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THE NUTRITIONAL NEEDS OF THE PREMATURE INFANT

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The physiological considerations modifying the food mixture for the premature are: the increased speed of growth, the impairment of renal function, diminished intestinal absorption, incomplete development of enzyme systems, and the deficient antenatal storage of minerals and vitamins.

GROWTH SPEED

It has usually been assumed that in this accelerative phase of the first sigmoid curve of growth, the caloric requirement was higher than that of the baby born at term and entering into the decelerative phase. Levine and Gordon¹ felt that this was not true and that the figure of 120 calories per kilogram was adequate for this age. Using the same mixture, however, (half skimmed milk with about 8 per cent added carbohydrate) that they subsequently studied, we found that consistent gain was achieved on about 130 calories per kilogram.

RENAL FUNCTION

In our concern with the relative amounts of protein, fat, and carbohydrate, little attention has been given until recently to the load imposed on a possibly immaturely functioning kidney by the high mineral content of many of the artificial food mixtures offered. In an interesting study of the comparative loads involved in feeding a conventional evaporated milk, water, and dextrimaltose mixture and an evaporated milk-water mixture without added carbohydrate, Pratt² brings out the marked drain on the reserves of body water with the latter. While the kidney seems able to manage this solute load of mineral and urea, it would seem to do so by taxing available water to the utmost, and the occurrence of any added drain, such as imposed by diarrhoea, might well prove fatal.

I was first concerned about this many years ago when, following about a month of apparent progress, we lost a number of prematures with diarrhoeal disease, that in a mature infant I feel sure we could have managed. Other recent studies suggesting a possible relationship between edema and the development of retrorenal fibroplasia still await confirmation in the human. But if, as some people feel, retrorenal fibroplasia may ultimately be shown to have a viral origin, the development and course of any infection is unfavorably influenced by the oedema state.

INTESTINAL ABSORPTION

Diminished absorption of fat would seem to be the chief reason for the relative increase in calories to be derived from protein and carbohydrates, rather than any

specifically higher need for protein conditioned by the rapid growth. This accelerated growth is largely cared for by the increased nitrogen retention of the premature. There is a very real question of how much retention should be sought. In any critical evaluation of food mixtures, the criteria of optimal must include many things that we are unable to measure in the human. In work with rats, it can be shown that while rates of gain and the attainment of maturity increased *pari passu* with increases in nitrogen intake, on the other hand, length of life, reproduction, survival of offspring and possibly resistance to infection were optimal with moderate intakes. In studies of the infant in the first two months of life we have felt that we frequently exceeded tolerance with mixtures in which the protein exceeded 20 per cent of the total calories. This has not seemed to be true with the mixture here described in which part of the nitrogen is given as amino acids. Provision for the oil-soluble vitamins A and D in an absorbable form is made necessary by the defect in absorption of fat.

INCOMPLETE DEVELOPMENT OF ENZYME SYSTEMS

One of the striking findings of Levine and Gordon³ was the demonstration of an incomplete oxidation of tyrosine and phenylalanine, a defect which was correctable by the giving of large amounts of ascorbic acid—100 mg. daily. This must be included for optimal results.

DEFICIENT STORAGE OF MINERALS AND VITAMINS

To this have been attributed the relatively higher occurrence of rickets and tetany in premature infants. While it is true that the amounts of calcium and phosphorus in breast milk are very low compared to cow's milk, their more favorable ratio and economy of utilization in the presence of adequate amounts of vitamin D make me question their inadequacy even in this period of rapid growth. With these considerations in mind, we have used for about ten years a mixture of whole milk, water, amino acids, and dextrimaltose with which we hoped to achieve reasonable concentration, relatively high but more easily utilized protein, low fat and some reduction in mineral. This mixture is shown in Table I.

Table I—THE HENRY FORD HOSPITAL MIXTURE FOR PREMATURE INFANTS

PASTEURIZED MILK	500 cc.
WATER	500 cc.
PROTOLYSATE	60 gm.
DEXTRIMALTOSE	30 gm.

The chemical analysis of this mixture is shown in Table II.

Table II—THE CHEMICAL ANALYSIS OF THE HENRY FORD HOSPITAL MIXTURE FOR PREMATURE INFANTS

Values in Grams

	P	F	CHO	MIN	Mg	S	K	Na	Cl	Ca	P
Whole Milk 500 ml	17.0	19.0	23.0	3.500	.060	.165	.775	.250	.525	.590	.465
Water 500 ml											
Dextri-Maltose No. 2 60 grams			59.4								
Protolysate 30 grams	22.5			1.650	.015	.180	.090	.450	.450	.120	.360
Total	39.5	19.0	82.4	5.150	.075	.345	.865	.700	.975	.710	.825
Values per 100 ml	3.95	1.90	8.24	.515	.0075	.0345	.0865	.070	.0975	.071	.0825
Values per liter in milliequivalents					6.2	21	22	30	27	36	82.5

20 cal/oz

Nitrogen—.631 gms per 100 ml. of mixture.

	Calories	Calories
Protein	158.0	24%
Fat	171.0	26%
Carbohydrate	330.0	50%
	659.	

The results from this formula are compared with breast milk, and 2 per cent milk with 8 per cent added carbohydrate, in respect to daily gain and hospital days in Table III.

Table III—COMPARATIVE WEIGHT GAINS OF THREE GROUPS OF TEN PREMATURE INFANTS ON VARIED FEEDINGS

Groups	Birth Weight Average and Range	Feeding	Gain per Day	Hospital Days
I	1692 gms. 1265-1960 gms.	Breast Milk	24.6 gms.	34.2
II	1709 gms. 1240-2800 gms.	2% Skimmed milk with 8% added carbohydrate	21.5 gms.	32.
III	1546 gms. 1060-1850 gms.	Ford Hospital Mixture*	22.6 gms.	36.4

*Whole milk 500 cubic centimeters, water 500 cubic centimeters, protolysate 60 grams, dextrimaltose 30 grams.

On this mixture clinical results have been good. Comparative gains in weight are admittedly an inadequate criterion, but I have not seen the nutritional breaks with diarrhoea that we formerly saw.

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