BASIC INFANT FEEDING*

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Too often breast feeding is decried these days on the grounds that modern artificial feeding is so efficacious that the irksomeness of natural feeding is unnecessary. The fact remains, however, that among artificially fed babies the incidence and severity of gastro-enteritis and, indeed, the death rate are appreciably higher than in breast-fed infants living under similar socio-economic conditions. This applies particularly to our non-White population. Breast feeding is still the 'feeding system' of choice. In this paper, however, only basic artificial feeding will be considered.

ARTIFICIAL FEEDING SYSTEMS

In the early decades of this century rigid and complicated artificial feeding systems, said to be scientifically exact, were preferred to simple methods. It was not unusual for scientific enthusiasts to spend weary hours computing diets mathematically, but infants thrived on these no better than they do under the simpler and more flexible feeding methods in vogue to-day.[1] In discussing the history of infant feeding, Wickes[2] mentioned a book by Tuley which recommended that feeds for normal infants be worked out algebraically!

Methods of artificial infant feeding may be conveniently discussed under 3 headings: (1) percentage feeding, (2) computed formulas, and (3) simple feeding involving a minimum of calculation.

1. *Percentage Feeding*

It was Rotch who advocated feeding infants by prescribing the exact quantities of carbohydrate, protein and fat for each individual baby. He believed that the slightest variation from the optimum composition of such feeds was sufficient to interfere with their proper digestion. Per-

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centage feeding has its counterpart in the fixed-formula, so-called 'humanized milks' in use today (see later).

2. *Computed-formula System*

Scientific enthusiasts in the past have stressed the desirability of computing infant formulas on a mathematical basis. The most practical of these methods, and one used at the present time by many paediatricians, is the calculation of infant feeds based on energy requirements in terms of calories. This calorie feeding has in recent years been simplified by making calculations on a basis of 45 - 50 calories per lb. of expected body weight per day, and expressing the calorie values of important foods in round figures: for example, milk and sugar as 20 and 120 calories per oz. respectively. Nevertheless, many general practitioners appear to have difficulty in applying the calorie system to infant feeding, especially for the undernourished infant.

Systems of varying complexity have appeared from time to time. Clemens von Pirquet is famous for the discovery of allergy, but his feeding system is scarcely known today. Its interest lies in its complexity and unusual basis, and because it emphasized the use of highly concentrated feeding for certain conditions such as prematurity, neurotic vomiting, rumination, pyloric stenosis, pylorospasm, and failure to thrive. Pirquet used highly concentrated feeds at a time when Truby King and others were vociferously denouncing the use of strong infant-feeding mixtures under any circumstances! Among the concentrated feeds advocated for the type of case mentioned above were the 3-fold concentrated gruel with a calorie value of 60 to the oz. (designated *Trifa*) and the better-known *Dubo* ('duplex lac bovinum'). *Dubo* is prepared by adding 17% of sugar to whole cow's milk. Strong mixtures are commonplace now, but in the early twenties these must have been revolutionary.

Pirquet's system. Pirquet[3] used milk as his standard physiological nutriment, the nutritive value of 1 G. of milk being expressed as 1 *nem* ('nutritional element milk'). The nutritional value of other foodstuffs is compared with milk — so many *nem* per gram of a particular food. Formulas are calculated not on weight, but on the square of the sitting-height in centimetres, because theoretically this bears a relationship to the body weight and to the absorptive capacity of the intestines. The sitting-height (top of head to sitting area) is measured and feeds are calculated on a *nem* basis, 1 *nem* per sq. cm. of sitting height being the amount of food which the human body can consume within 24 hours without overloading digestion. The complexity of the system is apparent but it 'works'. Of this system Abt[4] has written: 'A plan of feeding conceived in the mind of a genius who showed precision in detail and mathematical accuracy'.

3. *Simple Feeding*

The revolt against rigid and complicated feeding systems is not new. About 40 years ago Pfaundler was using the following scheme: cow's milk 1/10th, and carbohydrate (maximum 50 G.) 1/100th of the infant's body weight per day, with water to 1 litre, divided into 5 feedings; the baby to take as much at each feeding as it desired. Today the emphasis is on simple feeding.

The question arises — should milk for artificial feeding of infants be diluted with water and sugar added, or not? Babies have been fed from birth on whole cow's milk and even undiluted double-strength evaporated milk mixtures, with no apparent ill effect.

Nevertheless, Calcagno and Rubin,[5] Pratt and Snyderman,[6] Hansen and Smith,[7] and others have shown that in newborn and premature babies, because of the higher protein and mineral content of whole and concentrated milks, the renal solute load is raised, i.e. an excessive amount of water is needed to excrete urea and mineral salts in the urine. Carbohydrate puts no added load on the kidneys; in fact, where carbohydrate is added to milk, not only does water tend to be conserved in the body, but also there is a better weight gain. Under normal conditions the body can cope with whole milk, but where there is excessive water loss, as in fever, renal impairment or during hot weather, limited dilution of whole milk plus carbohydrate would appear to be preferable, because this type of mixture tends to raise the safety margin against dehydration.

FEEDING-MIXTURE CONSTITUENTS

In the past, weak mixtures were customary, often leading to undernutrition. Today, the tendency is to use a milk mixture approaching full-strength cow's milk or its equivalent in proprietary milk products. Lactose (sugar of milk), sucrose (cane sugar) and dextrimaltose are the sugars in common use; cane sugar is the cheapest of these and is the sugar of choice for the healthy baby. Readily available proprietary milk products are the evaporated (condensed) liquid preparations and the powdered milks (full-cream, half-cream and 'humanized').

Sweetened condensed milk contains 45% of added cane sugar, and when reconstituted with water to full-strength, has a high carbohydrate content. The unsweetened evaporated milks now marketed locally are cow's milk preparations condensed to half their original volume, so that the addition of an equal quantity of water reconstitutes the product to full-strength cow's milk. The so-called 'humanized milks' have an adapted percentage composition similar to that of breast milk, and most of these products are reinforced with essential vitamins; the formula is fixed and is usually kept unaltered irrespective of the age of the infant. Humanized milks are issued with a special measure and the full-strength mixture is obtained by dissolving 1 measureful of powder in 2 oz. of water (humanized milk, type 'A'), or 1 measureful of powder in 1 oz. of water (humanized milk, type 'B').

Sugar and powdered milk have to be measured. The suggested standard measure for this purpose is the packed, level, regular household teaspoon, obtainable everywhere, and of 5 ml. fluid capacity. This measure is used for sugars and powdered milks other than humanized milks.

The following milks are in common use for infant feeding:

1. Natural cow's milk.
2. Condensed (evaporated) milks:
   (*a*) Full-cream unsweetened (e.g. Ideal Milk, Carnation Milk).
   (*b*) Full-cream sweetened (e.g. Nestle's Milk).

TABLE I. FEEDS FOR AN INFANT OF 3 MONTHS WHOSE WEIGHT IS 12 LB.

Total fluid for 24 hours (12 × 2½) = 30 oz.
Cane sugar (1 teaspoon per 4 oz. of mixture) = 7½ teaspoons.

1. Natural cow's milk Cow's milk (⅘) = 22½ oz. Water = 7½ oz. Cane sugar = 7½ teaspoons	*3. Unsweetened evaporated milk* Ideal Milk / Carnation Milk = 11 oz. Water = 19 oz. Cane sugar = 7½ teaspoons
2. Full-cream dried milk Klim / Nespray (12×3) = 36 teaspoons Water = 30 oz. Cane sugar = 7½ teaspoons	*4. Humanized (fixed-formula) milk* Type 'A': Bremil / Lactogen / Olac = 15 measures Water = 30 oz. Type 'B': SMA / Pelargon = 30 measures Water = 30 oz.

3. Powdered milks:
   (*a*) Full-cream: 3·5% fat (e.g. Klim, Nespray).
   (*b*) Half-cream: less than 3·5% fat (e.g. Semilko, Dryco, acidified Eledon, Cow & Gate Half-cream, Cow & Gate Tropical).
   (*c*) Humanized milk, type 'A' (e.g. Lactogen, Olac, Bremil).
   (*d*) Humanized milk, type 'B' (e.g. SMA, acidified Pelargon).

BASIC FEEDING SCHEME

In 1948 I stressed the importance of feeding simplification,[8] and suggested a simple feeding method for the normal infant. The present scheme is still further stripped of non-essentials and includes certain of the proprietary products not in common use at that time.

The first step is to jettison unnecessary foodstuffs. The healthy baby does not need to be fed on sweetened condensed milk, a half-cream milk, dextrimaltose, or lactose. This leaves water, cane sugar, natural cow's milk, unsweetened evaporated milk, full-cream dried milk, and humanized milk. It is further suggested that from 8 months of age onwards, the infants be given undiluted cow's milk without added carbohydrate. The basic scheme is as follows:

1. Mixtures are calculated to the age of 8 months. Thereafter, undiluted cow's milk is offered.

2. The total fluid for 24 hours is calculated on a basis of 2½ oz. per lb. body weight, with a maximum of 40 oz. a day.

3. Where sugar is indicated, cane sugar is given — 1 teaspoon per 4 oz. of mixture (maximum, 9 teaspoons).

4. Strength of mixture:
   Natural cow's milk: ¾ milk, ¼ water, plus sugar.
   Evaporated milk (unsweetened): half the quantity of cow's milk — 3/8ths milk, 5/8ths water, plus sugar.
   Full-cream dried milk: 3 teaspoons per lb. body weight, plus sugar.
   Humanized milk (type 'A'): 1 measure per 2 oz. of water, no sugar.
   Humanized milk (type 'B'): 1 measure per 1 oz. of water, no sugar.

5. When changing from one type of milk to another, diminish the quantity temporarily by calculating the mixture on the infant's weight minus 1 lb.[1]

Table I illustrates how basic feeds are calculated. It applies to an infant 3 months old whose weight is 12 lb., to be fed on natural cow's milk, unsweetened evaporated milk, full-cream powdered milk, or type 'A' or type 'B' humanized milk.

This basic scheme is by no means perfect. It does not take into account the individuality of the baby or the problems associated with difficult feeders. Nevertheless, the scheme should succeed with the majority of healthy babies. Where weight gain is inadequate, a slight adjustment of feed concentration or the addition of a little extra sugar should suffice to augment the weight. Vitamins are given towards the end of the first month of life; cereals and vegetables at 4 months or when the weight is 14lb., whichever is the earlier; and a fuller mixed diet from about 7 - 8 months.

A historical review of infant feeding indicates that there have always been paediatricians who were convinced that their particular feeding 'system' is the one best suited to humanity. Experience teaches that any sensible feeding method based on modern concepts is likely to be satisfactory. Therefore, the feeding scheme employed might just as well be a simple one.

SUMMARY

1. Methods of infant feeding are discussed under 3 headings: percentage feeding, computed formulas, and simple feeding involving a minimum of calculation.

2. The modern tendency is towards simplification of infant feeding.

3. A simple basic feeding scheme is outlined, applicable to most types of milk in common use, to include natural cow's milk and proprietary milk products.

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