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THE FEEDING OF NORMAL AND PREMATURE INFANTS

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General Principles of Infant Feeding

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The subject of infant feeding is one well worn by previous discussion, but there is always something to be gained by reviewing the accepted facts and presenting again the controversial matter. My task is to deal with the subject in a general way, and as there are papers by other speakers on breast-feeding (Waller, 1952) and artificial feeding (Smellie, 1952) I shall do my best to avoid anything more than a casual reference to these particular aspects.

One accepts the fact that human milk taken by the infant from the mother's breast is the ideal food for the human infant: this needs restating, particularly at the present time, because it has recently been questioned and figures have been published showing that small infants fed on a modified cow's-milk mixture with a high protein content, can achieve more rapid gains in weight than with breast milk (Gordon, Levine & McNamara, 1947). That this is so can be accepted, but it is salutary to remind ourselves that good nutrition cannot be determined merely by a gain in weight. Indeed, except for the very small premature infant in the first weeks of life, a too rapid gain may be disadvantageous: overweight infants succumb to infections more frequently than those who are of average weight for age.

Cause of failure to gain weight

There is no doubt, I think, that in the past artificial feeding has been made unnecessarily complicated, and this has resulted in a tendency to recommend some proprietary food, telling the mother to follow the instructions on the label. If the infant thrives all is well, but if he fails to thrive, owing to some congenital abnormality or infection, that particular brand of food is blamed and another one tried. This often heralds the onset of a long series of changes usually with a falling caloric intake and consequent failure to gain in weight. The end result of such a regime is

a wasted infant who is regarded as a 'feeding problem' with the implication that the mother was unable to find a food to 'suit the baby'.

As a working hypothesis, it may be suggested that an infant fails to gain in weight for one or more of three reasons: some congenital abnormality, an infection, or underfeeding. We are not concerned in this discussion with the first two, which belong to the realm of clinical medicine. As far as the feeding is concerned, the usual mistake is not of giving the wrong food but of giving it in amounts inadequate for the needs of the infant. The percentages of fat, carbohydrate and protein are relatively unimportant and 'percentage feeding' fostered for so long by the German school, has now been discarded. A similar attitude can be taken to artificial breast milk and humanized milk. Cow's milk cannot be humanized, and this process as far as infant feeding is concerned is wasteful of time and money. The important point is that the milk in whatever form it is given to the infant must be free from pathogenic organisms. Therefore all milk must be sterilized, preferably by heat (boiling). This applies even to breast milk that is exhausted from the mother and kept in a breast-milk bank. Here I would like to pay tribute to the Ministry of Health who in wartime provided a subsidized dried milk for infant feeding. Among the various factors which in the last 10 years have contributed to the fall in infantile mortality, the provision of an ample supply of cheap, sterile, vitaminized dried milk must rank very high.

Taking a broad view of infant feeding there are three main aspects for consideration: (1) the quality of food, (2) the quantity of food, (3) the accessories (minerals and vitamins); and two subsidiary ones: (1) the technique of breast and artificial feeding, and (2) the prevention of infection. The technique of infant feeding may be held to include the emotional and psychological factors that in some infants loom so large, and to the practising physician the prevention of infection in the small infant presents many problems as yet unsolved.

Calorie requirements

I should like to deal specially with the quantity of food necessary to make an infant thrive. Its importance has already been stressed. To determine it, some system is required and some unit of energy necessary. For years now, the Calorie (large) has been used, and although from time to time there have been other suggestions made, none has proved popular. Without some method of expressing the amount of energy required, infant feeding becomes a hit or miss affair. To quote Graham Lusk (1919) 'the so-called "scientific feeding" of infants is unworthy of the name unless the caloric requirement is carefully considered. From lack of this knowledge babies are frequently systematically starved.' The older child can express his feelings of satisfaction or hunger in different ways, but the underfed infant has the same method as one with colic from overfeeding.

The quantity of food required obviously varies with the weight of the infant, that is, with his age. Normally, the infant's weight is doubled in 6 months and trebled in a year. This rate of growth is far beyond anything that occurs at any other period of life and is the rational explanation of why deficiency diseases such as rickets and iron-deficiency anaemia appear so readily in the 1st year of life.

Infants require food for four purposes. These and the energy requirements/kg/day for each are as follows (Fleming, 1923-4):

Basal requirement	55 Cal.
Growth	5 Cal.
Loss in excreta	5 Cal.
Muscular activity	35 Cal.

The first three of these are capable of reasonably accurate measurement; the fourth, muscular activity, is a guess, but small infants unable to walk or stand or even sit up unsupported do not vary in this respect as much as older children, and an allowance of 35 Cal./kg/24 h is generally accepted as adequate.

The sum of these four requirements is 100 Cal. One should aim therefore at giving the healthy infant 100 Cal./kg/day certainly for the first 9 months of life, because the basal metabolic rate remains unchanged throughout this period. Having arrived at this figure, it only remains to convert the calories into terms of food for infants of varying ages. To do this, the following information is required:

Average birth weight	3.2 kg
Gain/month for first 6 months	0.6 kg
Gain/month for second 6 months	0.5 kg
One oz. milk (30 ml.) yields	20 Cal.
One rounded teaspoonful of sugar (5 g) yields	20 Cal.

An average healthy infant aged 3 months weighs 5 kg (3.2 kg + 1.8 kg) and requires 500 Cal. or in terms of milk 25 oz. daily. If he is fed 4-hourly, with five feeds daily at 6 a.m., 10 a.m., 2 p.m., 6 p.m., 10 p.m., this works out at 4 oz. milk and one teaspoonful of sugar in a feed. If this amount is taken by the infant and retained (i.e. there is no diarrhoea, vomiting or fever) and absorption is adequate (as it should be in healthy infants), he will thrive. The only important cause of failure to thrive, apart from disease processes, is underfeeding.

Requirements of the undernourished infant

I should like very briefly to make one more point that is of the greatest importance in the feeding of the undernourished infant. It seems fairly obvious that the calorie requirements will be the same for undernourished as for heavier infants as long as the basal metabolic rate remains unchanged. The fall in it does not occur unless the infant is 65 % or less of his expected weight.

In practice this means that a 3-month-old infant who weighs 4 kg instead of 5 kg (i.e. who is 80 % of his expected weight) requires as much food as if he weighed 5 kg. He has as much active metabolic tissue, but 1 kg less of inactive metabolic tissue in the form of fat and water. Too often the underweight infant is fed less than the healthy infant of the same age, the argument being that because he is small he should be fed less. Infants therefore should be fed according to their expected weight (that is, according to their age) rather than their actual weight. Prescribing an adequate feed for a healthy infant is thus simplified. One needs only to know his age to determine his expected weight.

In very marasmic infants, when the weight is below 65 % of the expected weight, and the basal requirements fall, less food will of course be required and allowance can be made for this by a simple calculation.

SUMMARY

The importance of the caloric intake in infant feeding is stressed and an outline of the reasoning behind the determination of the amount of food required at various ages is given. This applies equally to breast- and bottle-fed infants.

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The Importance of Breast Feeding

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The implication in the title of my paper is that breast feeding has an advantage over artificial feeding. That indeed is my belief, but The Nutrition Society will not want belief but proof; and frankly I cannot bring forward any likely to convince it. The rate of infant mortality has been falling steadily in this country during the past 50 years; the period being notable for a great improvement in the safety of bottle feeding. There is no evidence that I know to show the reduction in the death rate of babies owes anything to an increase in the number breast fed.

For such proof as there is of the importance of breast feeding we have to rely on carefully planned statistical surveys. Often quoted is one carried out by Grulee and his co-workers in Chicago between 1924 and 1929 (Grulee, Sanford & Schwartz, 1935). The mortality rate of the 20,000 babies they reviewed was but 11/1000; and among the wholly breast fed only 1.6/1000. These figures are so low that when published they seemed quite inapplicable to this country. Morbidity is much more difficult to assess, but they claimed that the incidence of infection was directly related to the method of feeding: 37 % in the breast fed, 64 % in the artificially fed. I will only quote one example of work in this country, where epidemic enteritis has always been a special risk to young bottle-fed babies. Despite the improvement in safety already mentioned, in a series of 216 cases of infantile gastro-enteritis, Gairdner (1945) found recently a death rate of 61 % when breast feeding lasted for less than a month, and 28 % if it had been prolonged beyond that time. I chose that example because in clinical practice there is ample, one might say daily, evidence that the ability to accommodate itself to artificial milk is least in the newborn and becomes progressively greater with the passage of time. So much so that by the age of 6 months there are not many who will not thrive on cow's milk. They thrive, that is