STUDIES IN ACUTE NEPHRITIS *

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In this communication I wish to present certain observations recently made on three cases of acute nephritis that were admitted to the medical wards of the Royal Victoria Hospital. The patients were admitted at the onset of the condition and were studied until convalescence was well established. Two of the cases have been subsequently followed for a prolonged period. Observations were made as nearly simultaneously as possible by four methods which I believe give the most valuable data obtainable in kidney function studies. These four methods are (1) the test meal; (2) the estimation of the rate of excretion of urea; (3) the determination of the calculated and actual blood plasma chlorids in coordination with their rate of excretion, and (4) the phenolsulphonephthalein test.

The Nephritic Test Meal.—The nephritic, or better the kidney function, test meal, as first advanced by Hedinger and Schlayer,¹ and later elaborated by Mosenthal² and O'Hare,³ has proved to be of great value in estimating the ability of the kidney to eliminate fluid, salt and nitrogen. After a study of some 200 meals, given in this clinic according to the Mosenthal technic, I think that the total balances of fluid, salt and nitrogen are of little value, as in most cases the intake is accurately known only during the twenty-four hours of the test. The three points which I consider to be of the most importance are (a) the volume of the night urine; (b) the variation of specific gravity throughout the twenty-four hours, and (c) the concentration of nitrogen at night. Even the last point, the ability of the kidneys to concentrate nitrogen at night, must be considered conservatively, since Mosenthal⁴ recently has shown that there are certain kidneys, apparently normal in all other respects, that fail in this function.

Excretion of Urea and of Chlorids.—The rates of excretion of urea and of chlorids have been studied according to McLean's⁵ method. For the former, we have derived both his index and the Ambard con-

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* I should like to express my appreciation of a grant from the James Cooper Fund of McGill University which made this work possible.

1. Hedinger and Schlayer: *Deutsch. Arch. f. klin. Med.*, 1914, **114**, 120.

2. Mosenthal: *THE ARCHIVES INT. MED.*, 1915, **16**, 733.

3. O'Hare: *THE ARCHIVES INT. MED.*, 1916, **17**, 711.

4. Personal Communication.

5. McLean: *Jour. Exper. Med.*, 1915, **22**, 212.

stant; for the latter, the calculated and actual blood plasma chlorids, as well as the chlorid threshold.

The Phenolsulphonephthalein Test.—The phenolsulphonephthalein test has been performed according to Rowntree and Geraghty's⁶ original technic, 0.006 gm. of the dye being injected intramuscularly into the lumbar region and ten minutes allowed for the dye to reach the kidneys. One and two hour specimens were collected.

The methods used are for

Total Nitrogen: Kjeldahl-Gunning modification.

Urea: Van Slyke and Cullen's⁷ modification of Marshall's urease method.

Ammonia: Folin's⁸ micromethod.

Chlorids (in both blood plasma and urine): McLean and Van Slyke's⁹ method.

Blood Sugar: Lewis and Benedict's¹⁰ original technic.

REPORT OF CASES

A brief synopsis of the three cases follows, and the laboratory notes are given in full.

CASE 1. (Medical No. 24738). *History.*—A man, aged 55, was admitted to the Royal Victoria Hospital, Oct. 24, 1916, complaining of swelling of feet and legs, shortness of breath, and headache.

The patient was in usual health until four days previously, when he noticed swelling and soreness of the left ankle. The next day his right ankle also became sore and swollen, which was followed by a generalized edema of both legs. At this time he began to suffer from headaches and shortness of breath on exertion. Two days later the headaches became much worse. His personal history was negative except that he had scarlet fever when a child, and there was nothing of importance in his family history.

Examination.—He was a well developed, middle aged man, the muscles were of good tone, but he was unable to lie on the left side without coughing and becoming dyspneic. The digestive, genito-urinary, locomotor and integumentary, lymphatic and nervous systems were normal; also the fundi were normal.

Respiratory System: At the right base behind there was a triangular area of dullness extending upward to the level of the seventh dorsal spine and laterally to the anterior axillary line. Over this area the percussion note was flat, tactile fremitus was absent, and breath and voice sounds were much diminished.

Cardi of Circulatory System: The pulse was regular but tension was increased. The cardiac transverse dullness was 14 cm. at the level of the fourth space; otherwise negative.

Temperature and Pulse: On admission there was a slight evening temperature of 100 F., which dropped very gradually, reaching the normal on November 27. While the evening temperature was present the pulse rate averaged from 90 to 100, dropping to a level of from 70 to 80 as the temperature fell.

6. Rowntree and Geraghty: THE ARCHIVES INT. MED., 1912, **9**, 284.

7. Van Slyke and Cullen: Jour. Biol. Chem., 1914, **19**, 211.

8. Folin and MacCallum: Jour. Biol. Chem., 1912, **11**, 523.

9. McLean and Van Slyke: Jour. Biol. Chem., 1915, **21**, 361.

10. Lewis and Benedict: Jour. Biol. Chem., 1915, **22**, 61.

TABLE 1.—A RECORD OF THE OBSERVATIONS MADE ON THE RATE OF—
Case 1. Medical No. 24788—

Date	Weight, Kg.	Urine, per 24 Hours, C.c.	Urea				
			Gm. per Liter of Blood, Ur	Gm. per Liter of Urine, C	Gm. per 24 Hours D	McLean's Index	Ambard Constant
10/28/16	....	.....	.....	.....	.....	....	.....
11/ 6/16	69.8	2,160	0.858	14.16	20.57	17.0	0.194
11/14/16	66.4	3,456	0.870	10.00	34.56	19.6	0.181
11/20/16	65.9	3,000	0.852	7.16	24.48	10.8	0.243
12/ 1/16	63.2	3,888	0.780	2.97	11.55	4.6	0.371
12/ 8/16	62.0	4,992	0.810	2.07	10.33	3.2	0.442
12/14/16	61.1	3,744	0.810	2.97	11.11	4.3	0.391
12/23/16	60.3	2,880	1.530	9.19	28.51	5.2	0.329
1/ 2/17	60.9	3,768	1.140	4.96	18.43	4.8	0.370
1/10/17	59.5	4,176	0.600	2.94	12.26	8.9	0.269
1/13/17	60.4	5,112	0.570	1.65	8.43	4.6	0.370
1/25/17	60.2	4,872	0.420	2.37	11.54	15.0	0.212
2/ 2/17	63.9	3,792	0.390	5.37	20.35	43.5	0.110
2/ 9/17	63.9	4,104	0.570	4.74	19.45	18.4	0.188
2/16/17	64.1	3,792	0.480	4.08	15.46	19.0	0.185
2/23/17	65.7	5,472	0.540	4.65	25.44	25.7	0.159
3/ 9/17	66.4	5,592	0.660	4.65	25.99	17.4	0.192
3/24/17	66.7	1,800	0.630	14.34	25.81	33.1	0.139
4/ 6/17	76.5	2,568	0.510	10.06	25.82	42.0	0.124
4/20/17	68.3	4,320	0.585	6.66	28.77	28.5	0.149
5/ 4/17	68.4	3,696	0.510	7.74	28.56	40.0	0.126
5/18/17	68.5	5,328	0.630	4.11	21.89	14.7	0.210
6/ 1/17	69.2	2,040	0.585	14.04	28.64	40.5	0.126
6/22/17	67.5	5,000	0.585	5.29	26.45	23.5	0.165
7/ 6/17	68.1	3,552	0.540	3.99	14.16	12.7	0.226

—UREA AND CHLORID EXCRETION AND ON PHENOLSULPHONEPHTHALEIN TEST

—Diagnosis: Acute Nephritis

Sodium Chlorid					Thresh- old	Phenol- sulphone- phtalein, Two Hours, per Cent.	Remarks
Gm. per Liter of Urine, O	Gm. per 24 Hours, D	Gm. per Liter of Plasma					
		Calcu- lated	Actual	Differ- ence			
....	.....	.....	.....	.....	.....	86	Edema of lower limbs
2.61	5.64	5.695	6.556	+0.861	6.381	..	Albumin = 8 gm. per liter
3.15	10.87	5.964	6.687	+0.723	6.343		
3.1	7.65	5.840	6.125	+0.285	5.905		
1.68	6.52	5.798	5.937	+0.139	5.759	Trace	Albumin, 2 gm. per liter
2.43	12.13	5.888	5.937	+0.049	5.669	Trace	
1.4	5.23	5.775	5.687	-0.088	5.532	15	
2.6	7.48	5.837	6.25	+0.413	6.083	20	
2.4	9.04	5.853	6.50	+0.647	6.267	..	No red blood cells
1.0	4.17	5.748	5.47	-0.278	5.342	24	Jan. 9, 1917, theophyllin, 15 grains
0.62	3.16	5.718	6.062	+0.344	5.964	..	Albumin, a trace
1.62	7.87	5.819	6.062	+0.243	5.863	41	Discharged Jan. 27, 1917
6.94	26.30	6.126	7.062	+0.936	6.556	42	Ate extra salt
6.0	24.62	6.092	7.062	+0.97	6.59	40	
3.25	12.31	5.906	6.750	+0.844	6.464	..	Albumin = 0
3.37	18.43	5.969	6.625	+0.656	6.276	40	
3.4	19.01	5.973	6.437	+0.464	6.084	46	
3.7	15.66	6.024	6.625	+0.601	6.221	41	
6.2	15.92	5.992	6.625	+0.633	6.253	34	
5.6	24.19	6.065	6.312	+0.247	5.867	51	Albumin = 0
5.7	21.06	6.037	6.312	+0.275	5.895	41	
2.4	12.78	5.881	6.000	+0.119	5.739	..	Albumin, a trace
7.7	15.70	6.006	6.062	+0.056	5.676	51	
2.6	13.0	5.89	5.937	+0.047	5.667	57	Albumin = 0
1.6	5.68	5.778	5.625	-0.153	5.467	56	

Blood Pressure: Oct. 24, 1916, the systolic pressure was 150, and the diastolic 115 mm. of mercury. These gradually dropped, the most prompt reduction taking place in the diastolic pressure.

BLOOD PRESSURE

Date	Systolic	Diastolic
Nov. 20, 1916.....	140	100
Jan. 4, 1917.....	140	90
Jan. 10, 1917.....	135	90
Jan. 15, 1917.....	130	95
Jan. 25, 1917.....	130	90
Feb. 3, 1917.....	150	110
March 9, 1917.....	144	92
April 20, 1917.....	140	90
May 4, 1917.....	124	90
June 1, 1917.....	126	80

Blood: Oct 26, 1916, the red blood cell count was 4,200,000; white blood cell count, 9,400, and the hemoglobin 50 per cent. (Sahli).

Urine: Oct 24, 1916. The urine was of an amber color with a "smoky" appearance, acid in reaction, with a specific gravity of 1.021. There were 8 gm. per liter of serum albumin and the microscopic examination showed large numbers of red blood cells, granular and cellular casts.

Oct. 28, 1916, 1,650 c.c. of opalescent, yellowish fluid were withdrawn from the right pleural cavity. The specific gravity was 1.012 and it contained 200 cells per cubic millimeter, mostly small mononuclears.

The results of the study of the kidney function are shown in the accompanying tables. Table 1 gives the observations made on the rate of urea and chlorid excretion as well as on the phenolsulphonephthalein test. The diet throughout the period of these observations is shown in Table 2, the dates indicating a change.

TABLE 2.—THE DIET GIVEN THROUGHOUT THE PERIOD OF OBSERVATIONS RECORDED IN TABLE 1.

Date	Diet	Sodium Chlorid	Fluid Total, C.c.
10/31/16	Restricted protein.....	.....	1,000
11/11/16	Low protein diet.....	Salt-free	1,000
12/ 8/16	Low protein diet.....	Salt-free	2,000
12/12/16	Protein, 52; fat, 60; carbohydrate, 100.....	Salt-free	2,000
12/17/16	Protein, 60; fat, 65; carbohydrate, 150.....	Salt-free	2,000
12/29/17	Low protein diet.....	Salt-free	2,000
1/26/17	Protein, 52; fat, 60; carbohydrate, 100.....	Salt-free	2,000
1/27/17 discharged	Restricted protein.....	Restricted salt in cooking; no free salt	

Three nephritic test meals that show the changes in function in relation to the rate of excretion of urea and chlorids are given in full. The first was administered during the period of acute inflammation, the second during that of greatly impaired function, and the third at the time of convalescence.

TABLE 3.—RESULTS OBSERVED AFTER THE ADMINISTRATION OF NEPHRITIC TEST MEALS.

Case 1: Nov. 15, 1916. Meal given during the period of acute inflammation

Time of Day	Urine, C.c.	Specific Gravity	Sodium Chlorid		Nitrogen	
			Per Cent.	Gm.	Per Cent.	Gm.
8-10.....	122	1.015				
10-12.....	170	1.014				
12- 2.....	165	1.015				
2- 4.....	160	1.014				
4- 6.....	170	1.015				
6- 8.....	140	1.015				
Total day.....	927	.....	0.290	2.67	0.574	5.30
Night, 8-8.....	960	1.013	0.418	4.03	0.539	5.18
Total 24 hours.....	1,887	.....	.....	6.70	.....	10.48
Intake.....	1,760	.....	.....	8.4	.....	13.4
Balance.....	-127	.....	.....	+1.7	.....	+2.92

Case 1: Jan. 20, 1917. Meal given during period of greatly impaired function

8-10.....	168	1.013				
10-12.....	118	1.016				
12- 2.....	33	1.019				
2- 4.....	79	1.020				
4- 6.....	121	1.016				
6- 8.....	106	1.018				
Total day.....	625	.....	0.318	1.97	0.371	2.30
Night, 8-8.....	620	1.016	0.328	1.93	0.387	2.39
Total 24 hours.....	1,245	.....	.....	3.90	.....	4.69
Intake.....	1,760	.....	.....	8.5	.....	13.4
Balance.....	+515	.....	.....	+4.6	.....	+8.71

Case 1: March 23, 1917. Meal given during convalescence

8-10.....	103	1.022				
10-12.....	62	1.024				
12- 2.....	98	1.025				
2- 4.....	104	1.026				
4- 6.....	118	1.025				
6- 8.....	130	1.023				
Total day.....	615	.....	0.77	4.69	0.97	5.91
Night, 8-8.....	517	1.024	0.66	3.36	1.02	5.20
Total 24 hours.....	1,132	.....	.....	8.05	.....	11.11
Intake.....	1,760	.....	.....	8.5	.....	13.4
Balance.....	+628	.....	.....	+0.45	.....	+2.29

CASE 2 (Medical No. 25374). *History*.—A man, aged 30, was admitted to the Royal Victoria Hospital, March 6, 1917, complaining of "Cold in the chest." His present illness began ten days previously with a cold that was rapidly followed by a severe sore throat, hoarseness, and cough with expectoration. With the onset of cough he had several slight chills followed by sweats. For the previous week the urine had been of a dark brown color. His personal and family history were unimportant.

TABLE 4.—RESULTS OF THE STUDIES MADE ON THE RATE OF UREA AND—
Case 2, Medical No. 25374—

Date	Weight, Kg.	Urine, per 24 Hours, C.c.	Urea				
			Gm. per Liter of Blood, Ur	Gm. per Liter of Urine, O	Gm. per 24 Hours D	McLean's Index	Ambard Constant
3/ 9/17	76.0	1,104	0.540	10.78	11.88	15.8	0.203
3/15/17	75.4	1,584	0.570	17.38	27.52	42.0	0.124
3/28/17	71.4	936	0.555	23.4	21.84	43.0	0.122
4/ 4/17	71.7	1,056	0.360	18.79	19.82	83.0	0.088
4/10/17	70.4	1,682	0.435	17.44	28.44	80.0	0.089
4/17/17	71.7	1,920	0.345	12.28	23.57	87.0	0.086
4/24/17	71.7	4,368	0.352	7.68	33.53	94.0	0.083
5/ 1/17	71.3	2,712	0.285	10.0	27.12	133.0	0.069
5/ 8/17	72.3	864	0.270	16.2	18.99	95.0	0.082
5/16/17	72.6	1,464	0.255	13.62	19.15	135.0	0.069

Examination: He was a well developed and nourished young man. The physical examination was negative except for an inflamed throat and diffuse, large, moist râles over both sides of the chest. The fundi were normal.

On admission the temperature was 101 F., but it rapidly dropped to an evening temperature of 99 F., which was maintained until March 23.

Blood Pressure: Systolic, 130; diastolic, 70. Further estimations failed to show any variations.

Urine: March 7, 1917, this was observed to be brown and "smoky" with a specific gravity of 1.015; there were 4 gm. of albumin per liter, with red blood cells, cellular and granular casts.

Table 4 gives the results on the rate of urea and chlorid secretion and the phenolsulphonephthalein test.

CASE 3 (Medical No. 24890). *History*.—A boy, aged 15, was admitted to the Royal Victoria Hospital Dec. 3, 1916. The patient complained of swelling of face and ankles and difficulty in passing urine. He was in usual health until twelve days previously, when he caught cold. At the onset he had chilly sensations and his face and ankles became swollen. He had no polyuria, but during the previous week micturition had been painful. The patient had scarlet fever, with a normal convalescence, when 5 years of age. The family history was unimportant.

Examination: The patient was a fairly well nourished boy; the mucous membranes were pale and around both eyes and ankles there was marked edema. The examination was otherwise negative. The temperature was normal, also the fundi.

BLOOD PRESSURE

Date	Systolic	Diastolic
Dec. 4, 1916.....	130	80
March 2, 1917.....	140	88
April 20, 1917.....	120	60
May 4, 1917.....	128	88

—OF CHLORID EXCRETION AND THE PHENOLSULPHONEPHTHALEIN TEST
—Diagnosis: Acute Nephritis

Sodium Chlorid					Thresh- old	Phenol- sulphone- phthalein, Two Hours, per Cent.	Remarks
Gm. per Liter of Urine, C	Gm. per 24 Hours, D	Gm. per Liter of Plasma					
		Calcu- lated	Actual	Differ- ence			
2.5	2.76	5.736	6.125	+0.389	6.009	59	Slight edema of legs: albumin = 4 gm. per liter
4.56	7.20	5.84	6.562	+0.722	6.342	79	
3.5	3.27	5.763	6.50	+0.737	6.357	72	
3.87	4.08	5.783	5.875	+0.092	5.712	73	Albumin = 2 gm. per liter
3.37	5.49	5.804	5.843	+0.039	5.659	74	
4.81	9.23	5.879	5.906	+0.027	5.647	75	Albumin, a trace
4.12	17.97	5.966	6.200	+0.234	5.966		
5.68	15.40	5.968	5.812	—0.156	5.464	48	
7.18	6.19	5.853	5.937	+0.084	5.704	81	Discharged. Albumin a trace
9.93	14.53	6.006	6.062	+0.056	5.676	85	

TABLE 5.—THE DIET PRESCRIBED IN CASE 2 DURING THE STUDY
OF THE KIDNEY EXCRETIONS.

Date	Diet	Sodium Chlorid	Fluid Intake, C.c.
3/ 6/17	Restricted protein.....	Salt-free	1,500
3/14/17	Protein, 52; fat, 73; carbohydrate, 118.....	Salt free	1,500
3/20/17	Protein, 64; fat, 86; carbohydrate, 187.....	Salt-free	1,500
4/11/17	Protein, 80; fat, 90; carbohydrate, 250.....	Salt-free	1,500

Two nephritic test meals, one shortly after admission and one late in convalescence, are given in full. The second shows a marked impairment of function.

Blood: Dec. 5, 1916, the red blood cell count was 3,305,000, white blood cells, 7,000, and the hemoglobin was 55 per cent. (Sahli).

Urine: Dec. 4, 1916, the color was reddish amber; specific gravity 1.020, with 6 gm. of albumin per liter. Microscopically there were many red blood cells, granular and cellular casts.

Table 8 gives in full the urea and chlorid studies and the phenolsulphone-phthalein tests.

TABLE 6.—RECORD OF RESULTS FOLLOWING NEPHRITIC TEST MEALS.

Case 2: March 8, 1917. Administered shortly after admission

Time of Day	Urine, C.c.	Specific Gravity	Sodium	Chlorid	Nitrogen	
			Per Cent.	Gm.	Per Cent.	Gm.
8-10.....	135	1.018				
10-12.....	155	1.017				
12- 2.....	190	1.016				
2- 4.....	135	1.015				
4- 6.....	163	1.016				
6- 8.....	185	1.015				
Total day.....	968	.....	0.26	2.52	0.886	8.50
Night, 8-8.....	720	1.018	0.22	1.58	0.992	7.04
Total 24 hours.....	1,688	.....	.....	4.10	.....	15.54
Intake.....	1,760	.....	.....	7.5	.....	13.4
Balance.....	+72	.....	.....	+3.4	.....	-2.14

Case 2: May 14, 1917. Administered late in convalescence

8-10.....	111	1.026				
10-12.....	112	1.023				
12- 2.....	145	1.018				
2- 4.....	171	1.016				
4- 6.....	116	1.020				
6- 8.....	118	1.023				
Total day.....	773	.....	0.72	5.58	0.63	4.90
Night, 8-8.....	740	1.018	0.62	4.62	0.62	4.59
Total 24 hours.....	1,513	.....	.....	10.20	.....	9.49
Intake.....	1,760	.....	.....	8.5	.....	13.4
Balance.....	+247	.....	.....	-1.70	.....	+3.91

DISCUSSION OF RESULTS

The first two cases may be grouped together, as they both show an involvement of the kidney's ability to eliminate nitrogen and chlorids, while the third may be considered to be a true chlorid case.

Case 1. Impairment in Rate of Urea Excretion with Convalescence.—In this case the main point that I wish to emphasize is the marked impairment in the rate of urea and of phenolsulphonaphthalein excretion starting on December 1. Simultaneously the actual concentration of blood plasma chlorid and the level of the chlorid threshold show a return to practically normal figures. This prolonged extreme impairment in the rate of urea excretion first appeared at the time when the patient started to show marked improvement in the general clinical condition. From December 1 to January 13, clinically, he improved rapidly, his anemia disappeared, strength returned and hematuria rapidly subsided. The hematuria had completely disappeared by January 2, and the albuminuria, 8 gm. per liter at the onset, had dropped to a slight trace. At no time was there any serum globulin in the urine.

Case 2.—Steady Improvement in Function.—In contrast to the findings in Case 1 are those of Case 2, in which there was no slump in function, the rate of urea and of phthalein excretion improving from the onset. The general clinical condition of the patient ran parallel to the functional findings. On considering this point I believe that the marked and prolonged slump in function, as shown in Case 1, was due to a subsidence of the acute inflammatory condition present in the kidneys at the onset. Evidently, if an acute nephritis is severe enough, the function is hyperactive. As the inflammation subsides and the stimulation is removed the kidneys display a function which is more truly an index of the actual state of affairs. This is the critical period in any case of acute nephritis, as it is during this prolonged rest that great care must be taken not to overstrain the exhausted function. That this low level of function is often of much longer duration than supposed might be indicated by the results in Case 1.

In contrast to Case 1 are the findings in Case 2, in which there is no slump, but a steady improvement in function. This is explained, I believe, by the fact that the original inflammation was not severe enough to cause a hyperactive organ, rather the rate of urea excretion was in proportion to the disturbed process, and accordingly became a true index of the severity of the condition. Such would be the findings in the milder types of acute nephritis. Nevertheless, the function, as shown by the second test meal, has not improved to such an extent as the results in the rate of excretion of urea and of chlorids would indicate.

TABLE 7.—RECORD IN DETAIL OF THE STUDIES RESPECTING UREA—
Case 3. Medical No. 24890—

Date	Weight, Kg.	Urine, per 24 Hours, C.c.	Urea				
			Gm. per Liter of Blood, Ur	Gm. per Liter of Urine, O	Gm. per 24 Hours D	McLean's Index	Ambard Constant
12/ 4/16	50.0	4,800	0.42	12.67	60.81	220	0.054
12/ 8/16	47.7	2,722	0.27	5.4	14.64	88	0.085
12/20/16	40.8	3,986	0.46	7.87	30.96	98	0.081
1/ 2/17	40.9	1,440	0.45	18.51	26.64	124	0.072
1/13/17	40.7	1,056	0.39	18.12	18.91	117	0.074
1/26/17	41.1	10,968	0.18	0.51	5.59	27	0.157
2/ 2/17	40.7	1,680	0.36	15.63	26.25	177	0.060
2/ 9/17	40.6	1,368	0.30	17.82	24.37	252	0.055
2/16/17	40.8	370	0.27	25.65	9.48	144	0.089
3/ 2/17	43.2	2,496	0.135	6.09	15.19	427	0.089
3/16/17	45.4	5,760	0.12	2.23	12.84	264	0.049
4/ 6/17	47.1	1,320	0.255	18.01	23.76	295	0.047
4/20/17	47.5	1,296	0.255	13.02	16.93	178	0.060
5/ 4/17	47.4	1,848	0.315	20.32	37.53	324	0.044
5/18/17	48.2	5,424	0.265	5.04	32.13	192	0.058
6/ 1/17	47.6	2,160	0.285	12.85	27.75	231	0.053
6/22/17	50.1	972	0.28	22.75	22.10	238	0.052
7/ 6/17	46.9	4,080	....	.....	.....	...	.....

—AND CHLORID EXCRETION AND THE PHENOLSULPHONEPHTHALEIN TESTS

—Diagnosis: Acute Nephritis

Sodium Chlorid					Thresh- old	Phenol- sulphone- phthalein, Two Hours, per Cent.	Remarks
Gm. per Liter of Urine, C	Gm. per 24 Hours, D	Gm. per Liter of Plasma					
		Calcu- lated	Actual	Differ- ence			
6.12	29.37	6.205	6.875	+0.67	6.29	36	Edematous
5.56	15.07	6.04	6.987	+0.897	6.517	..	Albumin = 6 gm. per liter
1.68	6.6	5.842	7.162	+1.320	6.940	81	
3.56	5.11	5.856	6.900	+1.044	6.664	81	
2.87	3.02	5.792	6.625	+0.833	6.453	..	Jan. 25, 1917, theophyl- lin, 15 grains
0.62	6.84	5.796	6.718	+0.922	6.542	..	Albumin = 2 gm. per liter
6.45	10.82	6.02	6.875	+0.855	6.475		
7.18	9.82	6.011	6.750	+0.739	6.359	..	Albumin = 0.5 gm. per liter
4.87	1.79	5.771	6.687	+0.916	6.536	85	Feb. 22, 1917, discharged
4.43	11.04	5.977	6.562	+0.585	6.205	74	
2.06	11.86	5.890	7.037	+1.147	6.767	89	Ate extra salt
6.62	9.73	5.974	6.625	+0.651	6.271	82	Albumin, heavy trace
7.13	9.24	5.970	5.969	-0.001	5.619	55	
2.68	4.95	5.821	6.062	+0.241	5.861	80	
2.12	11.52	5.907	6.062	+0.155	5.775		
3.37	7.29	5.877	5.812	-0.065	5.555	84	
6.0	3.83	5.880	5.625	-0.255	5.365	83	Albumin, a trace
1.3	5.30	5.775	5.437	-0.338	5.262	86	

TABLE 8.—DIET IN CONNECTION WITH THE OBSERVATIONS
RECORDED IN TABLE 7.

Date	Diet	Sodium Chlorid	Fluid Intake, C.c.
12/10/16	Protein, 61; fat, 85; carbohydrate, 127.....	Salt-free	1,500
12/17/16	Protein, 82; fat, 91; carbohydrate, 139.....	Salt-free	1,500
1/17/17	Low protein diet.....	Salt-free	1,500
1/27/17	Protein, 82; fat, 91; carbohydrate, 139.....	Salt-free	1,500
2/13/17	Protein, 79; fat, 119; carbohydrate, 149.....	Salt-free	1,900

The results of the study of one nephritic test meal carried out on admission is recorded in Table 9.

TABLE 9.—A STUDY OF THE RESULTS FOLLOWING A NEPHRITIC TEST MEAL
Case 3: Dec. 4, 1916

Time of Day	Urine, C.c.	Specific Gravity	Sodium Chlorid		Nitrogen	
			Per Cent.	Gm.	Per Cent.	Gm.
8-10, 10-12.....	192	1.019				
12- 2.....	120	1.019				
2- 4.....	105	1.020				
4- 6.....	129	1.020				
6- 8.....	140	1.019				
Total day.....	686	.....	0.60	4.08	1.00	6.86
Night, 8-8.....	375	1.018	0.58	2.14	0.85	3.14
Total 24 hours.....	1,061	.....	.....	6.22	.....	10.00
Intake.....	1,680	.....	.....	8.2	.....	9.4
Balance.....	+619	.....	.....	+1.98	.....	-0.6

Case 3. Functional Disturbances Confined to Excretion of Chlorids.

—The third case is one in which the chlorid function is at fault and demonstrates rather well the possible duration of the disturbance even when on a salt-free diet, since it requires six months to bring the threshold to a normal level. Throughout, the rate of urea excretion was not impaired. The phenolsulphonephthalein, except for the first estimation on December 6, remained within normal limits.

Edema.—All three of the cases showed a moderate amount of edema on admission. This condition was most marked in Case 3. The edema disappeared long before the chlorid threshold had reached normal levels, but did not reappear when at a later date their levels became temporarily raised. Serum globulin failed to show in the urine in

Case 3, and the blood cholesterol remained normal, which would exclude it from the group of cases recently described by Epstein.¹¹

Relation of Nephritis to Glucose Threshold.—The raised level of the glucose threshold present in many cases of acute nephritis is well shown in Case 1, in which, after 100 gm. of glucose were administered by mouth on a fasting stomach, the following results were recorded, November 8:

11:50 a. m.	0.100 per cent.	No glucose
12:00 noon	100 gm. glucose in black coffee	
1:00 p. m.	0.184 per cent.	No glucose
2:00 p. m.	0.217 per cent.	No glucose
3:00 p. m.	0.170 per cent.	Faintest trace
4:00 p. m.	0.111 per cent.	No glucose

On November 28 the test was repeated with the following results:

7:45 a. m.	0.090 per cent.	No glucose
8:00 a. m.	100 gm. glucose in black coffee	
9:00 a. m.	0.152 per cent.	No glucose
10:00 a. m.	0.156 per cent.	No glucose
11:00 a. m.	0.122 per cent.	No glucose
12:00 noon	0.120 per cent.	No glucose
2:00 p. m.	0.080 per cent.	No glucose

The foregoing results would indicate that the block for glucose was present only during the period of stimulation.

Action of Theophyllin.—There is another point which I wish to present. In Case 1, 15 grains of theophyllin (theocin) were administered by mouth January 9, which was followed by a very marked diuresis lasting for two days. Simultaneously with this diuresis the level of the chlorid threshold dropped to 5.342 gm. per liter, January 10, returning to 5.964 gm. per liter January 13. In Case 3, also, 15 grains of theophyllin were administered by mouth January 25, but there was no diuresis, and the chlorid threshold, January 26, was slightly raised to 6.542 gm. per liter. Simultaneously the McLean index fell from 117 to 27. This would indicate that in Case 3 the kidney failed to respond to the drug, accordingly showing an impairment of function rather than an improvement. Following up these suggestions I have tried the action of theophyllin on normal and pathologic kidneys with results that seem to indicate that the drug acts on the chlorid threshold, allowing the chlorids to pass out of the blood stream, as well shown in Case 1 in which the blood plasma chlorid dropped from 6.50 to 5.47 gm. per liter, the water following.

In no case in which diuresis was not obtained was there a lowering of the chlorid threshold. Usually when there was no diuresis the chlorid threshold became markedly raised and the rate of urea excretion impaired. This is well shown in a chlorid case of chronic nephritis

11. Epstein: Tr. A. M. A., June, 1917.

(Med. No. 25180) in which there was no diuresis, the chlorid threshold going from 6.114 to 6.640 gm. per liter, with a drop in the rate of urea excretion from 212 to 6.9 (McLean's index). Further observations are being conducted on the action of theophyllin which will be reported at a subsequent date.

SUMMARY

Studies have been conducted on three cases of acute nephritis which demonstrate the following points:

1. In very severe cases of acute nephritis the kidney function during the early stages is much better than the actual state of the kidneys would seem to warrant. This is due to the increased stimulation from which they are suffering.

2. With the subsidence of the inflammation the function tends to fall to a very low level, which level is more truly an index of the kidney state. As convalescence is established this level tends to return to that at which the kidneys remain permanently damaged. This "slump" in function takes place simultaneously with a marked improvement in the clinical condition of the patient.

3. Theophyllin probably acts in part by lowering the chlorid threshold, thereby allowing the chlorids to pass out of the blood plasma, water following.

I should like to express my thanks to Miss Jacobson, my chemical technician, for her careful work in carrying out a large part of the chemical estimations.