

## STUDIES OF SERUM ELECTROLYTES

### V. URINARY ELECTROLYTE EXCRETION IN PNEUMONIA<sup>1</sup>

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(Received for publication October 30, 1928)

In a previous paper (1) one of us has presented studies of weight and nitrogen and chloride balance in pneumonia. It is probable that the changes studied could have been more readily interpreted had we had full information with respect to the other electrolytes as well as with respect to chlorides. To obtain this was not at the time practical. We have, however, data on the urinary excretion of fixed base, sulphate and phosphate from the same subjects over the same period of days in pooled specimens of urine each representing the combined collection of urine from a subject for those consecutive days during which the chloride excretion had been fairly constant. These data are presented and discussed in this paper. Case numbers are the same as in the previous paper.

Total base was measured by Fiske's method (2), inorganic sulphate by Folin's method (3) and phosphate by Briggs' method (4). The figures for phosphate excretion are expressed as m.Eq. which have been calculated by assuming 1.8 m.Eq. per mM. of  $\text{PO}_4$ .

In order that we might have some standard with which to compare the rates of excretion of these electrolytes in our patients with pneumonia we placed two normal subjects for 2 days on a similar dietary intake and had them undergo severe sweating in a cabinet light bath on each of the 2 days. We have made our comparisons with the second day of study of these normal subjects. Furthermore, in order to compare the patients, who differed greatly in size, all excre-

<sup>1</sup> Aided by a grant from the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation.

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<sup>3</sup> Service of Dr. George W. Norris.

tion rates have been reduced to constant surface area by multiplying by the ratio of the surface area of the subject to 2.10. The data are given in Table I.

#### RESULTS

*Cases not receiving extra salt (B1, B3, B4 and B5).* In the total periods of B1 and B5, in the first period of B3 and in the first two periods of B4 the following features are evident when comparing the excretion rates with those of the second day of the control subjects:

1. The total water output by all channels was 35 to 96 per cent above the controls.

2. The urinary output however, was not increased in two of the four cases although moderately or markedly increased in the other two.

3. In contrast to the low chloride excretion the sum of the measured anions excreted was little reduced or actually increased as compared with the controls. When we consider that Holten (5) has demonstrated considerable increase in organic acid excretion in pneumonia the sum of the anions should probably be still further increased relative to the controls. This deserves emphasis as indicating that the very low chloride excretion in the urine in the precritical period of pneumonia is not necessarily paralleled by low total electrolyte excretion and it suggests the possibility that the low chloride excretion may be in part an adaptation to make way for other anions the excretion of which is perhaps more important.

4. The excretion of phosphate was slightly increased in three of the four cases as compared with the controls.

5. The excretion of sulphate was strikingly increased in all four as compared with the controls. The ratio of sulphate to nitrogen excreted was in these periods of the patients and in the controls approximately the same and it seems proper to correlate the increased sulphate excretion with the increased protein metabolism.

6. The fixed base excretion was greatly reduced ranging from only 20 to 85 per cent of the mean for the two controls. The low base relative to the anion excretion was presumably compensated for by high ammonia and titratable acid in the urine. Our pneumonia patients in the periods under consideration were therefore excreting an excessive amount of certain acid metabolites under the handicap

of limited excretion of fixed base. At least one factor in the limitation of fixed base available for excretion was undoubtedly the low base intake of the diet.

A consideration of these results suggests that the low chloride excretion in the precritical period of pneumonia is dependent in large

TABLE 1  
Average excretion per day of measured electrolytes in urine

Case number	Days of period	Total water output	Urine							Surface area
			Water	Chloride	SO <sub>4</sub>	PO <sub>4</sub>	Measured anions	Fixed base	SO <sub>4</sub> 3.61N	
		liters	liters	m. Eq.	m. Eq.	m. Eq.*	m. Eq.	m. Eq.		sq. m.
B1	-1, +1	5.3	1.26	0	72	43	115	22	0.82	1.68
B3	-3, +1	4.3	1.35	7	78	68	153	86	0.89	} 2.40
	+2, +7	4.1	2.08	88	64	54	206	152	1.01	
B4	-2, +3	5.4	2.01	30	} 85 {	74	} 194 {	135	} 0.88 {	} 1.91
	+4, +6	4.4	2.48	37		81		142		
	+7, +8	3.8	3.03	176		109		79		
B5	-3, +3	6.3	3.66	29	68	34	131	60	0.81	1.02
B6	-5, -4	5.2	2.01	34	154	63	251	62	} 1.02	} 1.68
	-3, +4	4.8	2.31	338	46	52	436	298		
B7	-6, -5	4.0	1.23	3	61	31	95	52	} 0.94	} 1.87
	-4, -1	3.8	2.05	83	} 47	} 34	} 146	80		
	0, +1	2.4	1.12	48				75		
	+2, +3	2.3	1.19	45				83		
B8	2	3.1	1.09	61				43	49	153
B9	2	3.3	1.62	58	40	50	148	129	0.87	2.17

\* Estimated as 1.8 m. Eq. per mM.

measure on low chloride intake and perhaps in part upon the need for excretion of excessive amounts of sulphate, phosphate, and organic acid under the handicap of little fixed base available for excretion. It is possible, furthermore, that this demand for fixed base for excretion is a factor in the low base concentration in the serum in the precritical period of pneumonia. Correlated with this would be a

tendency for lowering of the serum chloride. Furthermore, in the need for transporting the increased amounts of sulphate, organic acids, and phosphate from the tissues to the kidneys we have perhaps a reason, although not a mechanism, for the disproportionate lowering of the serum chloride.

In the two patients B3 and B4, studied through more than one period the following features are evident in the final period:

7. There was a diminution in the high total output of water associated with increase in the urine and necessarily diminished loss of water by skin and lungs.

8. The fixed base excretion was increased.

9. The ratio of sulphate to nitrogen increased.

10. The chloride excretion increased in correlation, we believe, with the increased intake of chloride and fixed base consequent upon the more liberal food intake.

*Cases receiving extra salt (B6 and B7).* As compared with the patients receiving no extra salt these two subjects exhibited high excretion of fixed base and chloride. In B7 the excretion of chloride was much below the intake and this was associated with marked retention of water and eventually with visible edema. That a tendency to chloride retention characterizes the behavior of patients with pneumonia when given NaCl freely was pointed out in the previous paper (1).

#### SUMMARY

The low chloride excretion observed in the urine in the precritical period in patients on the usual low diet not receiving salt was associated with low urinary excretion of fixed base but with very high excretion of sulphate and phosphate so that the total anion excretion in the urine was not far from that of normal subjects on a similar diet. The high sulphate excretion was proportional to the high nitrogen excretion and is probably to be correlated with the tissue catabolism.

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