitial nephritis.

the collection of urine. Catheterized specimens were not employed, so the figures for urine volumes are averages only, obtained by dividing the total urine volume of 7 days by the number of days in the period. Daily examinations of urine were made for abnormalities over a period of from one to 3 weeks after the administration of the nephrotoxic substance (killed culture and "Lysate" which had been prepared *in vivo* from the *Streptococcus scarlatinae* by the method of Duval and Hibbard[1]). Of dogs who survived several months, urine examinations were made at weekly intervals after the first 3 weeks. The P.S.P. test for kidney function was repeatedly carried out on all dogs at approximately weekly intervals.

Fourteen young healthy dogs were employed. Two methods of inducting the nephritis were resorted to, namely: intraperitoneal and intravenous injections of "killed" culture and "Lysate" of *Streptococcus scarlatinae* respectively. The dosage of "killed" culture was the entire 48 hour surface growth of 3 blood-agar slants suspended in 15 cc. of normal sterile saline; while the "Lysate" dose was 10 cc. to 15 cc. of sterile Berkefeld "N" filtered peritoneal fluid from the immune rabbit that had previously received intraperitoneally a 48 hour streptococcal surface growth of 12 blood-agar slants.

It is noteworthy that the nephritic histopathology in all 14 animals corresponds to that of the various kidney lesions in scarlatina. The "killed" culture acted in the same manner as the "Lysate" in the production of nephritis; and regardless of whether the nephrotoxic substance was introduced intraperitoneally or intravenously.

In regard to nephritis all dogs employed in the experiment reacted to the streptococcal product in a characteristic manner. The nephritic effect was primarily upon the glomeruli, which frequently was hemorrhagic in character, as shown by the urine findings and histopathology. Four animals died in 3 to 4 days after the first injection of the "Lysate", and apparently the result of an acute hemorrhagic glomerulo-nephritis. The remaining 12 dogs of the series lived through the entire period of observation (1 to 6 months); however, they were all quite sick from 1 to 3 days following each injection, as was manifested by vomiting, anorexia, fever and the abnormal urine findings.

The urine findings from day to day were a fairly reliable index to the anatomical changes occurring in the kidneys as revealed by the histopathological study. Blood in the urine invariably meant glomerular hemorrhage, while fine granular casts foretold serious retrograde changes in the epithelium of the convoluted tubules which

[1] Duval, C. W., and Hibbard, R. J., *J. Exp. Med.*, 1926, xliv, 567.

seemed to be dependent upon, and always secondary to, lesions of an obstructive character in the capillary tufts of the glomeruli. The primary glomerular followed by secondary tubular lesions is the reverse picture of the parenchymatous nephritis in dogs induced with uranium nitrate which, according to Mac Nider,[2] produces a primary lesion of the epithelial cells of the proximal convoluted tubules.

The appearance of albumen and casts in the urine was a constant happening in all the injected dogs. In most cases albumen and casts occurred in 24 hours after the injection of the nephrotoxic agent, while in others, these abnormalities were found only after 2 to 3 days. In addition to albumen and casts the majority of dogs showed quantities of blood and bile in the urine, though usually these abnormal substances did not appear before the third day following the injection.

Four of the acute nephritic dogs were allowed to live for 6 months or longer. These animals in 2 or 3 months after the last injection of "Lysate" apparently returned to a normal renal function as indicated by the total absence of abnormal constituents in the urine. However, at autopsy there was very definite gross evidence of chronic renal changes which was confirmed by the microscopic study.

The results of the experiment as a whole show that the toxic product of *Streptococcus scarlatinae* whether introduced intraperitoneally or intravenously has a selective affinity for the glomeruli of the kidney, affecting primarily the capillary tufts (hemorrhagic glomerulonephritis). Secondary changes of a retrograde character occur for the tubular epithelium, particularly the epithelium of the convoluted tubules. It appears that regeneration of the tubular epithelium does not occur where the corresponding glomerular tuft is destroyed.

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The Heart of the Thoroughbred Race Horse. Studies in Hypertrophy.

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The interesting note in Sir William Osler's "Textbook of Medicine" on the heart of Eclipse, the famous race horse, and Master

[2] Mac Nider, Wm. de B., *J. Exp. Med.*, 1929, xlix, 387.