DIET OF THE INFANT.* *

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The subject which I have to discuss with you this evening is the "Diet of the Infant". Infancy, as you probably know, is a very elastic term. On the Continent, as in France, children up to 12 years are considered infants, for the French speak of "Maladies des Enfants" as we do of "Diseases of Children". I intend, however, to employ the term in the English sense, which signifies the age period from birth to the end of the first year.

Natural Feeding.

One would have thought that it would be generally accepted that natural feeding is the ideal method, and that it would be quite unnecessary at this late date to do more than give it passing reference. However, the frequency with which our obstetric colleagues airily discard the breast and embrace the bottle (with its many hidden dangers), and the delivery of a lecture some few months ago by the M.O.H. of Cardiff, entitled "Does Breast-Feeding Matter", show that there still prevails some difference of opinion on the matter and justify me in devoting some time to the question.

Advantages of Breast-Feeding. If breast-milk is present the advantage of using it would surely seem self-evident. In the first place, there is no more simple method of feeding. With it there is no call to worry about the grade of the milk (whether it is T.T., Grade A or Certified) nor to care about its preservation. There is no preparation of complicated milk mixtures, no necessity to watch the temperature of the feed, no demand for sterilization of the bottles or need to measure the amount the child is to get. The babe is simply put to the breast at stated times and allowed to drink for say 20 minutes, by which time the normal infant will be satisfied. These facts are no doubt very important, more especially in the case of the less favoured families where time and money are of such moment, and this we should never forget refers to the great majority of the population. But what is even more important, the results show that breast-feeding is undoubtedly the best method of nourishing the infant.

One would of course expect that Nature would supply the right kind of food. We know that the milk of all species of animals is not the same. The different milks vary in composition so far as fat, protein, sugar and salts are concerned, each variety being specially designed for the particular needs of the species. Thus, so far as the infant is concerned, human milk probably contains the various nutritive elements in the optimum proportions and in a condition which permits of the optimum activity of digestion and absorption. That this is so is revealed by the fact that all experiments have demonstrated that the fat, protein, calcium and phosphorus of human milk are absorbed and retained by the infant in relatively greater amount than is the case with cow's milk.

There is, however, another factor which is of great importance in differentiating breast-feeding from artificial feeding, viz.: the sterility of the food when abstracted direct from the breast. In these circumstances there is no opportunity for contamination. It is the frequency with which artificial food is contaminated by pathogenic organisms, and thus produces various diseases (particularly gastro-enteritis), which constitutes the most serious danger of bottle-feeding.

*Being one of a Series of Lectures on Diet and Dietetics delivered under the auspices of Fellowship of Medicine on October 31st, 1934.

These facts alone would indicate that breast-feeding is probably better than bottle feeding, but it is the results which really matter and these, I personally believe, do show that breast feeding is best. The breast-fed child has a better colour, his tissues are firmer, he is less subject to disease and particularly gastro-enteritis and marasmus.

Nevertheless, it is not universally admitted that natural feeding has any advantages over artificial feeding. Indeed, from a survey of the literature one appreciates why the M.O.H. of Cardiff should, as just mentioned, raise the question, "Does Breast-Feeding Matter?" There is quite a body of opinion which holds that the bottle-fed child is just as good, and indeed often better, than the breast-fed, and that he does not show an increased susceptibility to disease. If, for example, we contrast the better-class child, who is not only taller and heavier age for age than the child of the less-favoured classes, in which breast-feeding is undoubtedly more frequent, one might wonder if indeed the natural method had any advantages. But in this comparison other factors than feeding, e.g., environment, come into play. If correct conclusions are to be drawn we must be careful to compare groups of infants between which the only difference is the method of feeding. This is not always easy or so straightforward as at first sight might appear, for even in the same social class the child may be weaned because of ill health and thus is probably a less virile child, or again, the child may be artificially fed because the mother has had to go out to work and so, from the consequent neglect of the home, environment becomes involved. Nevertheless, when strictly comparable groups are compared, the advantage would seem to lie with the breast-fed. For instance, in a study of infants of the industrial classes in Glasgow and Dundee, Dr. Noël Paton and I found that the average weight of the wholly breast-fed child—both boys and girls—was distinctly above that of the child not entirely breast fed.

One of the most striking features of work in a children's hospital is the rarity with which the breast-fed child is admitted suffering from either gastro-enteritis or other form of nutritional disease. Housden found that of 318 consecutive examples of gastro-intestinal disorder admitted to the Hospital for Sick Children, Great Ormond Street, 89 per cent. were artificially fed. This same fact is also shown in the statistics from Paris which Truby King used in his propaganda work on breast-feeding. And in the study of infantile mortality it is remarkable what a large proportion of the deaths are due to gastro-enteritis, in fact so important is this particular cause that it dominates the trend of the curve and determines whether the rate will be high or low. In this connection one cannot help from recalling that during times of famine and industrial trouble the infantile mortality rate falls. This is probably to be explained by the almost universal resort at these times to breast-feeding because it is the cheapest.

Disadvantages of Breast-Feeding. It cannot be denied that breast-feeding has some disadvantages. The greatest of these, and in my opinion the only one, is the tax it entails on the mother. A nursing mother must literally devote herself to her child, and one is glad to be able to say that there never was a time when the mother was more anxious than she is to-day to do the right thing by her infant. The burden of breast-feeding should be viewed by us medicals in a sympathetic attitude and we should do all in our power to lighten it.

Of recent years there has been much talk about breast milk not containing a sufficiency of iron for the child's needs, and that by the fourth or fifth months anæmia almost universally develops. My chief criticism of this teaching refers to the method adopted to get the normal standard. Dr. Helen Mackay, who is chiefly responsible for this doctrine, does not take the average hæmoglobin content as the normal but the level to which it can be raised by the administration of extra iron. If this method were applied to the other constituents of the blood, e.g., calcium, phosphorus, urea and sugar, then we would require to alter all our views of what is normal and what is pathological. But apart from this point of view, it has not been my experience that the average breast-fed or even bottle-fed child does develop anæmia unless when a wholly milk diet has been continued unduly. In my experience it is during the second year of life, and especially among the better classes, that this condition (nutritional anæmia) is met with because the mother in this social class is not infrequently ridiculously strict in the matter of feeding.

One also hears it stated that human milk on occasions is deficient in vitamins. I do not wish to enter upon a detailed discussion of this aspect of the food question, because so much of it has as yet no real clinical significance. One may, however, refer to scurvy which of all the varieties of so-called avitaminosis is the one beyond question, although there are some authorities who do not believe that this disease is due entirely to the absence of an "accessory food factor" but that it is an infection superimposed on a diathesis. Whatever view may be held, the mother's milk would seem to be a sufficient preventative for there has never been recorded an example of this disease in the breast-fed child, and that even although the mother herself is affected as is not infrequently the case in countries, like Russia, where scurvy is endemic.

Technique of Breast-Feeding. So far as the diet of the nursing mother is concerned, one can only stress the necessity for her taking a sufficiency of fluid. This is self-evident, since milk contains such a large proportion of water. It is not necessary, however, that any special type of fluid be chosen, milk, soups, water, &c., do equally well, but all alcoholic beverages should be eschewed. The same restrictions apply to spiced articles of food or anything which is known to cause allergic phenomena.

It is advisable both for the child and the mother that the feeds be as infrequent as possible. Four hourly feeds during the day, with one eight-hourly interval during the night, are often most satisfactory. Such a spacing of the nursing periods gives the mother ample time to take part in social engagements and secures for her an uninterrupted night's rest, while at the same time it allows the child's stomach to get rid of one feed before another is presented and thus conforms to a fundamental law of dietetics. Occasionally, however, the child apparently cannot take a sufficiency at any one time to last for four hours and three-hourly intervals during the day, with one of six hours during the night, must be resorted to.

Time of Weaning. It was observed by Dr. Noël Paton and myself, in our study of the weight curves of comparable series of breast-fed and bottle-fed babies, that at about the age of nine months (between the eighth and ninth months in girls and at the tenth month in boys) the average weight of the breast-fed child, which until then had been the greater, falls and thereafter runs at a lower level than that of the artificially fed child. This would indicate that after this period the average mother is not able to supply the needs of her child and that additional nourishment

is necessary. It is wise, therefore, at this age to replace the breast, and if being bottle-fed, to give in addition to the milk, something in the nature of a cereal, egg yolk (which by the way is the food richest in Vitamin D) and vegetable like spinach for its blood-forming qualities. These various articles, with potato and gravy and rusks, will carry the child on satisfactorily till his first birthday.

Ability to Breast-Feed. Unfortunately, all mothers are not able to suckle their children. Many women cannot perform this natural function even for the first few days of the child's life, far less for the requisite nine months. Of the hospital class of mother 20 per cent. are never able to suckle at all, and only 50 per cent. manage to do so for nine months. Of the better classes also 20 per cent. are never able to suckle, 50 per cent. can do so for three months and only 25 per cent. for nine months. Unfortunately, too, the number of women, particularly among the better classes, who are unable to suckle their children is increasing and that in spite of much propaganda and a sincere desire on their part to do so.

Artificial Feeding.

It is thus seen that a considerable proportion of children cannot receive breast milk and for them some substitute must be found. Naturally, in view of our faith in the ability of Nature to supply the ideal food, our thoughts turn to some similar substance devised for the nourishment of the young. Several varieties of milk of other mammals have been employed and, except in the case of milk hypersensitivity when one particular variety may be essential, there is no theoretical ground for differentiating between them. The variety which is mostly used, at least in this country, is cow's milk simply because it is the one of which we can obtain a sufficient supply.

However, whatever the variety employed, it is very different in its composition from human milk. The methods suggested to modify it in an attempt to make it more suitable for the child are almost legion. An account of these would be the history of infant feeding, and incidentally of biochemistry as well, and for such a task we have not sufficient time at our disposal this evening. Nor do I intend to outline any particular method which I recommend, because I consider our time will be best spent by a consideration of fundamental principles which apply to all systems of feeding. These I shall discuss under three headings,

- (a) Quantity,
- (b) Quality, and
- (c) Sterility.

(a) Quantity. The body is like an engine, and a very efficient engine it is for it goes on working day and night without ceasing and repairs itself at the same time. But just like an engine it requires fuel for the production of energy, although from the amount sometimes given the medical man or nurse must think he or she is dealing with some miraculous machine able to do its work on air and water alone.

The infant must receive fuel or nourishment for its normal functions (the supply of heat, the activity of the various organs and especially muscular contractions), for growth, to repair wear and tear, and a surplus to cope with waste (the excreta). If a sufficiency for these various functions is not supplied then

only one result can follow, viz.: emaciation, which is proportionate to the deficiency. There may be just enough for the vital functions (heat production and activity of the various organs) and for the repair of wear and tear, yet there may be no loss of weight, because the body can be taught to do with less than its optimum amount as was revealed very often during the Great War. If, however, there is not enough for these purposes, and to repair wear and tear, then the child will live on his own tissues and must inevitably waste.

An insufficiency of food is a very common cause of disease. In the West of Scotland and in London it is probably the commonest cause of nutritional disease in infancy. It is important to remember, too, that it may not always come under our notice in this guise. In consequence of under nourishment the child's resistance is lowered, not only to food but to micro-organisms, and all sorts of diseases readily develop, e.g., enteritis, otitis media, pneumonia and suppurative pyelo-nephritis. These conditions reduce the child's tolerance still further and render him less able to digest his food so that a veritable vicious cycle is created.

The chief symptom of underfeeding is a stationary weight or a loss of weight. The child is always cross, seems hungry and, although he settles down after a feed, he awakens long before his next one is due and becomes increasingly fretful till fed again. One symptom which is apt to mislead is vomiting. This is frequently present in the under-fed child and may simply be an expression of the child not being well, since it is without doubt the commonest symptom of disease during infancy, no matter what its cause or nature. Another symptom which is often misconstrued and considered evidence of enteritis, and hence an indication to diminish the intake, is the frequent passage of dark green, slimy-looking stools. These, however, are the so-called hunger stools, being characterised by an absence of all food residue and consisting entirely of mucus, secretions and bacteria.

Different methods have been employed to estimate the amount of food required at different periods during infancy. Several doctors, by weighing their own children before and after every feed, have determined the amount of milk taken during the whole course of breast-feeding. Within recent years, by measuring the amount of O_2 consumed or of CO_2 excreted, the amount of food burned up can be calculated. This is usually expressed in the calorie, i.e., the unit of nourishment. Roughly, these two methods give the same results and show that the relative amount of food is greater the younger the child. According to Rubner 100 calories per kilo of body weight are required for the first three months, 90 per kilo during the second three months, 80 per kilo during the third three months and 70 per kilo during the last trimester of the first year. This amount of food or fuel can be expressed in ounces of breast milk or of cow's milk, which have practically the same nutritive value, and in the following table is shown for different age periods.

During 1st week	0 to 16 ozs.
„ 2nd week	17 „
„ 3rd and 4th weeks	20 „
„ 4th to 8th weeks	27 „
„ 8th to 14th weeks	28 „
„ 14th to 20th weeks	30 „
From 20th week on	35 „

(b) *Quality of Food.* As I have already mentioned, the milks of different species of animals are not identical in their composition. The proportion of fat, albumin, sugar and salts shows wide variations, which are probably dependent on the needs of the young of that particular species especially so far as the rate of growth is concerned. It is, however, not only in the proportion of the different proximate principles that a difference prevails, but also as regards the make-up or constitution of these same substances, which is a much more important matter.

Let us for a moment consider the protein. Protein as such owes its virtue to the amino-acids or ultimate elements of which it is composed and in no two types of protein is the grouping of these various amino-acids identical. For example, one of the amino-acids—tryptophan—which is essential for growth, is more than twice as abundant in human-milk protein as in cow-milk protein, and hence to supply the optimum amount of this essential substance, at least if we take as our index that which is provided by nature, the quantity of protein when using cow's milk for the infant should be doubled and not halved as is so frequently done. As further reasons for not diluting cow's milk are its lesser content of iron and its relatively lessened utilisability. Provision, of course, could be made for the deficiency of iron by adding some ferruginous salt to the milk-mixture, as recommended by Helen Mackay, but there is no such remedy for the paucity of tryptophan.

It must also be appreciated that the disintegration of the protein into its ultimate constituents, and the regrouping of these in the correct proportion for the formation of the native protein of any animal, can only be done by the activity of the digestive juices and organs of that particular animal. This cannot be done outside the body by any process of predigestion and dilution, and hence to speak of humanising cow's milk is a mere figment of the imagination. Indeed, it is because of fundamental differences like these that one often wonders if it is really worth while considering the modification of cow's milk for infant feeding, because we can do little more than alter the most superficial characteristics. In my own experience, and in that of many pædiatricians, undiluted cow's milk seems to do as well, if not better, than any specially devised milk-mixture. By such a method the technique is simplified and at least underfeeding, which as I have already mentioned is one of the chief dangers of artificial feeding, is less likely.

(c) *Sterility.* One of the chief virtues of breast-milk is its sterility, just as the most potent danger of cow's milk is its germ content. Indeed, of all the factors in connection with the use of cow's milk in the feeding of infants, this is far and away the most important. This aspect of the question has engaged the increasing interest of our Public Health Authorities and has been the subject of many Commissions. In consequence, the purity of our milk supply is at a higher level than it has ever been, but it is still not quite satisfactory and requires the greatest vigilance on our part and much education of the general public to a proper appreciation of the true state of matters.

Cow's milk may contain many different types of organisms. Some are saprophytic and of little moment, while others are pathogenic for man and cause the greatest havoc. These pathogenic organisms may reach the milk at its source,

as e.g., the streptococci and the tubercle bacillus from disease of the udder, and the bacillus abortus, the cause of undulant fever, by passage from the blood when the cow is suffering from epidemic abortion. It is quite unnecessary to point out to this audience the extent of the mischief caused in this way. But pathogenic organisms, it is important to bear in mind, may also gain entrance to the milk during its transit from the source to the consumer by being handled by individuals suffering from enteric fever, diphtheria and dysentery. Hence it is not sufficient to pay attention only to the cow, and then to think that all is well. By all means let us produce as pure a milk as possible, and free from all disease-producing organisms, but we must remember that so far as tuberculosis is concerned this cannot reach a consummation for many years to come. It will take a long time to rear in this country a stock of tuberculosis-free cattle, but that it can be done has been shown in America and by the Reading and the Ayrshire Research Institutes at home. In the meantime, however, it is wise to consider most of the milk suspect and to treat it accordingly. This means sterilization, or preferably pasteurisation, at the farm or some central depot where the milk from many sources is collected, and, what is equally important, it must be immediately bottled and sealed in order to avoid any chance of contamination during the process of distribution because this is a danger which never can be eliminated. And finally, it may be taken as a sound rule that, if one is not certain about the sterility of a milk to be given to an infant, or indeed to any child, it should be boiled or pasteurised in the home before use.

There has been, and still is, much criticism of this treatment of the milk on the grounds that it destroys or changes its nutritive qualities. Most of this criticism, however, is based on pure theory and has no relation to actual facts. In the first place, there is absolutely no proof that pasteurisation of milk renders it less nutritive for the infant; as a matter of fact there is a certain amount of evidence the other way, viz., that boiled milk is better utilized by the infant than raw milk. In the second place, there is also no proof that simple boiling or pasteurisation destroys the vitamin content of the milk. Personally, I have never observed scurvy, which, by the way, is prevented by the least resistant of the various vitamins, develop during feeding with boiled or pasteurised milk. In my experience scurvy usually results from the use of dried milks or from the use of pasteurised milk which has been boiled or pasteurised for a second time. In any case, the danger of scurvy is not of serious moment, since it can be absolutely and easily prevented by the administration of some raw fruit juice.

Conclusions.

In conclusion I may perhaps be permitted to draw the lessons from my talk this evening and to express them in the four following short sentences:—

- (1) Breast milk is best.
- (2) Undiluted cow's milk is the best substitute.
- (3) Be sure the child gets a sufficient amount, and
- (4) Be sure that the milk is safe from microbic contamination, which is only possible by pasteurisation.