SALT CONTENT OF WOMAN'S MILK IN SOME CASES IN WHICH ITS USE WAS NOT BENEFICIAL

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During a period of four successive years there is a record at the Hospital for Sick Children, Toronto, of ninety infants admitted suffering from tetany in a more or less severe form. Of this number twenty had been breast-fed to date, some of the older infants taking in addition a milk dilution and sometimes cereal and biscuit. Two others of the ninety had been exclusively breast-fed to within two weeks of admission, and eight more had been breast-fed for a period of six months or longer after birth, though on artificial feeding for a month or more preceding the attack. Thus one-third of the infants with tetany had been breast-fed to date or for a period of six months or more after birth. It seems not unreasonable to conclude either that the mothers' milks were abnormal in composition, or that under adverse conditions normal woman's milk does not afford sufficient protection against tetany.

It is customary when breast-fed infants are admitted to the hospital suffering from tetany, or showing marked signs of rickets without tetany, to discontinue breast feeding entirely. Since under these circumstances it is usually a simple matter to obtain a large representative sample of the mother's milk, it seemed advisable to make complete salt analyses of the milk in as many cases as possible in order to learn how nearly these milks showed values within the normal range. As far as possible the milk was collected under the supervision of a nurse in the infant ward, and in the other cases explicit directions for making the collection were given the mother. The aim was to get all the milk that could be expressed from both breasts until a total of twenty ounces or more was obtained, the period of collection not to exceed three days. Beginning and end milkings by themselves were particularly to be avoided. The samples were kept cold until collection was completed, and no milk was used for analysis in a curdled state or when the cream could not be shaken into a homogeneous mixture with the rest of the milk.

Occasionally infants showed other symptoms than those of rickets and tetany which were assumed to be related to their being fed at the breast. This assumption was made because no other explanation was apparent and because usually the symptoms entirely disappeared when the infant was changed on to artificial feeding. In all such cases also, when practicable, collection of the mothers' milk was made for analysis. Altogether there were thus obtained for analysis seventeen milk samples from mothers of infants suffering from rickets and tetany, and thirteen from women whose milk appeared not to agree with the infants as indicated by other symptoms, such as, convulsions, not tetany, vomiting, diarrhoea, failure to gain in weight.

If the collected sample was sufficiently large, fat was estimated according to Babcock and a nitrogen separation was made in the fresh milk. The bulk

of the collection was immediately measured and set on a steam bath to dry to constant weight. In the powdered dried milk, total ash, calcium, magnesium, phosphorus, chloride, potassium and sodium were determined according to standard gravimetric methods. The sodium and potassium separation was made by the cobaltinitrite method according to the procedure of H. H. Green¹. There has been some criticism of the cobaltinitrite determination of potassium on the ground that the precipitate of sodium potassium cobaltinitrite is not a strictly constant compound. The values obtained by this procedure are given for what they are worth, but because of their possibly questionable value there are also included in the table values for total sodium and potassium chloride as separated from the other salts before the determination of potassium was made. It must be kept in mind that these values being chlorides of the elements are large in comparison with the total ash values.

Table 1 gives the values in grammes per 100 c.cm. of milk for the salt analysis (A) of the milks of mothers of infants suffering from tetany or rickets, and (B) for the milks when the infants showed other symptoms supposedly related to the breast feeding. Table 2 was compiled from table 1 to bring out in a more graphic way a comparison of these values with the normal averages. Values are considered average, indicated by 'ave.', if very close to those obtained for mature milk by Holt et al². In the case of CaO the average was considered to run to .043 grm. per 100 c.cm. of milk because of the somewhat lower normal values found by Burhans and Smith³ and by DeBuys and Meysenburg⁴, and in the case of K₂O the average was extended to .060 grm. per 100 c.cm. of milk, the value reported by Burhans and Smith. One (+) and one (—) was assigned to a value lying between the average and the normal limits for each element as given in Holt's tables, with a slight extension of the lower limit for calcium and the upper for potassium. For values higher or lower than the normal limits, the number of signs indicates the degree of divergence from the normal values. This distribution of signs is arbitrary but affords an approximately accurate measure of comparison of the different milks, particularly so in respect to each element by itself.

Considering table 2 as a whole it is seen that the greatest number of values outside the normal range, with more than one (+) or (—), occurs in the magnesium, chloride and sodium columns. In Group (A) alone sodium, calcium and magnesium have the greatest number of divergences, while in (B) all the columns except calcium and potassium show a large proportion of the values beyond the normal range. Thus it appears from these findings that the milks taken by the infants suffering from rickets and tetany show considerably less divergence from the normal in salt content than the milks which failed to agree with the infants for various other reasons. It is perhaps significant that in the rickets and tetany Group (A) the calcium and magnesium values, especially those for calcium, were mostly in the low direction from the average, though only about one-third were actually beyond the range found for normal milks. The values for phosphorus were more in the high direction, though few were beyond the normal range. The sodium column in this group shows many very high values in marked contrast with the calcium and magnesium values. This

is probably why the values for total salts were mostly in the normal range in this group. In Group (B) nearly all the values for total salts were higher than normal, for in Group (B) most of the abnormal values for the separate salts were in the direction of high values.

In four instances in which the milk calcium content was below the normal, values were obtained for the infants' blood calcium or phosphorus or both. In two of these both calcium and phosphorus of the blood were low, in one other calcium was low, phosphorus not being determined, and in the fourth calcium was normal but phosphorus very low, the infant in this case suffering from rickets only. In six other cases of Group (A) in which the milk calcium content was lower than the average but not beyond the normal limit, blood calcium or phosphorus or both were low.

The literature bearing upon the effect of diet upon the composition of the milk secreted was discussed in a preceding paper⁵ in which four of the milk samples included in those here presented were reported, and the discussion will not be taken up again now. In connection with most of these milk collections a description of the diet of the mother was obtained, particular attention being given to the quantity of the milk taken and whether adequate sources of fat-soluble and other vitamins were included. Although these reports were not altogether satisfactory, on the basis of them an attempt has been made to classify the diets of the mothers represented in Group (A) as poor, if glaringly defective in quantity of milk and vitamin supply, fair if deficient in one of these respects but not the other, and very poor when total caloric intake as well as quantity of milk and vitamin supply were clearly below requirement. Of these mothers whose milk calcium content was below the normal limit the diets were in two cases rated very poor, in two poor, and in two fair. In four cases in which the milk calcium content was below the average but within normal limits, the diets of the mothers were rated poor. In no case was a diet of the mothers of the infants suffering from rickets or tetany rated above fair. Curiously one of the most deficient diets reported was that of the mother indicated (Case 16) in the table, whose values for milk salts were among those the most nearly normal in the Group (A). Nursing, however, had not been so long continued as in the majority of cases in the group, the infant being only four months of age. In most of the milks of Group (A) the fat content was lower than the average, in three cases abnormally low.

The cases in Group (B) require some individual discussion. Case 18, a six weeks' old infant, had convulsions which ceased on removal from the breast, the convulsions being considered not due to tetany. The milk was abnormally low in calcium and magnesium content. Case 19 also had convulsions not due to tetany, calcium content of the blood serum being normal. There was also an acute infection in this case. The concentration of milk salts was almost normal. Case 27, a two weeks' old infant with a temperature unaccounted for, was taking a milk almost lacking in magnesium and abnormally high in total salts, sodium and potassium. Case 28, an infant who was vomiting

when taking mother's milk, recovered when changed to artificial feeding. This milk had a magnesium and sodium content lower than normal, that of potassium higher. Case 25, a 3 months' old infant with eczema, was taking a milk abnormally high in total salts, magnesium, sodium and chloride. Cases 23, 20, and 22 designate milks of wet nurses supplying premature infants in hospital wards. The infants were not thriving or showing the progress expected under the circumstances. Analyses were not complete for two of these milks, but the only outstanding abnormalities found were a very high calcium content in one, and very high phosphorus content in another. With a three months' old infant not thriving on mother's milk (Case 24), the low fat content seemed to be sufficient reason for the failure to gain in weight. There was also a decidedly abnormal salt content, phosphorus, sodium and chloride all being extremely high. The mother took exceptionally large amounts of table salt with her food. In three other cases (21, 29 and 30), the infants had ceased to gain and suffered from diarrhoea while taking mother's milk, and improved when removed from the breast. All these milks had phenomenally high sodium, potassium, chloride and total salt content. In two cases sodium and potassium were not determined but the great concentration of these elements can be inferred from the other values. In the milk highest in sodium and potassium chloride, calcium and phosphorus concentration was extremely low. In one of these three cases (No. 29), the mother took unusually large amounts of table salt with her food. There was no report on this point with the other two.

Summary.

1. Analyses to determine the content of the various salts were made in thirty samples of woman's milk which appeared to have an unfavourable effect upon the infant or infants taking it: in seventeen samples in cases in which the infants were suffering from rickets and tetany and in thirteen in which there were other unfavourable symptoms supposedly due to the breast feeding.

2. The milks in the tetany and rickets group showed a tendency to be low in calcium and magnesium, high in sodium content. In the other group the tendency was to be high in total salt, sodium, potassium and chloride, though there were some markedly abnormal values found in respect to all the salts determined. Only two milks of this group showed no striking abnormality.

3. Whenever the blood calcium and phosphorus were determined and one or both were found to be lower than the normal, the calcium content of the milk was either lower than the normal limit or at least lower than the normal average.

4. The diets of all but one of the mothers represented in the tetany and rickets group were looked into and all were found to be more or less deficient in one or more of the following points:—total quantity of milk, sources of vitamins, especially the fat soluble, and total caloric value of intake. Three were deficient in all three respects.

5. In the group in which the infants showed unfavourable symptoms other than those of tetany and rickets, with two exceptions the milk analyses showed abnormal values for two or more salts, in many cases extremely abnormal values. Two of the mothers were accustomed to taking large amounts of table salt with their food.

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3. Burhans, G. W., & Smith, D. N., *Loc. cit.*, 1923, XXVI, 303.
4. DeBuys, L. R., & Von Meysenburg, L., *Loc. cit.*, 1924, XXVII, 438.
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SALT CONTENT OF WOMAN'S MILK

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TABLE 1.

SALT CONTENT OF ABNORMAL MILKS: GRAMMES PER 100 C.C.M. MILK.

Case No.	Name	Month	Total solids	Fat	Nitrogen	CaO	MgO	P ₂ O ₅	Cl	Na ₂ O	K ₂ O	Na & K as chlorides	Total Ash
GROUP A.													
1	Bak.	Mar.	13.17	—	—	.0363	.0056	.0464	.0392	.0145	.0801	.1545	.2343
2	Ro.	Mar.	11.54	2.5	.1551	.0349	.0102	.0618	.0346	.0365	.0324	.1203	.1830
3	Wa.	Apr.	10.68	3.75	.1185	.0317	.0041	.0375	.0350	.0156	.0537	.1148	.1719
4	He.	Jan.	11.49	2.7	.1979	.0295	.0056	.0431	.0429	.0467	.0705	.2000	.2635
5	Ca.	Mar.	11.51	4.4	—	.0367	.0067	.0541	.0379	.0161	.0723	.1450	.2076
6	Ha.	Mar.	9.90	1.5	.1261	.0331	.0070	.0357	.0494	.0281	.0538	.1384	.2067
7	Ste.	Mar.	12.94	—	—	.0384	.0064	—	—	.0355	.0719	.1811	.2711
8	Mar.	Feb.	12.72	3.5	.1694	.0276	—	.0584	.0290	.0166	.0979	.1866	.1483
9	Mi.	Jan.	11.70	3.4	.1379	.0285	.0029	.0291	.0340	.0100	.0861	.1556	.2340
10	Hun.	Jan.	11.26	2.0	.1876	.0378	.0022	.0345	.0246	.0086	.0665	.1217	.1914
11	Hut.	Feb.	12.32	2.65	.2184	.0395	.0075	.0284	.0411	.0260	.0732	.1653	.2489
12	Bi.	Mar.	13.51	4.3	.1876	.0431	.0040	.0352	.0330	.0308	.0572	.1489	.2125
13	Boe	June	12.36	—	—	.0290	.0074	.0258	.0475	.0284	.0618	.1517	.1928
14	Ch.	Feb.	10.43	—	—	.0290	.0035	.0418	.0309	.0195	.0584	.1295	.1823
15	Mat.	Feb.	13.0	3.9	.1838	.0384	.0069	.0466	.0394	.0192	.0644	.1384	.2124
16	So.	Dec.	11.92	—	—	.0498	.0076	.0337	.0449	.0068	.0254	.0532	.2410
17	DeR	Mar.	10.25	1.4	.1701	.0343	.0045	.0315	.0508	.0336	.0646	.1660	.2325
GROUP B.													
18	Ja.	Feb.	13.59	—	—	.0150	.0009	.0625	.0462	.0138	.0658	.1304	.2347
19	Bo.	Feb.	10.39	1.3	.1743	.0540	.0064	.0264	.0469	.0227	.0533	.1275	.2258
20	Sta.	June	12.91	3.5	.1680	.0417	.0045	.0682	.0239	.0161	.0528	.1141	.1940
21	Au.	Nov.	12.90	3.5	.3024	.0633	.0076	.0625	.0697	.0355	.1079	.2383	.3477
22	Mas.	Sept.	11.56	—	.1736	.1003	.0117	.0540	—	—	—	—	.2250
23	I.W.	Feb.	12.85	—	.1799	.0345	.0057	—	—	—	—	—	.1719
24	Be.	May	9.77	1.1	.1477	.0463	.0051	.0741	.0674	.0283	.0607	.1498	.2463
25	Bar.	Mar.	13.57	3.9	.2342	.0412	.0148	.0414	.0554	.0357	.0622	.1662	.2504
26	Ho.	Nov.	9.92	1.2	.1667	.0356	.0038	.0243	.0546	.0436	.0559	.1711	.2273
27	Sc.	Nov.	13.30	3.7	.2583	.0356	.0002	.0437	.0413	.0316	.0841	.1931	.2547
28	Tu.	Oct.	12.75	3.2	.1774	.0409	.0040	.0316	.0317	.0060	.0925	.1582	.2270
29	Gi.	Jan.	8.95	0.9	.1834	.0412	—	.0161	.1488	—	—	—	.3881
30	Sm.	Oct.	7.46	2.2	.1995	.0095	.0055	.0142	.2566	—	—	—	.5607

TABLE 2.
RELATION TO NORMAL VALUES.

Case No.	Name	Age (mths)	Symptoms	Serum Ca. and P.	CaO	MgO	P ₂ O ₅	Cl	Na ₂ O	K ₂ O	Total solids
1	Bak.	7	Tetany, and sl. Rickets.	Ca 9.7	—	—	+	ave.	ave.	++	+
2	Ro.	9	Tetany, and sl. Rickets.	Ca 5.6 P 3.3	—	+	++	ave.	++++	--	ave.
3	Wa.	8½	Tetany.		--	--	ave.	ave.	ave.	—	—
4	He	7	Tetany. Rickets.	Ca 5.0	--	—	+	+	++++	+	++
5	Ca.	12	Tetany. Rickets.	Ca 5.2 P 6.8	—	—	++	ave.	ave.	+	ave.
6	Ha.	7	Tetany. Rickets.	Ca 4.6 P 7.0	—	—	ave.	++	+++	—	ave.
7	Ste.	9½	Tetany. Rickets.	Ca 7.8 P 4.4	—	—	(n.e.)	(n.e.)	++++	+	++
8	Mar.	4	Tetany. Rickets.		--	(n.e.)	++	—	ave.	+++	--
9	Mi.	7½	Tetany. Rickets.	Ca 6.3 P 3.5	--	---	—	ave.	—	++	+
10	Hun.	4	Tetany. Rickets.	Ca 6.2 P 6.4	—	---	ave.	--	—	+	ave.
11	Hut.	2	Tetany. Rickets.		—	ave.	—	+	++	+	++
12	Bi.	3	Prem. Tet. Rickets.	Ca 7.6 P 3.0	ave.	--	ave.	—	+++	ave.	ave.
13	Boe	6	Abscess. Rickets.	Ca 9.2 P 2.8	---	ave.	—	++	+++	+	ave.
14	Ch. Twins	4	Anæmia. Rickets.	Ca 9.7—9.2 P 4.6—2.6	--	--	+	—	+	ave.	ave.
15	Mat.	8	Rickets.	Ca 6.8 P 2.0	—	—	+	ave.	+	+	ave.

n.e. = not estimated.

TABLE 2—Continued.
RELATION TO NORMAL VALUES.

Case No.	Name	Age (mths)	Symptoms	Serum Ca. and P.	CaO	MgO	P ₂ O ₅	Cl	Na ₂ O	K ₂ O	Total Solids
16	So.	4	Rickets.		+	ave.	ave.	+	--	----	+
17	DeR.	5	Rickets.		—	--	—	++	++++	+	+
18	Ja.	1½	Convulsions and vomiting ceasing on changed food.		-----	-----	++	++	ave.	+	+
19	Bo.	7	Convulsions not tetany.	Ca normal	+	—	—	++	+	—	+
20	Sta.	2	Premature. Infants not thriving.		—	--	+++	--	ave.	—	ave.
21	Au.		Premature. Diarrhoea.		+++	ave.	++	+++	++	++++	++++
22	Mas.	3½	Infant not thriving.		+++ ++	++	++	(n.e.)	(n.e.)	(n.e.)	+
23	I.W.		(Composite) Infants not thriving.		—	—	(n.e.)	(n.e.)	(n.e.)	(n.e.)	—
24	Be.	3	Inf. not thriving.	Ca normal	ave.	--	++ ++	+++	+++	ave.	++
25	Bar.	3	Pyloric spasm. Slight eczema.		—	++++	+	++	++	+	++
26	Ho.		Anæmia. Inf. not thriving.		—	--	—	++	+++ ++	ave.	+
27	Sc.	½	Unaccounted for temperature.		—	----- -----	+	+	+++	++	++
28	Tu.		Vomiting ceasing on changed food.		—	--	—	—	--	+++	+
29	Gi.	4	Diarrhoea.		—	(n.e.)	---	+++ ++	(n.e.)	(n.e.)	+++ ++
30	Sm.	13	Infant not thriving.		----- -----	—	-----	++++ ++++	(n.e.)	(n.e.)	++++ ++++

n.e.=not estimated.