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Experimental Uremia. Uremic Enteritis.

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The objects of this research were to determine what effect uremia has on the Gastro-intestinal canal and to explain if possible the causation of uremia on a chemical basis.

Uremia was produced in dogs by repeated injections of 10% to 20% urea solution (sterile) intravenously, giving 200 cc. daily for 3 days at the rate of 5 cc. per minute (Woodyatt pump). One ureter had been ligated in many instances and in other cases the ureter had been intact. The blood, urine and feces were collected at 24 hour intervals for chemical determinations and at necropsy gross and microscopic tissue studies were made.

In about 40% of the dogs a picture similar to that of uremic coma, the so-called "Kussmaul picture", was produced after a single injection of 200 cc. of 10% or 20% urea solution and in practically 100% of the animals coma was invariably produced after the 2nd or 3rd injection.

The outstanding features of the chemical analysis may be grouped as follows: (a) A progressive acidoses demonstrated by a marked fall in CO_2 content. (b) A marked fall in blood proteins evident in the decrease of the refractometric index. (c) Marked rise in urine chlorides. (d) Disturbance in the calcium-potassium ratio—the ratio approaching 1 or 1+. (e) Marked increase in blood urea.

Upon careful analysis of the output of urea in the form of ammonia nitrogen and urea-nitrogen, it is evident that only 25% to 30% is recovered in the urine and feces.

A very interesting observation was made by Andrews that the identical chemical picture was produced by intravenous injection of a 5% sodium-chloride solution. He suggests that "The disturbance of the osmotic equilibrium resulting from maintaining high blood urea levels for a prolonged period causes or is associated with changes in the mineral salt balance which bears a striking resemblance of that found in human uremia or experimental uremia from sodium chloride injections."

Histologic examination showed the following changes: *Intestine*, marked enteritis; *Liver*, marked congestion—but no cellular changes; *Lung*, marked hyperemia; *Kidney*, marked hyperemia—

TABLE I. *Experimental Uremia.*
Chemical analysis of intravenous injection of urea solution—200 cc. of 20% given daily for 3 days. Rate of injection—5 cc. per minute. (Muriel H.)

	Before Inj.			72 hrs. after Inj.			Comment
	Urine	Bld.	Fec.	Urine	Bld.	Fec.	R. ureter ligated. Average wgt. of dog 17 kilos (female). Food given. Series of 15 dogs. Convulsions. Vomiting. Increased Resp. Diarrhea Coma. Death.
Output	700 cc.		31G	650cc.		68G	
T. N.	4.7 G		3.9G	11.9G		1.4G	
NH_3N	0.4 G		0.02G	1.6G		0.34G	
Urea N	0.38 G	19 mg.	0.04G	7.1G	76mg	0.08G	
Albumin	—						
CO_2		52.4cc.			32.1cc.		
Chlorides		402mg.			492mg.		
Calcium		8.2 mg.			11.3mg		
Potassium		20.2mg			20.4mg		
Ref. Index		50			50		

Data for 24 and 48 hours after injection not recorded in table.

TABLE II. *Experimental Uremia.*
Chemical analysis of intravenous injection of urea solution—200 cc. of 20% given daily for 3 days. Rate of injection 5 cc. per minute. (Peggy O'C.)

	Before Injection			72 hrs. After Inj.			Comment
	Urine	Bld.	Feces	Urine	Bld.	Feces	Ureter not ligated. Average wgt. of dog 17 kilos (female). Food given. Series of 9 dogs. Convulsions. Vomiting. Cheyne-stokes breathing. Diarrhea. Coma. Death.
Output	750cc		22G	750cc		9G	
T. N.	4.1G		4.0G	16.5G		1.1G	
NH_3N	.3G		.03G	.6G		.1G	
Urea N	.4G	18mg	.05G	12G	148mg	0G	
Albumin	—			+			
CO_2		50.8cc			32cc		
Chlorides		418mg			673mg		
Calcium		8.1mg			16.2mg		
Potassium		20mg			13.1mg		
Ref. Index		54			48		

cloudy swelling of the epithelium—obstruction of lumen of convoluted tubules.

Conclusions: Intravenous injection of 10% to 20% urea solution intravenously produces a marked enteritis. All clinical and chemical features of uremia may be reproduced even though both kidneys be intact.