The Feeding of Premature Infants

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The general principles of infant feeding have to be modified for premature infants because of their physical handicaps and their greater nutritional requirements.

Handicaps

Premature babies have certain handicaps due to their incomplete development. Those affecting nutrition include weakness or absence of the sucking or swallowing reflexes, a tendency to inhale regurgitated fluids caused by absence of the coughing reflex, poor absorption of food and inadequate antenatal stores.

Management of handicaps. If the sucking and swallowing reflexes are completely absent, gavage (oesophageal feeding) is necessary, but weakness or rapid exhaustion of the reflexes may be overcome by giving small frequent feeds or divided feeds with 5 min rest during the feed.

The danger of regurgitation and inhalation may be reduced by delaying the commencement of feeding for several days, the smaller the infant, the longer the starvation period. When the infant is fed, it should be placed on its right side with the head raised; a clothed infant should be kept on the one or other side between feeds, when infants are nursed naked the head rolls over naturally on to the side; the feeds should be small and frequent to reduce distension of the stomach, and the smaller infants should be handled as little as possible, especially after feeding.

Poor absorption of food and poor antenatal storage are considered in the next section.

Nutritional requirements

The premature baby has greater nutritional requirements than the full-term infant, because of its relatively rapid postnatal growth combined with the handicap of inadequate storage.

The optimum rate of postnatal growth is not yet known. There is a tendency to aim at the maximum growth possible, but it is not yet proved that the maximum is the optimum. In the light of present knowledge it seems reasonable to use the intra-uterine rate of growth as a yardstick, and expect the gain in weight to average 5 oz. weekly for infants weighing less than $3\frac{1}{2}$ lb. and from 7 to 8 oz. weekly for infants of greater weight (Streeter, 1920; Huggett, 1946; Crosse, 1949).

Such a rate of growth can be expected only after the initial loss of weight has been regained. Just as in the full-time child, an initial loss of from 6–10 % ($1-1\frac{1}{2}$ oz./lb.) of the birth weight may be expected, but the birth weight should be regained by about the end of the 2nd week, earlier in the larger babies and later in the smaller ones. If the intra-uterine rate of growth is then continued, a weight of from 6 to 8 lb. should be reached 2 weeks after the expected date of delivery, the weight being then equivalent to that of a full-time infant that has just regained its birth weight. The weight curve before the expected date of delivery lies below the intra-uterine weight curve, but should be parallel to it.

Calories

Before the age of 2 weeks the calorie requirement is very small because the basal metabolism is low and activity is relatively slight. After the first 2 weeks an allowance of from 55 to 60 Cal./lb. body-weight daily maintains a satisfactory rate of growth, provided that the calories are given in a suitable form and that the infant is cared for in a suitable environment.

Overfeeding, with its great dangers, must be avoided during the first 2 weeks of life. The requirements are small, and the danger of underfeeding is very slight, as is shown by the now common practice of starving premature infants for several days after birth. During these early days the premature baby, like the full-time one lives on body fat. It has relatively little of such fat but its small needs enable the fat to last for a long time.

It is important to know how the necessary calories should be provided. Certain requirements have been determined by balance tests and others by clinical trial, but there is still much to learn and no one can yet be dogmatic about requirements.

Protein

The smallest premature babies grow about twice as fast as full-time babies, and may require twice as much protein. It is, therefore, possible that human milk may not supply sufficient protein for the optimum growth of premature babies, even if allowance is made for their better utilization of protein, which varies inversely with the weight of the infant (Gordon & Levine, 1944).

Levine (1945) recommends a daily allowance of from 2·0 to 2·7 g protein/lb. body-weight for premature infants, and from 1·5 to 2·0 g for full-time ones; the full-time infant, however, does remarkably well on human milk although it obtains less than 1·0 g protein from a daily intake of 2½ oz./lb. body-weight.

At this point it may be well to remember the influence of artificial feeding on infant mortality. In a Birmingham survey of 1380 premature babies, feeding appeared to have little effect on the neonatal mortality, but between the ages of 1 and 6 months, the percentage mortality in breast-fed infants was 0·8 and in artificially fed infants 5·6.

Because of the low protein content of human milk various high-protein feeds have been tried, such as human milk with added protein and various modifications of cow's milk, and good weight gains have been reported (Langer, 1926; Hess & Lundeen, 1941; Magnusson, 1944; Gordon, Levine & McNamara, 1947). Feeding experiments in the Birmingham Premature Baby Unit support the view that high-protein feeds are well tolerated (Young, Poyner-Wall, Humphreys, Finch & Broadbent, 1950), but fail to show that they have any great advantage over unmodified human milk (experiments now in progress).

If it is necessary to substitute cow's milk for human milk, it is desirable to give a high-protein feed containing 3 % or more of protein. The extra protein ensures that the specific need for individual amino-acids will be met, the amino-acids being present in different proportions in human milk and cow's milk. There is no disadvantage in giving a relatively high percentage of protein provided that sufficient vitamin C is given also, to ensure complete metabolism of the amino-acids (Levine, Marples & Gordon, 1939; Dann, 1942).

Gordon *et al.* (1947) obtained the best results with a powdered, half-skimmed cow's milk mixture with added carbohydrate, and the Birmingham experiments confirm this finding. A cheap readily available mixture is 1 drachm of half-skimmed, dried milk to 1 oz. water, with the addition of 1 drachm sugar to every 3 oz. of the mixture; the percentage composition is protein 3·8, fat 2·1, carbohydrate 9·5, with 21 Cal./oz.

Fat

Determination of the respiratory quotient shows that premature babies tend to reject fat and utilize carbohydrate to a greater degree than full-time babies. The smallest babies usually have the least ability to absorb fat. The ability varies between individuals and even in the same individual at different times.

Many premature babies will tolerate high-fat feeds, but few utilize the fat well. If much fat is given, the excess is discarded in the stool and extra calories are required to compensate for the loss. There appear to be no advantages in high-fat feeding, and individual infants may even show intolerance to such feeding. On the other hand, provided an adequate dosage of fat-soluble vitamins is ensured, there are no dangers in giving relatively little fat, because fat is easily made from protein and carbohydrate.

It is a safe rule to assume that there will be difficulty in the utilization of fat during the first few months of life and to avoid high-fat feeds during that time. As the infant matures, the utilization of fat improves.

Carbohydrate

Premature infants utilize carbohydrates to a greater degree than full-time babies, and tolerate high proportions of non-fermentable sugars such as cane- or beet-sugar or dextri-maltose. High percentages of glucose or lactose may cause diarrhoea.

When cow's milk is the basis of the feed, a high percentage of sugar is necessary to compensate for the low percentage of fat and to allow the protein to be used for growth instead of being burnt for energy.

Fluid

Water accounts for a larger percentage of the weight at birth in premature than in full-time babies, from 80 to 85 instead of from 70 to 75.

Water-balance experiments have shown that the optimum daily fluid allowance after the 1st week of life lies between 2 and 3 oz./lb. body-weight. With less there is danger of dehydration, and if more is given the excess is eliminated as extra urine. Giving too little fluid is far more dangerous than giving too much, but it is necessary only to reach a daily amount of 2 oz./lb. body-weight by the end of the 1st week of life, and from 2½ to 3 oz. by the end of the 2nd week.

The volume of human milk that supplies the necessary calories supplies the necessary fluid also. If cow's-milk mixtures are used, they should not supply more than 24 Cal./oz. if the intake of a safe amount of fluid is to be ensured.

Mineral salts

Calcium and phosphorus. Premature birth deprives the infant of valuable antenatal-storage time and also increases the postnatal requirements.

Human milk has a low content of calcium and phosphorus; cow's milk has a higher content of both. An adequate supply of vitamin D is necessary for full utilization of the available calcium and phosphorus.

In the Birmingham Premature Baby Unit supplements of calcium and phosphorus are given to all premature babies from the 14th day as syrup of calcium lacto-phosphate, 7 minims/lb. body-weight daily. Radiographic examination of the wrists at the age of 3 months has been carried out on 227 infants thus treated, 109 breast fed and 118 fed on cow's milk. Bone changes suggestive of early rickets occurred in 13·8 % of the first group and in 25·4 % of the second. Clinical rickets was conspicuous by its absence in both groups.

Iron. The concentration of iron remains essentially the same throughout foetal growth, but the more rapid growth of the premature babies creates an extra demand.

Human milk contains little iron, and cow's milk still less, but there is no evidence that any useful purpose is served by giving extra iron before the age of from 4 to 6 weeks. After that age, administration is effective to prevent the development of an iron-deficiency anaemia.

Vitamins

The needs of the premature baby are greater than those of the full-time baby for the following reasons: the antenatal store is small, postnatal growth is more rapid, absorption of fat-soluble vitamins is poor, the need for vitamin C is increased with the use of high-protein feeds, and the need for vitamin D is increased by the extra needs for calcium and phosphorus. The following allowances are recommended:

Vitamin K, 10 mg daily until 2 days after the commencement of feeding.

Vitamin B complex, from the commencement of feeding; requirements unknown.

Vitamin C, from 50 to 100 mg daily from commencement of feeding, the larger dose being given to infants on high-protein feeding.

Vitamin D, from 3000 to 5000 i.u. daily from the end of the second week, or a massive dose commencing at the age of 2 weeks and repeated at monthly intervals.

Vitamin A, from the age of 2 weeks; requirements unknown.

SUMMARY

1. Gavage or bottle-feeding must be used to overcome early difficulties in sucking and swallowing.

2. Small frequent feeds may be necessary at first.

3. Full fluid and caloric requirements need be met only towards the end of the 2nd week of life.

4. From clinical experience, human milk appears to be a suitable food if given in sufficient quantity, 3 oz./lb. body-weight daily after the 14th day. Breast feeding tends to reduce the mortality rate of premature infants.

5. When cow's milk is used, as a substitute for human milk, a high-protein, low-fat, high-carbohydrate mixture is recommended.

6. Vitamins must be given in adequate amounts in a concentrated form.

7. Supplements of calcium and phosphorus are probably required after the age of 2 weeks, and of iron after the age of from 4 to 6 weeks.

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