Electrophoresis of Sera of Breast-fed Infants and Its Relation to Nutritional Dystrophy of Their Mothers

Studies on the Nutrition of Children in Hirosaki Area

(22nd Report)

By

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In the preceding papers¹⁾²⁾ I reported electrophoretic patterns of sera from children with or without nutritional dystrophy³⁾⁴⁾⁵⁾ in Hirosaki area. In the present investigation electrophoretic analysis of sera from the patients of the age of from 1 to 24 months was carried out and the results obtained will be discussed from nutritional point of view.

EXPERIMENTAL

Method and Materials

Estimation of total protein and electrophoresis of sera were carried out in the same way as described in my previous paper¹⁾.

The infants subjected to this investigation were those who visited our Clinic and those who had been admitted into a nursing room. All the infants were divided into the following 6 groups (Groups I, II, III, IV, V and VI).

Group I included 32 cases of the patients who were of the age from 1 to 12 months and were exclusively fed on milk from the mothers without nutritional dystrophy.

Group II included 18 cases of the patients who were of the age from 1 to 12 months and were exclusively fed on milk from the mothers with nutritional dystrophy.

Group III included 25 cases of the patients who were of the age from 13 to 24 months and who were fed partly on an additional food (see below) and partly on milk from the mothers without nutritional dystrophy. The additional food, for infants of the age of 12 months or more, consisted chiefly of carbohydrate, that is to say, of large amount of rice-gruel and

small amount of vegetables and fishes. Meat and egg were scarcely taken by the inhabitants and also by the infants in this area.

Group IV included 6 cases of the patients of the age from 16 to 24 months, who were fed partly on the additional food and partly on milk from the mothers with nutritional dystrophy.

Group V included 12 cases of the infants who were of the age from 6 to 21 months and who were admitted into a nursing room on account of economical shortage of their family. They had been, therefore, undernourished at the time of their admission but they had been suffering from none of underlying diseases. Their body weight increased gradually during staying in the nursing room, but it still remained slightly lower than the normal at the time of this investigation.

Group VI included 8 cases of the patients of the age from 3 to 20 months, who had been fed on mother's milk for a few months of their life and thereafter fed chiefly on rice gruel. Clinical manifestations of nutritional dystrophy were frequently found in the mothers or/and the infants in this Group.

Results and Comment

The results obtained are given in Tables I, II, II, IV, V and VI, and are summarized in Table VII.

(1) Electrophoretic patterns of Groups I and II (Cf. Tables I, II and VII).

A decrease in albumin and an increase in alpha and gamma globulins were found in Group II with significant differences as compared with those in Group I. Judging from the normal values⁶⁾ of electrophoretic components of infants of the age from 3 to 12 months, it may be said that a decrease in albumin and an increase in gamma globulin were significant and alpha and beta globulins ranged near the upper limit of the normal values in Group II; and that, in Group I, electrophoretic patterns remained within the normal range, but showed a tendency to a decrease in albumin and an increase in alpha and beta globulin. The average of total protein is higher in Group II than in Group I, but no significant difference was found between the two groups.

(2) The electrophoretic patterns of Groups III and IV (Cf. Tables III, IV and VII).

The averages of albumin was lower in Group IV than in Group III, and those of total protein and of alpha, beta and gamma globulins were higher in Group IV than in Group III. The differences in these components were not significant between these two groups. As compared with the normal values⁶⁾ it may be said that a decrease in albumin and an increase in alpha (probably in beta and gamma) globulins were found in

TABLE I

Electrophoretic Pattern of the Sera from the Breast-fed Infants
whose Mothers are free from Clinical Manifestations of
Nutritional Dystrophy

No. of case	Name, sex and age (months)	Clinical diagnosis	Total protein gm. per 100 cc.	Albumin %	Globulin (%)			A/G
					α	β	γ	
1	K.E. ♂ 1.	Acute pharyngitis	6.61	53.6	13.1	14.6	19.1	1.18
2	Y.Y. ♂ 1.	Eczema	5.21	64.6	12.0	13.5	9.9	1.82
3	G.Y. ♀ 1.	Acute pharyngitis	4.81	57.7	14.5	16.2	11.6	1.36
4	Y.H. ♀ 2.	Pertussis	5.91	69.6	10.6	10.6	9.2	2.29
5	K.T. ♂ 2.	Pertussis	5.15	58.1	15.3	17.1	9.5	1.39
6	I.K. ♂ 2.	Infantile beriberi	5.41	64.5	14.8	12.5	8.2	1.82
7	N.W. ♀ 3.	Acute bronchitis	5.85	62.2	14.6	13.5	9.7	1.65
8	F.M. ♀ 3.	Acute pharyngitis	5.31	53.4	20.2	17.4	9.0	1.15
9	Y.I. ♀ 3.	Congenital stridor	5.92	56.3	18.1	17.4	8.2	1.29
10	T.K. ♂ 4.	Angina	5.85	59.5	14.0	13.8	12.7	1.47
11	T.S. ♂ 4.	Varicella	5.38	59.4	14.6	16.1	9.9	1.46
12	N.K. ♂ 4.	Spastic hemiplegia	7.24	50.2	19.7	20.0	10.1	1.01
13	K.I. ♀ 5.	Patent ductus arteriosus	5.30	72.2	12.9	9.3	5.6	2.60
14	O.N. ♂ 6.	Acute pharyngitis	6.27	69.6	12.4	12.8	5.2	2.29
15	K.K. ♂ 6.	Acute pharyngitis	6.77	70.0	11.6	11.2	7.2	2.23
16	C.T. ♂ 6.	Acute pharyngitis	6.46	60.1	17.1	15.1	7.3	1.43
17	M.K. ♂ 6.	Acute pharyngitis	5.77	55.9	13.4	21.1	9.6	1.27
18	A.K. ♂ 7.	Acute pharyngitis	6.36	60.2	13.0	14.7	12.1	1.51
19	K.E. ♀ 7.	Acute pharyngitis	5.82	62.7	16.7	11.3	9.1	1.68
20	N.S. ♀ 7.	Acute pharyngitis	6.23	58.1	13.3	19.7	8.9	1.39
21	I.Y. ♀ 7.	Acute pharyngitis	5.87	56.2	15.9	14.6	13.3	1.28
22	S.K. ♀ 7.	Infantile diarrhea	5.71	58.6	16.0	13.3	12.1	1.42
23	K.M. ♀ 8.	Pertussis bronchitis	7.35	51.4	16.2	20.1	12.2	1.06
24	M.S. ♂ 9.	Acute bronchitis	6.41	48.2	18.7	16.6	16.5	0.93
25	Y.C. ♀ 9.	Neuropathy	6.55	51.3	14.4	16.9	17.4	1.05
26	N.K. ♀ 10.	Varicella	6.83	63.1	11.9	11.3	13.7	1.71
27	T.Y. ♀ 11.	Acute bronchitis	5.83	53.1	21.2	13.6	12.2	1.13
28	K.Y. ♀ 11.	Acute pharyngitis	6.23	56.7	19.4	13.8	10.1	1.31
29	I.A. ♀ 11.	Angina	6.33	49.5	17.9	17.6	15.0	0.98
30	K.K. ♀ 12.	Heine-Medin's disease	7.11	51.2	18.2	15.1	10.5	3.39
31	K.Y. ♀ 12.	Angina	5.35	53.6	17.2	17.6	11.6	1.16
32	K.T. ♂ 12.	Acute pharyngitis	6.71	61.3	13.2	15.6	9.9	1.59
		Average	6.05	58.5	15.3	15.1	10.9	1.46
			(±0.23)	(±3.1)	(±0.7)	(±1.0)	(±1.1)	(±0.15)

TABLE II

Electrophoretic Pattern of the Sera from the Breast-fed Infants whose Mothers show Clinical Manifestations of Nutritional Dystrophy

No. of case	Name, sex and age (months)	Clinical diagnosis	Total protein gm. per 100 cc.	Albumin %	Globulin (%)			A/G
					α	β	γ	
1	S.Y. ♀ 1.	Acute pharyngitis	5.63	47.0	16.7	14.0	22.3	0.89
2	F.C. ♀ 3.	Bronchopneumonia	5.95	57.7	18.2	14.6	9.5	1.36
3	K.T. ♂ 4.	Subcutaneous abscess	6.77	54.2	15.5	18.3	12.0	1.18
4	I.T. ♂ 5.	Acute bronchitis	6.21	50.3	20.0	16.7	13.0	1.01
5	S.A. ♂ 5.	Acute laryngitis	6.33	51.3	18.4	18.0	12.3	1.05
6	K.I. ♀ 6.	Acute pharyngitis	6.41	62.4	13.7	13.4	10.5	1.66
7	I.E. ♀ 7.	Atrophy	7.30	52.0	17.3	16.5	14.2	1.08
8	K.H. ♂ 7.	Acute bronchitis	6.13	43.9	17.8	18.3	20.0	0.78
9	N.C. ♂ 7.	Premature, rickets	6.50	51.4	18.6	18.1	11.9	1.06
10	S.M. ♂ 8.	Acute pharyngitis, rickets	7.03	30.4	21.0	15.6	32.6	0.44
11	K.K. ♀ 9.	Pertussis	6.74	57.1	15.1	13.8	14.0	1.33
12	A.A. ♀ 9.	Varicella	6.01	50.9	16.0	16.6	16.5	1.02
13	K.K. ♂ 10.	Pertussis	7.03	46.8	17.7	17.8	17.7	0.88
14	J.H. ♀ 10.	Acute bronchitis	5.93	53.0	17.0	14.2	15.8	1.13
15	K.S. ♂ 8.	Acute pharyngitis	5.93	48.1	24.3	17.9	9.7	0.92
16	S.H. ♂ 12.	Acute pharyngitis	5.81	48.3	17.1	17.1	17.5	0.93
17	A.H. ♀ 12.	Epidemic vomiting	7.31	52.7	11.7	11.3	24.3	1.17
18	O.H. ♂ 12.	Acute bronchitis	6.21	51.4	18.5	16.0	14.1	1.06
		Average	6.40	50.5	17.4	16.0	15.9	1.04
			(± 0.26)	(± 3.6)	(± 0.1)	(± 0.8)	(± 2.9)	(± 0.15)

both Groups III and IV, especially in the latter.

(3) Electrophoretic patterns of Groups V and VI (Cf. Tables V, VI and VII).

The infants of Group V and those of Group VI were of the body weight lower than the normal, but the former had been fed on milk formula and the latter had been fed on the diet, a large portion of which consisted of carbohydrate (rice-gruel).

As compared with the normal values⁶⁾ it may be said that beta globulin was increased in both Groups V and VI and that an increase in gamma globulin and a decrease in albumin and total protein were significant in Group VI, while considerable variations from the normal were not found in total protein, albumin and alpha and gamma globulins in Group V.

Yamada *et al.*⁷⁾ determined, by means of Cohn's method, the components of serum protein of the normal infants of the age under 24 months

TABLE III
Electrophoretic Pattern of the Sera from the Breast-fed Infants
in Weaning Period whose Mothers are free from Clinical
Manifestations of Nutritional Dystrophy

No. of case	Name, sex and age (months)	Clinical diagnosis	Total protein gm. per 100 cc.	Albumin (%)	Globulin (%)			A/G
					α	β	γ	
1	T.A. ♀ 13.	Acute dyspepsia	6.62	59.4	13.8	13.8	13.0	1.46
2	S.R. ♀ 13.	Acute pharyngitis	6.53	46.9	15.6	15.6	21.9	0.88
3	O.T. ♂ 13.	Rickets	6.30	54.4	15.6	17.9	12.1	1.20
4	T.H. ♀ 13.	Acute pharyngitis	7.01	48.7	16.6	15.2	19.5	0.95
5	O.M. ♂ 13.	Acute bronchitis	6.91	59.0	16.3	16.1	8.3	1.44
6	F.E. ♀ 13.	Heine-Medins' disease	6.48	50.0	16.2	18.0	15.8	1.00
7	Y.S. ♀ 14.	Izumi fever	7.32	55.4	19.0	12.4	13.2	1.24
8	F.S. ♂ 15.	Acute laryngitis	5.50	47.0	16.8	15.6	20.6	0.89
9	S.N. ♂ 15.	Angina	6.18	56.7	14.4	11.5	17.4	1.31
10	I.M. ♀ 15.	Acute bronchitis	6.15	53.6	14.9	13.2	18.3	1.16
11	H.K. ♂ 15.	Acute pharyngitis	5.45	52.0	16.9	16.0	15.1	1.08
12	J.H. ♂ 16.	Acute bronchitis	6.35	51.1	20.9	14.2	13.8	1.04
13	M.Y. ♂ 16.	Hypochromic anemia	6.75	57.0	11.3	13.1	18.6	1.33
14	I.N. ♀ 16.	Acute bronchitis	5.68	51.0	18.4	16.3	14.3	1.04
15	H.Y. ♀ 17.	Angina	7.42	45.3	22.0	13.7	19.0	0.83
16	O.T. ♂ 17.	Measles	5.93	67.1	13.9	13.3	5.6	2.04
17	K.B. ♀ 17.	Idiocy	6.73	59.7	13.7	14.7	11.9	1.48
18	K.M. ♂ 17.	Angina	6.71	51.1	16.0	15.2	17.7	1.04
19	S.K. ♂ 18.	Acute bronchitis	5.91	52.1	15.3	12.6	19.9	1.09
20	A.Y. ♀ 18.	Pertussis	1.85	57.1	11.6	17.5	13.6	1.33
21	A.M. ♀ 18.	Thrush	6.73	43.8	22.6	16.8	16.8	0.78
22	S.S. ♂ 20.	Exanthema subitum	6.68	51.8	24.1	14.6	9.5	1.07
23	N.T. ♂ 23.	Acute pharyngitis	6.77	57.8	15.2	13.9	13.1	1.37
24	K.G. ♂ 23.	Parotitis epid.	6.78	53.3	15.7	14.5	17.5	1.14
25	S.A. ♂ 24.	Acute pharyngitis	6.57	59.5	12.7	11.4	16.4	1.47
		Average	6.49	53.6	16.3	14.7	15.3	1.18
			(± 0.18)	(± 2.1)	(± 1.2)	(± 0.7)	(± 1.5)	(± 0.10)

and they reported that total protein, albumin, alpha, beta and gamma globulins were 6.30 g. per 100 cc., 62.6%, 13.7%, 12.0% and 13.8% respectively. These values for the normal infants in Japan showed a fairly good accordance with those reported by Karte⁶⁾, who investigated German normal infants by means of electrophoresis.

Yamada *et al.*⁷⁾ reported also that total protein, albumin, alpha, beta and gamma globulins were 6.16 g. per 100 cc., 45.7%, 21.0%, 20.5% and

TABLE IV
Electrophoretic Pattern of the Sera from the Breast-fed Infants
in Weaning Period whose Mothers showed Clinical
Manifestations of Nutritional Dystrophy

No. of case	Name, sex and age (months)	Clinical diagnosis	Total protein gm. per 100 cc.	Albumin (%)	Globulin (%)			A/G
					α	β	γ	
1	J.S. ♂ 16.	Izumi fever	6.75	41.9	23.2	19.6	15.3	0.72
2	S.T. ♀ 17.	Angina	7.42	45.3	22.0	13.7	19.0	0.83
3	U.T. ♂ 19.	Bronchopneumonia	7.07	51.0	17.7	16.0	15.3	1.04
4	M.S. ♂ 21.	Acute pharyngitis, rickets	6.43	55.6	13.6	15.1	15.7	1.25
5	S.K. ♂ 22.	Heine-Medin's disease	7.08	47.2	21.3	16.3	15.2	0.89
6	H.T. ♂ 24.	Acute bronchitis	7.01	49.5	17.3	15.5	17.7	0.90
		Average	6.96 (± 0.39)	48.4 (± 4.8)	19.2 (± 3.6)	16.0 (± 1.9)	16.4 (± 1.6)	0.94 (± 0.18)

TABLE V
Electrophoretic Pattern of the Sera from the
Infants Staying in a Nursing Room

No. of case	Name, sex and age (months)	N.D.* (Infant)	Total protein gm. per 100 cc.	Albumin (%)	Globulin (%)			A/G
					α	β	γ	
1	A.J. ♀ 6.	—	5.81	50.2	18.0	17.1	14.7	1.01
2	K.E. ♀ 7.	—	6.11	56.6	17.9	17.5	8.0	1.30
3	I.Z. ♂ 7.	—	5.81	56.3	16.3	15.6	11.8	1.27
4	N.S. ♀ 8.	—	6.11	55.7	14.6	16.6	13.1	1.26
5	K.M. ♂ 12.	—	7.11	53.9	12.3	14.8	19.0	1.17
6	M.S. ♂ 13.	—	6.61	54.1	15.5	13.8	16.6	1.18
7	I.T. ♂ 15.	—	6.21	56.0	11.9	14.8	17.3	1.27
8	S.J. ♂ 9.	—	6.53	52.1	14.9	15.6	17.4	1.09
9	A.T. ♀ 21.	—	6.43	55.4	13.0	14.7	16.9	1.24
10	Y.Y. ♂ 6.	—	6.13	56.0	13.2	11.7	19.1	1.27
11	K.Y. ♀ 10.	—	6.23	57.8	12.3	15.9	14.0	1.37
12	K.O. ♂ 12.	—	6.63	56.0	14.8	16.9	12.3	1.27
		Average	6.28 (± 0.24)	55.3 (± 1.4)	14.5 (± 1.1)	15.3 (± 0.8)	14.8 (± 2.0)	1.23 (± 0.12)

* N. D.=Nutritional Dystrophy.

12.8% respectively as the averages obtained from the infants of the age from 3 to 24 months who were of the body weight below 80% of their

TABLE VI
Electrophoretic Pattern of the Sera from the
Infants with Starch Injury

No. of case	Name, sex and age (months)	Complications	N.D.*		Total protein gm. per 100 cc.	Albumin (%)	Globulin (%)			A/G
			Infants	Mothers			α	β	γ	
1	Y.A. ♂ 3.	Acute bronchitis	+	—	3.72	46.4	14.5	10.0	29.0	0.87
2	M.T. ♂ 4.	Starch injury	+	+	6.52	51.6	11.5	13.5	12.5	1.06
3	O.K. ♂ 7.	Starch injury, Stomatitis	+	—	5.37	58.8	15.8	12.4	13.4	1.40
4	M.M. ♂ 16.	Acute pharyngitis, Acute dyspepsia	+	+	6.68	54.6	17.6	11.3	16.6	1.20
5	S.H. ♀ 19.	Starch injury	—	—	6.23	46.8	18.3	17.0	17.9	0.88
6	O.S. ♀ 19.	Acute pharyngitis	—	+	6.51	42.5	17.7	15.3	24.5	0.77
7	M.M. ♀ 19.	Rickets	—	+	6.72	54.3	14.8	13.3	17.6	1.19
8	J.T. ♀ 20.	Bronchopneumonia	+	—	5.28	30.4	12.4	26.3	30.9	0.44
		Average			5.92	48.1	15.3	14.8	20.3	0.97
					(± 0.83)	(± 7.0)	(± 6.9)	(± 4.4)	(± 5.5)	(± 0.25)

standard and who were not complicated by any obvious diseases.

The majority of the infants subjected to my own investigation were complicated with acute or chronic infections. According to Karte⁶⁾, acute and chronic infections cause profound alterations in electrophoretic patterns of sera of infants. Karte⁶⁾ reported that acute infections such as bronchopneumonia, purulent meningitis, purulent otitis, pyuria, peritonitis and certain cases of tuberculosis caused a decrease in albumin and an increase in alpha and gamma globulins and that an increase in alpha globulin was more conspicuous than that in gamma globulin; and that subacute or chronic infections caused a decrease in albumin and an increase in alpha and gamma globulins and the increase in gamma globulin was more marked than in alpha globulin; further that these patterns were found in the cases with congenital syphilis, primary infection of tuberculosis, atrophy and dystrophy with recurrent infections. In the cases with atrophy, according to Karte⁶⁾, a slight increase in gamma globulin (15–26%), a decrease in albumin and normal or slightly diminished total protein were found and the increase in gamma globulin was not ascribed to infections but to protein deficiency.

As already reported¹⁾ a decrease in albumin accompanied by an increase in alpha, beta and gamma globulins was found in electrophoretic patterns of children who visited our Clinic as patients and who showed

TABLE VII
Total Protein and Electrophoretic Components of Groups I, II, III, IV, V
and VI and Values for 'Normal Infants'

Group	Method of nutrition	Age of infants	N.D.* of mothers	Total protein gm. per 100 cc.	Albumin (%)	Globulin (%)		
						Alpha	Beta	Gamma
I } II }	M.M.**	1-12 m.	(-) (+)	6.05±0.23 6.40±0.26	15.3±3.1 50.5±3.6	15.3±0.7 17.4±0.1	15.1±1.0 16.0±0.8	10.9±1.1 15.9±2.9
III } IV }	M.M. + rice gruel	13-24 m.	(-) (+)	6.49±0.18 6.96±0.26	53.6±2.1 48.4±4.8	16.3±1.2 19.2±3.6	14.7±0.7 16.0±1.9	15.3±1.5 16.4±1.6
V	Chiefly evaporated milk	6-21 m.		6.28±0.24	55.3±1.4	14.5±1.1	15.3±0.8	14.8±2.0
VI	Chiefly rice gruel	3-20 m.	(+)	5.29±0.83	48.1±7.0	15.3±6.9	14.8±4.4	20.3±5.5
	'Normal'	2-10 m.		6.34 (5.5-7.45)	64.1 (59.5-69.5)	13.6 (9.7-17.4)	11.3 (7.8-16.1)	11.0 (7.8-13.8)
		3-7 y.		6.94 (5.93-7.63)	62.6 (56.1-69.4)	10.7 (4.9-13.7)	11.1 (8.0-15.7)	15.6 (10.6-19)

** M.M. = Mother's milk.

clinical manifestations of nutritional dystrophy.

The similar patterns of electrophoresis as above mentioned—a decrease in albumin accompanied by an increase in alpha, beta and gamma globulins—were found²⁾ also in apparently healthy children except that they showed clinical manifestations of nutritional dystrophy.

Sato and I⁹⁾ found that a decrease in albumin accompanied by an increase in gamma globulin was in a remarkable degree found in the sick children who showed degeneration of hepatic cells with portal fibrosis in the biopsied livers.

Sato⁹⁾ reported that “vaquolige” degeneration of hepatic cells, fatty infiltration and portal fibrosis were frequently observed in the biopsied liver of children who showed clear symptoms of nutritional dystrophy and who were not suffering from any other severe illness at the time of biopsy.

In the present investigation, clinical manifestations of the mothers of those infants were taken up as an indicator of nutritional environment of their infants, because angular stomatitis, cheilosis, swelling of lingual papillae, hyperkeratosis and hyperpigmentation of the skin were not commonly seen among the infants who were fed on milk from the mothers with nutritional dystrophy (Cf. Kagaya¹²⁾).

This finding—a rare occurrence of manifestations of nutritional dystrophy in breast-fed infants of the mothers with manifestations of nutritional dystrophy—will be explained without difficulty, if clinical symptoms of nutritional dystrophy in those breast-fed infants will have become clinically manifest only then, when they weaned (—they actually wean mostly beyond one full year—) and have begun to take the diet qualitatively peculiar to that district or to take food similar to that taken by their mothers with nutritional dystrophy.

Out of 50 cases of exclusively breast-fed infants, none showed clinical manifestations of nutritional dystrophy, whether or not their mothers were of nutritional dystrophy.

Out of 31 cases of the infants of the age of 12 months or more, 3 cases showed angular stomatitis, cheilosis and red swollen tongue.

It may therefore be suspected that a decrease in albumin accompanied by an increase in gamma globulin in electrophoretic patterns of the infants of Group IV and VI is related to probable hepatic changes arisen from deficient nutrition.

How to explain the decrease in albumin accompanied by an increase in gamma globulin in the exclusively breast-fed infants of Group II?

Arakawa *et al.*¹⁰⁾ found that enlargement of the liver was frequently observed among the infants who were fed exclusively on milk from mothers with nutritional dystrophy, and they suspected that this hepatic enlargement was related to probable changes in ingredients of mother's milk.

Morinaga¹¹⁾ of our Laboratory found that methionine content was lower in milks from mothers with nutritional dystrophy than in those from healthy mothers.

It may therefore be assumed such a possibility that a decrease in albumin accompanied by an increase in gamma globulin in Group II is ascribed to 'hepatic changes' which are caused by alterations in ingredients of milk from mothers with nutritional dystrophy.

SUMMARY

1. Mothers in Hirosaki area show, as has been repeatedly shown by us, clinical symptoms of nutritional dystrophy.

2. Exclusively breast-fed infants of these mothers, as has been shown by Kagaya, do not show clinical signs of nutritional dystrophy.

3. These infants, however, show in electrophoretic pattern of serum protein, a decrease in albumin and an increase in gamma globulin.

4. So these breast-fed infants without clinical symptoms of nutritional dystrophy show a close nutritional connection with their mothers with distinct clinical symptoms of it in that peculiar electrophoretic pattern of serum protein.

CONCLUSIONS

Infants exclusively fed on milk of the mothers with clinical symptoms of nutritional dystrophy generally do not show manifest symptoms of nutritional dystrophy. But these apparently healthy infants do show a serum picture of nutritional dystrophy—an increase in gamma globulin with a decrease in albumin, as is shown in electrophoretic pattern of serum protein of children with nutritional dystrophy.

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References

- 1) Yoshida, H., Tohoku J. Exp. Med., 1953, **57**, 205.
- 2) Yoshida, H., Hirosaki Igaku, 1953, **4**, 142.
- 3) Masuda, K. & Aoyama, J., Tohoku J. Exp. Med., 1951, **55**, 1.
- 4) Arakawa, Ts., Wada, Sh. & Takahashi, F., *ibid.*, 1951, **55**, 61.
- 5) Wada, Sh. and Sato, Y., *ibid.*, 1952, **56**, 259.
- 6) Karte, H., Zeitschr. f. Kinderheil., 1953, **73**, 467.
- 7) Yamada, Sh., Kondo, T., Niki, T., Saigo, M., Gumma, F. & Akatsuka, T., Jika Zasshi, 1950, **54**, 43.
- 8) Yoshida, H. & Sato, Y., Tohoku J. Exp. Med., 1953, **57**, 211.
- 9) Sato, Y., Liver Biopsy of Children with Nutritional Dystrophy, in press in this Journal.
- 10) Arakawa, Ts., Sato, Y. & Kagaya, A., Hepatic enlargement of breast fed infant and its Relation to Riboflavin Content in Mother's Milk, in press in this Journal.

- 11) Morinaga, Ch., Methionine Content of milk from the Mothers with or without Nutritional Dystrophy, to be published in a coming issue of this Journal.
 - 12) Kagaya, A., Vitamins (Japan.), 1954, 7, 568.
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