Urine Chlorin of Infants Nursed with Human Milk of Different Arakawa's Reaction.*

98th Report of the Peroxidase Reaction.

By

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The chlorin intaken is, as Amberg¹⁾ or Rietschel²⁾ or Noeggerath-Eckstein³⁾ writes from a survey of literature, in a normal metabolism of infants, chiefly excreted in the urine, and its quantity in the urine will depend usually upon its amount in the food. And the chlorin is poor in the urine of infants, for human milk is chlorin-poor and the artificially fed infant excretes, due to a larger amount of chlorin in the food, a larger quantity of chlorin in the urine than the breast-fed infant. Walther Freund⁴⁾ introduced in his exhaustive treatise the results of different authors concerning the urine chlorin in breast-fed infants, besides interesting experiments performed by Michel (Cf. Table 1). Michel estimated, he cites, chlorine intake of

* Arakawa-positive may be used in two different senses. One of these is: Arakawa-positive in a biochemical sense. A sample of human milk is said to have become Arakawa-positive, when it becomes blue on the addition of Arakawa's reagent. There it means that the sample is not negative to Arakawa's reaction. Arakawa-positive in a clinical sense: A sample of human milk is clinically Arakawa-positive only when it shows such a reaction as ++ or +++ in one minute of the addition of Arakawa's reagent. Another sample of human milk may be Arakawa-positive in the first described sense, but yet clinically negative.

1) S. Amberg, Abt's Pediatrics, 1923 Phil. & Lond., 4, 1111.

2) H. Rietschel, Handbuch der Kinderheilkunde, compiled by Pfaundler and Schlossmann, 1923 Lpg., Vol. 1, 340.

3) C. Noeggerath and A. Eckstein, Handbuch der Kinderheilkunde, compiled by Pfaundler and Schlossmann, 1923 Lpg., Vol. 4, 30.

4) W. Freund, Jahrb. f. Kinderh., 1898, 48, 137.

infants and determined chlorin in their urine and stools and saw a retention of the salt in the infantile organism. Freund himself experimented on it and asserted Michel's conclusion. Schiff saw, Freund cites, a considerable increase of chlorine content of urine in an infant nursed by a feverish mother and attributed the cause to an increase of chlorine content in the mother's milk due to chlorine retention caused by fever in the maternal body.

TABLE 1.

Chlorine data of different authors cited in the paper of W. Freund.

Authors	NaCl content in urine of infants
Dorn	0.033–0.497% (immediately after the delivery)
Martin and Ruge	0.107% (0–10 days)
Hecker and Vogel	0.089–0.150% (3–17 days)
Parrot and Robin	0.069% (0–8 days) 0.090% (9–30 days)
Ultzmann and Pollack	0.069% (5 weeks)

Now I have investigated in this paper the relation between Arakawa's reaction and the chlorine content of the urine of breast-fed infants.

Materials and Method of Investigation.

Materials were chiefly collected in the morning (9–12 A.M.) from the infantile out-patients of our Department. Only 22 out of all my 110 samples were obtained from healthy male infants at a baby show held in this city on May 5th. last year.

The chlorine method used for this purpose is that of St. Rusznayak.⁵⁾

Result of Experiment.

All the cases examined are given in Table 2.

As is shown in Table 3, the chlorine content in the urine of breast-fed infants is in Arakawa-positive cases 38.0 mgrms. %, and in negative cases 41.1 mgrms. %. If, however, negative cases are grouped into cases with intermediate reaction and cases with completely or al-

5) St. Rusznayak, Biochem. Z., 1921, 114, 23.

TABLE 2. All the cases examined.

Month: No. of experiment	Age of infant m = months d = days	Arakawa's reaction (Cf. Table 8)		Chlorin in urine (mgms. %)	Approximate amount (c.c.) collected	Specific gravity	Month: No. of experiment	Age of infant m = months d = days	Arakawa's reaction (Cf. Table 8)		Chlorin in urine (mgms. %)	Approximate amount (c.c.) collected	Specific gravity
		Right breast	Left breast						Right breast	Left breast			
V	1	4(+)	1(+)	46.1	8		III	5m	1(+)	1(+)	31.9	5	
	2	2(+)	1(+)	14.2	5			4m	3(-)	11(-)	60.3	15	
	3	16(-)	12(-)	49.7				31	8(-)	14(-)	17.7	12	
	4	16(+)	5(+)	24.8				95d	9(+)	15(-)	35.5	20	
	5	1(+)	1(+)	74.5	5			4m	11(-)	16(-)	35.5	4	
VI	6	1(+)	1(+)	46.1	3		IV	8m	12(-)	11(+)	7.1	2	
	7	1(+)	1(+)	31.9	2			45d	7(+)	6(-)	46.1	10	
	8	2(+)	2(+)	67.4	3			106d	8(-)	6(-)	21.3	10	
	9	11(+)	8(-)	85.2				52d	2(+)	3(-)	39.0	3	
	10	11(+)	7(+)	46.1				5m	12(-)	12(-)	14.2	5	
VII	11	5(+)	3(+)	78.1			V	66d	6(-)	1(+)	31.9	10	
	12	16(-)	13(-)	44.4				40	3(-)	3(-)	21.3	10	
	13	10(+)	8(-)	31.9				11m	11(+)	16(-)	60.3	5	
	14	14(-)	11(-)	31.9				6m	1(+)	1(+)	60.3	1	
	15	5(+)	5(+)	31.9				4m	13(+)	13(+)	28.4	2	
X	16	9(+)	2(+)	67.4			VI	5m	7(+)	7(+)	31.9	9	
	17	8(-)	8(-)	31.9				4m	16(-)	5(+)	74.5	4	
	18	4(+)	7(+)	81.6				26d	14(-)	16(-)	42.5	10	
	19	6(+)	11(+)	67.4				87d	16(-)	11(+)	19.1	10	
	20	2(+)	5(+)	67.4				11m	11(+)	4(+)	88.7	10	
I	21	1(+)	1(+)	67.4			VII	48	9(+)	8(+)	60.3	1	
	22	7(+)	6(-)	39.0	2			60d	16(-)	15(-)	15.9	6	
	23	4(-)	4(-)	28.4	4			10m	16(-)	1(+)	60.3	10	
	24	6(+)	10(-)	28.4	6			6m	1(+)	1(+)	46.1	5	
	25	1(+)	3(+)	60.3				4m	2(+)	1(+)	14.2	15	
I	26	7(+)	9(+)	42.6			VIII	11m	1(+)	1(+)	42.6	10	
	27	16(-)	4(-)	31.9				74d	1(+)	1(+)	88.7	2	
	28	7(+)	7(+)	39.0				60d	2(+)	2(+)	10.6	10	

Month; No. of experiment	Age of infant m = months d = days	Arakawa's reaction (Cf. Table 8)		Chlorin in urine (mgms. %)	Approximate amount (c.c.) collected	Specific gravity			
		Right breast	Left breast						
VII	57 7m	3(+)	1(+)	10.6	10	1005			
	58 11m	4(-)	8(-)	39.0	1				
	59 57d	6(+)	10(+)	67.4	15				
	60 4m	12(-)	7(+)	21.3	15				
	61 69d	6(-)	16(-)	49.7	15				
	62 4m	6(+)	11(+)	31.9	15				
IX	63 11m	3(+)	2(+)	31.9	15	1006			
	64 6m	1(+)	3(+)	31.9	10				
	65 3m	1(+)	4(-)	74.5	10				
	66 58d	4(-)	4(+)	88.7	12				
	67 11m	4(-)	4(-)	17.7	4				
	68 76d	16(-)	16(-)	24.8	6				
X	69 11m	4(+)	5(+)	60.3	10	1007			
	70 6m	2(+)	1(+)	39.0	5				
	71 4m	2(+)	2(+)	49.7	10				
	72 60d	3(+)	3(+)	31.9	8				
	73 8m	10(-)	10(-)	14.2	5				
	74 62d	10(-)	6(+)	24.8	10				
XI	75 7m	12(-)	12(-)	67.4	10	1008			
	76 11m	16(-)	16(-)	56.8	2				
	77 9m	1(+)	1(+)	53.2	4				
	78 97d	11(+)	9(+)	39.0	2				
	79 4m	9(+)	5(+)	39.0	5				
	80 30d	5(+)	12(-)	49.7	10				
1009	81 4m	10(+)	11(+)	21.3	15	1010			
	82 11m	16(-)	14(-)	53.2	10				
	83 74d	6(-)	2(+)	28.4	10				
	84 17d	16(-)	15(-)	42.6	10				
	1005	85 85			47d		16(-)	16(-)	17.7
		XII 86			4m		3(+)	5(+)	35.5
II 87				46d	10(-)	10(-)	42.6		
II 88				3m	7(+)	7(+)	35.5		
V 89				2m	1' 3'	1' 3'	24.8		
90 7m				7m	1' 3'	1' 3'	28.4		
91 6m				6m	1' 3'	1' 3'	17.7		
92 5m				5m	1' 3'	1' 3'	74.5		
93 5m				5m	1' 3'	1' 3'	17.7		
95 4m				4m	1' 3'	1' 3'	14.2		
1005	96 5m			5m	1' 3'	1' 3'	17.7		
	97 5m			5m	1' 3'	1' 3'	63.9		
	98 52d			52d	1' 3'	1' 3'	14.2		
	99 3m			3m	1' 3'	1' 3'	53.2		
	100 4m			4m	1' 3'	1' 3'	31.9		
	101 5m			5m	1' 3'	1' 3'	35.5		
	102 5m			5m	1' 3'	1' 3'	31.9		
	103 50d			50d	1' 3'	1' 3'	28.4		
	104 7m			7m	1' 3'	1' 3'	10.6		
	105 4m			4m	1' 3'	1' 3'	28.4		
1005	106 8m			8m	1' 3'	1' 3'	49.7		
	107 5m			5m	1' 3'	1' 3'	31.9		
	108 5m			5m	1' 3'	1' 3'	17.7		
	109 7m			7m	1' 3'	1' 3'	49.7		
	110 4m			4m	1' 3'	1' 3'	24.8		
	1005	111 4m			4m	1' 3'	1' 3'	24.8	
		112 4m			4m	1' 3'	1' 3'	24.8	
		113 4m			4m	1' 3'	1' 3'	24.8	
		114 4m			4m	1' 3'	1' 3'	24.8	
		115 4m			4m	1' 3'	1' 3'	24.8	
116 4m				4m	1' 3'	1' 3'	24.8		
117 4m				4m	1' 3'	1' 3'	24.8		
118 4m				4m	1' 3'	1' 3'	24.8		
119 4m				4m	1' 3'	1' 3'	24.8		
120 4m				4m	1' 3'	1' 3'	24.8		

TABLE 3.

Arakawa's reaction and chlorine content in urine of breast-fed infants.

	Arakawa-positive cases	Arakawa-negative cases			Average of all the cases
Chlorine content in urine (mgrms. %)	38.0 (27 cases in number)	41.1 (83 cases in number)	Intermediate reaction	41.5 (75 cases in number)	40.4
			Completely or almost completely negative reaction	37.3 (8 cases in number)	

most completely negative reaction, it is 41.5 mgrms. % in the former, while it is 37.3 mgrms. % in the latter.

TABLE 4.

Human milk chlorin according to the intensity of Arakawa's reaction.

	Arakawa-positive milks	Arakawa-negative milks	Completely or almost completely negative milks
Chlorine content in human milk (mgrms. %)	34.5 (34.9)* 266 (276)* cases in number	48.2 (50.7)* 532 (624)* cases in number	61.3 (63.6)*

* The data and the number of all the cases including samples within one month after the delivery.

Now, the chlorin intaken by those infants will be examined (Cf. Table 4). The chlorine content of mother's milk is in Arakawa-positive cases 34.5 mgrms. % (or 34.9 mgrms. %, if the cases within one month of the delivery are included among them), in Arakawa-negative cases 48.2 mgrms. % (or 50.7 mgrms. %, if the cases within one month of the delivery are included among them), and in completely or almost completely negative cases 61.3 mgrms. % (or 63.6 mgrms. %, if the cases within one month of the delivery are included among them). Though one whole day's amount cannot be cited here, yet we can obtain an idea of the chlorine metabolism in those breast-fed infants, if the chlorine content in mother's milk and that in infant's urine are compared with each other. Infants of Arakawa-positive mothers with 34.5 or 34.9 mgrms. % of chlorin in their milk excrete the urine with 38.0

mgrms. % of the salt, and those with Arakawa-negative mothers with 48.2 or 50.7 mgrms. % of chlorin in their milk excrete the urine with 41.1 mgrms. %, while those with completely or almost completely Arakawa-negative mothers with 61.3 or 63.6 mgrms. % of chlorin in their milk excrete the urine with 37.3 mgrms. %.

If I make bold to make the following substractions*:

a. $34.5-38.0=-3.5$; b. $48.2-41.5=+6.7$; c. $61.3-37.3=+24.0$, then I know only too well that these figures obtained do not show anything concrete. Yet the difference among these three figures: -3.5 , $+6.7$ and $+24.0$ is, I believe, of important significance. The figure in Arakawa-positive and -negative cases are of the same order (3.5 resp. 6.7), but the sense is entirely different (-3.5 resp. $+6.7$). As to the completely negative cases, the order of the figures is different (24.0 in contrast to 3.5 or 6.7). The relation among these figures has led me to draw such diagrams as are shown below (Cf. Figure).

Figure. Schematic presentation of chlorine intake and excretion in infants fed on Arakawa-positive and-negative human milk.

In drawing these diagrams, I have taken also Umemura's opinion into consideration.

Umemura⁶⁾ who has been investigating in this Laboratory the relation between Arakawa's reaction and mother's chlorine content in urine, is of the opinion that an abnormal chlorine retention will occur in Arakawa-negative mothers.

6) H. Umemura, to be published in this Journal. His opinion is based on his own result of the investigation of urine chlorin.

His result is:—

About 0.9 grms. % in the case of Arakawa-positive mothers,
 " 0.85 " " weakly Arakawa-negative mothers and
 " 0.7 " " completely " " " "

* These figures are not to be added or subtracted of course, but the results will be convenient to give a rough idea of the state to be described here.

If the abnormal large chlorine figure of Arakawa-negative mothers is the result of such a retention, and if I can assume again an abnormal chlorine retention in the body of babies fed with Arakawa-negative milk, then the relation shown in the accompanying figure (Cf. Figure) will not be altogether unnatural.

The Figure (Cf. Figure) shown above is of course not based on the quantitative estimation of one whole day's amount of milk chlorin or urine chlorin, yet, if milk secretion or better milk intake and urine excretion are assumed to be of an equal amount in infants of Arakawa-positive, Arakawa-negative mothers and those with intermediate reactions, then the figure will show a rough idea of chlorine metabolism of those infants.

TABLE 5.

Remarks.

Monthly variation of chlorine content in urine of infants according to Arakawa's reaction.

1. By way of appendix, monthly variation of chlorine content in the urine of breast-fed infants and the relation between the period of lactation and chlorine content of their urine are shown in Tables 5 and 6 (Cf. Tables 5 and 6).

Month	Chlorin (mgrms. %)	
	Arakawa-positive cases	Arakawa-negative cases
3— 4— 5	30.3 (11 in number)	36.4 (39 in number)
6— 7— 8	45.8 (11 " ")	51.5 (17 " ")
9—10—11	39.0 (4 " ")	42.3 (23 " ")
12— 1— 2	31.9 (1 " ")	37.3 (4 " ")

TABLE 6.

Periods of lactation and chlorin in urine of infants according to Arakawa's reaction.

Age of infant	Chlorin (mgrms. %)	
	Arakawa-positive cases	Arakawa-negative cases
12 — 30 days		38.3 (5 in number)
2 — 4 months	35.5 (8 in number)	38.9 (41 " ")
5 — 9 "	39.7 (16 " ")	39.9 (24 " ")
10 — 20 "	35.5 (3 " ")	51.6 (13 " ")

2. Chlorine content in the urine of 6 infants fed with allaitement mixte (mother's milk and cow's milk) is, as is shown in Table 7, remarkably higher than that of breast-fed infants (Cf. Table 7).

TABLE 7.

Chlorin in urine of the cases with allaitement mixte.

No. of exp.	Age of infant m=months	Chlorin in urine (mgrms. %)	Specific gravity
1	11 m	149.1	1012
2	7 m	334.0	1013
3	12 m	134.9	1005
4	10 m	170.4	1014
5	8 m	113.6	1013
6	4 m	156.2	1010

TABLE 8.

Table of signs for showing different Arakawa's reaction.

	1'	2'	3'	4'	5'		1'	2'	3'	4'	5'		
1.	1(##) stands for	##	##	##	##	25.	8(±)	"	±	±	+	++	##
2.	1(++)	"	++	##	##	26.	9(±)	"	±	±	+	++	##
3.	2(++)	"	++	++	##	27.	10(±)	"	±	±	+	++	##
4.	3(++)	"	++	++	++	28.	11(±)	"	±	±	+	++	##
5.	4(++)	"	++	++	++	29.	12(±)	"	±	±	±	++	##
6.	5(++) stands for	++	++	++	++	30.	13(±)	"	±	±	±	++	++
7.	1(+)	"	+	++	##	31.	14(±)	"	±	±	±	±	++
8.	2(+)	"	+	++	++	32.	15(±)	"	±	±	±	±	±
9.	3(+)	"	+	++	++	33.	1(-)	"	-	±	+	++	##
10.	4(+)	"	+	++	++	34.	2(-)	"	-	±	+	++	##
11.	5(+)	"	+	+	++	35.	3(-)	"	-	±	+	++	##
12.	6(+)	"	+	+	++	36.	4(-)	"	-	±	+	++	##
13.	7(+)	"	+	+	++	37.	5(-)	"	-	±	±	++	##
14.	8(+)	"	+	+	++	38.	6(-)	"	-	±	±	++	##
15.	9(+)	"	+	+	++	39.	7(-)	"	-	±	±	±	++
16.	10(+)	"	+	+	++	40.	8(-)	"	-	±	±	±	±
17.	11(+)	"	+	+	+	41.	9(-)	"	-	-	±	++	##
18.	1(±)	"	±	+	++	42.	10(-)	"	-	-	±	++	##
19.	2(±)	"	±	+	++	43.	11(-)	"	-	-	±	±	++
20.	3(±)	"	±	+	++	44.	12(-)	"	-	-	±	±	±
21.	4(±)	"	±	+	++	45.	13(-)	"	-	-	-	±	++
22.	5(±)	"	±	+	++	46.	14(-)	"	-	-	-	±	±
23.	6(±)	"	±	+	+	47.	15(-)	"	-	-	-	-	±
24.	7(±)	"	±	+	+	48.	16(-)	"	-	-	-	-	-

Explanation to the Table:—

Take, for instance, the sign: 2(++). This stands for Arakawa's reaction with the course (++)1' (++)2' (##)3' (##)4' (##)5'. The sign does not express any prompt result of the reaction, so the prompt reaction of the sign: 2(++), may be (-)0', (±)0', (+)0', or even (++)0', but this will not matter much, as the result of the reaction in one minute is the most important.

Summary.

In this paper the relation between A r a k a w a's reaction and the chlorine content of the urine of breast-fed infants is investigated. The chlorine content in the urine of breast-fed infants is 38.0 mgms. % in Arakawa-positive cases and 41.5 mgrms. % or 37.3 mgrms. % in intermediate or completely or almost completely negative cases. And viewed from the chlorine figures of milk of mothers with different A r a k a w a's reaction and those in the urine of breast-fed infants nursed with milks of different Arakawa's reaction, it is probable that an abnormal chlorine retention occurs in the body of babies fed with Arakawa-negative milk; more so, if U m e m u r a's opinion is taken into consideration.

Conclusion.

There is an abnormal chlorine retention in the body of babies fed with Arakawa-negative milk.