COMMON PRACTICES IN INFANT FEEDING.

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BREAST-FEEDING is sometimes impossible from the beginning, owing to gross illness or breast troubles on the mother's part, or to physical weakness, mental deficiency, or structural abnormalities of the suction apparatus in the child. In many cases again breast-feeding has to be abandoned after a period, perhaps some weeks or months, of trial which may have proved, wholly, or partially, successful for a time. In most cases the reasons for this failure of lactation is discernible, such as anxiety in the mother and nervous irritability in the child; in some, however, it must be admitted we are dealing with a type of infant which does not thrive on the mother's milk, despite the truism that no form of artificial feeding can compete in physiological value with breast-feeding; though the method of feeding may be ideal as regards quantities and intervals, the infant suffers from indigestion and fails to gain weight.

This occasional unsuitability of the mother's milk for the infant is not an unique phenomenon in the animal world, for the same thing is occasionally witnessed in the cow and her calf. The precise biological explanation of these cases has not been forthcoming and, as a rule, it is clinical observation rather than milk analysis which is the means, in any individual case, of demonstrating the unsuitability of the mother's milk. It is not right in any case of this kind to allow the infant to leave the breast until we have satisfied ourselves that the step is really necessary by orderly inquiry into:—

- (1) Times and length of feeding.
- (2) Condition of the mother and her breasts,

(3) The physical condition of the infant.

(4) The amount and quality of the breast milk.

The amount is calculated by taking an average of weighings of the infant before and after a feed. The quality of the milk can in some cases be shown defective by reason of a low content of protein or fat, though in many cases there is no abnormality to be found.

It must be mentioned also that there is little doubt that social and environmental conditions, in their effect on both mother and child, represent an aspect of this question which is of no mean importance.

In any of the above circumstances of failure of lactation, it becomes necessary to resort to the next best substitute, cow's milk, which, however, cannot compare in the convenience of sterility, warmth, and ease of conveyance from mother to child with human milk, nor can it attain the same standard of quality, for there are important physical and chemical differences between the two milks. The chief drawbacks to cow's milk are to be found in: (a) its different reaction and high buffer value; (b) the character of the protein, i.e., the high proportion of casein compared to albumin, with the consequent production of a large and coarse clot instead of the loose flocculent one of human milk; (c) the character of the fat; not only is the emulsion much coarser, but the fat is made up of an entirely different grouping of acids and glycerides, and the proportion of volatile fatty acids in cow's milk is seven times greater than in human milk; (d) the constitution of the salts, the most important difference being the high proportion of calcium in cow's milk, as compared with low calcium and high potassium percentage in the other.

By reason of these difficulties it is rarely wise, or always possible, to feed a child in the first few months on *whole sweet milk*. When modified in certain respects, normal infants will readily accommodate themselves to the remaining differences, principally

through an increased secretion of hydrochloric acid; modification can be fairly easily accomplished to suit the requirements of most cases, provided the protein, carbohydrate, fat and salts be present in *correct balance*, sufficient water be given and the necessary vitamins prescribed.

For the healthy infant, a choice can be made from one of the following:—

(1) Dilution of fresh milk on the plan of: (a) humanized mixtures; or (b) simple dilution with carbohydrates.

(2) Dried (sweet) milks. Full and half-cream strength.

(3) Acidified milk. Fresh or dried.

Dilution of Fresh Milk.—The only preliminary knowledge necessary to calculate dilution is the elementary one of the percentage of the ingredients of milk, which can, for all practical purposes, be said to contain:—

Protein, 3.5; sugar, 4.5; fat, 4; salts, 0.75; water 83 to 87 per cent. The element which varies most (i.e., in different cows and at different seasons) is the fat, and it is always wiser, for this reason, to use an "average" milk, i.e., one obtained from mixing the milk of several herds.

At the bottom of all the methods of feeding with dilutions of milk lies the idea of conforming, more or less, to a percentage of ingredients similar to that of human milk. In the past there was a greater tendency to preach and practise a closer adherence to those percentages than exists to-day. Experience has proved that considerable deviation of the prescription from the "human" standard is not only safe, but often more efficacious in attaining the best results.

In so-called "percentage" feeding the mixture is made by adding water to cow's milk to dilute the protein, and adding carbohydrate (as sugar) and fat (as cream or cod-liver oil) to make up the deficiency of those elements which has resulted from dilution.

The "simple dilution with added carbohydrate" method only differs from the

"percentage" system in that it deals with *amounts* of milk, sugar, &c., rather than with percentages of the different food elements, and in that it implies keeping the fat percentage low, while ensuring that the basal protein needs are met. This procedure is perhaps the one most commonly in use at the present day.

The usual plan is to start with a concentration of equal parts of milk and water, and slowly lessen the dilution until whole milk is given at the sixth month. Sugar is added to the mixture. This can, for practical purposes, be put in tabular form:—

Age	Weight	Milk	Water	Sugar added	No. of feeds
1 month	8 lb.	1½	1½	1 teaspoon	7
2 months	10 "	2	1	1 "	7
3 "	12 "	3	1	1 "	7
4 "	13 "	4	1	1 "	6
5 "	14 "	5	1	1 "	6
6 "	15 "	6	0	1-2 teaspoons malted sugar or starch (as flour)	6

Water between feeds.

Additions to the milk include sugar, starch and vitamins. The question of carbohydrate additions to the formula is an important one. As regards *sugars*, a choice can be made of several forms, lactose, cane-sugar and mixtures of lactose and dextrin, or of dextrin and maltose. The ideal is to choose the sugar which makes the least demands on the digestive powers and has the highest assimilation limit. On these criteria lactose (milk-sugar) and saccharose (cane-sugar) do not, from experimental results, compare favourably with maltose (malt-sugar) which is simple in structure and quickly converted into normal blood-sugar (dextrose) and is absorbed immediately, high up in the intestine, whereas the former tend to remain too long in the bowel, becoming subjected to excessive bacterial fermentation. The *dextrins* are rather more complex in structure, are converted more slowly into dextrose through the intermediate stage of maltose, and have the advantage of not being fermentable.

Lactose can be used in most cases in

normal infants, though the danger of giving more than 6 per cent. and causing diarrhoea is to be remembered. Large amounts are best avoided, and if a high percentage of sugar is required it is better to replace it, wholly or in part, by Dextri-Maltose (Mead's Nos. 1 and 2).

The effect of the combination "dextri-maltose" depends on the relative proportions of the two components; if maltose is in excess it tends to cause fermentation and loose stools, while dextrans are non-fermentable. In the above preparations (Meads Nos. 1 and 2) the maltose is only slightly in excess of the dextrans, and they are, therefore, advantageous if there is a tendency to excessive fermentation.

Mellin's Food and Mead's No. 3 are also dextri-maltose, but contain potassium carbonate, and are rather laxative in the action.

Though the amylolytic ferments are present both in the saliva and pancreatic juice at birth, it is usual in this country to defer the use of *starches* till after the third month at least, though in America and on the Continent its use is more in vogue in the early months. In some clinics abroad experts advocate feeding quite early on a mixture of milk, sugar and flour, though the amount given of the latter at first is quite small, being gradually increased as the child gets older. The flour is boiled to a mucilaginous consistence, is added to the required amounts of milk and sugar, and the whole mixture is again rapidly boiled.

The advantages of starch in a feed are stated to be its protective colloidal action in preventing the formation of large casein curds in the stomach and its capacity of assisting fat digestion. It is certainly true that starch, as flour, substituted for sugar, often does start a lagging weight curve in an upward direction. The possible explanation of this may be that it is broken down more slowly to maltose and so provides less chance of fermentation. One's own experience leads one to be cautious in the use of starch in the early months, and to reserve its use at this age for special circumstances.

The subject of carbohydrate additions, which applies equally when dried and acid milks are used, has been discussed a little fully, because it is such an important item in the feeding of both the healthy and the sick baby.

At the end of the second month it is wise to prescribe additions of orange juice and of cod-liver oil. At the fifth or sixth month starch can be added in the form of flour, and vegetable broth (with or without bones) can also be embarked on.

Before leaving the subject of *fresh milk* feeding, it is necessary to make the customary allusion to the methods of modifying the curd and aiding its digestion. In addition to boiling and diluting the milk with water or starch, already mentioned, peptonization and addition of alkalies (*e.g.* pot. cit.) are other methods. Peptonization is not usually advisable for long, or the child may fail to gain weight even in the absence of gross signs of indigestion. Both acidification and drying of milk help better than any of these to promote efficient protein digestion.

Dried Milks.—A dried milk is cow's milk reduced to powder by removal of the water content, and the equivalent of cow's milk is reconstituted by adding one part of powdered milk to eight parts water (Glaxo, Cow and Gate, Dorsella, Dryco, Trufood). Some of these milks are supplied in skimmed, half-cream, full-cream, and humanized forms.

Among the advantages of using dried milks are that they are relatively sterile, and that the percentage of ingredients is known within reasonable limits. The nutritive value, also, is not only unimpaired, but is probably improved, both because of the alteration of the protein, the casein being divided into minute particles, and because the size of the fat globules is reduced during manufacture. The keeping qualities are excellent, and it is claimed that none of the vitamins is impaired in the process, though some doubt has been expressed as to whether vitamin C is or is not impaired.

The disadvantages, besides the possible

diminution in the biological factor (which can easily be guarded against by giving orange juice and cod-liver oil), are that careless preparation may alter the strength of the mixture to an important degree. This can be avoided to a large extent if the standard measures provided are used.

My own experience has led me to avoid the routine use of the full-cream varieties in the first two or three months, since they frequently cause dyspeptic symptoms. It is my practice to start with half-cream strength with added sugar, and at three months or so replace it by the full-cream variety, and later at the sixth month by whole fresh-milk feeds. In children who display any weakness of digestion, especially of fats, resort to this plan is attended as a rule with success, though it is absolutely necessary when using dried milks to know accurately their constitution, especially regarding the fat.

Dried milks have taken an important place in infant feeding and, I think, deservedly so, because, in addition to the convenience of their use and their somewhat easier digestibility they are, by their greater sterility, free from the suspicion of conveying tubercle bacilli.

Acid Milks.—The subject of acidification of milk has received much attention of recent years, and excellent results attending its use have been published. If cow's milk is soured through growth of lactic acid-producing organisms, or if lactic or other acids are added to the point of curdling, it induces certain changes in the milk and improves digestibility. Marriott, an early advocate of this form of feeding, showed that the average hydrogen-ion concentration at the height of digestion in normal infants on breast milk was 3.75 per cent., while in infants fed on undiluted cow's milk it was 5.10 per cent. The addition of acid (up to 0.4 to 0.6 per cent of lactic acid or the chemical equivalent of other acids) leads to a neutralization of a portion of the buffer substances present, so that when the milk is the degree of acidification in the

stomach approximates that of breast-milk feeding.

According to Marriott the acidification helps to inhibit bacterial growth, allows the pyloric sphincter to act normally, promotes a good flow of bile, pancreatic and intestinal juices, and causes precipitation of casein curds in a finely-divided form, thus encouraging their easy digestion and a quicker emptying of the stomach than occurs with sweet milk.

Another effect is that, owing to the greater acidity of the stomach and upper part of the small intestine, the absorption of certain minerals, especially calcium, is rendered more easy and, as the acids themselves are quickly absorbed, the lower part of the intestine becomes alkaline, owing to the relative reduction of fermentative bacteria and the increased secretion of alkaline juices. These facts are demonstrated in the character of stools of babies fed on acid milk, which are alkaline, light brown in colour, firm and putty-like, and of sour odour, and contain a large amount of lime soaps and calcium phosphates.

There is no reason to show why, if so desired, this method should not be employed in healthy infants from birth, and there is no apparent disadvantage to its prolonged use. It has certainly proved itself a valuable means of enabling babies with poor digestions, who have high caloric requirements, to take large quantities of milk which would not have been possible had sweet milk been given. One practical disadvantage is that its acid taste may cause it to be refused by many infants at first, but perseverance nearly always overcomes this, and afterwards they seem to take it with relish; another is that great care needs to be exercised in its preparation, or else the curds are too large to pass through the holes in the teat.

Fresh milk can be acidified by adding lactic acid (B.P.) to whole milk (strength 4 drms. to a pint); the acid is added, drop by drop, to milk which has been very slightly warmed (99.5° F.) and the mixture must

be vigorously stirred during the process. Sugar can be added in the usual way. Cow and Gate prepare dried acidified milks in two strengths, skimmed and half-cream; these are very convenient to use, but require the same care in preparation.

METHODS OF CALCULATION OF FOOD REQUIREMENTS.

Whichever of these methods of feeding is employed, adjustments for individual requirements are continually necessary, and both in the first prescription of a mixture and in attempting to modify one which is proving unsuitable, it is necessary to test the suggested formula in the light of certain standards.

The first point of reference is the *percentage of the ingredients*. This is a matter of simple arithmetic, the effect of a given dilution on protein, fat, and carbohydrates being easily calculated, while addition of sugar and cream (48 per cent. fat) can be easily estimated on the data that one teaspoon of each added to a 3-oz. mixture will mean the addition of 3 per cent. sugar and 2 per cent. fat respectively. It cannot be too strongly insisted that infant feeding, on whichever method it is based, can only be carried out intelligently if the relative proportions of the ingredients is known, because the art of feeding healthy and sick babies is mainly in the nice adjustment of the protein, fat, carbohydrate and salts, so that they become so suitably balanced that the child may produce well-digested stools and thrive. The chief index to the success of the prescription, as regards balance, is the stools, which show neither too acid nor too alkaline a reaction. Excess of sugar, unless absorbed quickly, will cause increased fermentation and acidity in the lower bowel, while the reverse is true if large amounts of protein are given; the fats, unless they are fed in such a high proportion as to cause irritation of the stomach and vomiting, play, together with the salts, a determining part according to the reaction in the intestine. Since loose acid stools are

the commonest expression of dyspepsia, it is particularly the relative proportions of fat and sugar that must be watched. In practice, for instance, it is often safer to keep the fat percentage about 2 and make up the deficiency of calories by additions of carbohydrates in babies under 3 months old. That is why half-cream dried milks with added dextri-maltose provide such an easy and successful mode of feeding in the first few months. It should be a cardinal rule that no form of dried milk be used and no additions made to milk mixtures unless their composition and nature has been studied. The constitution of dried milks, both in the dried powder and when diluted, is stated on the tins.

The next assessment must be that of the *caloric value*. It has been reckoned that a baby requires 50 calories from birth to 3 months, 45 from then to 6 months, and 40 calories from 6 to 12 months, per lb. of body-weight.

These calories are mainly supplied, in infancy, by milk, sugar, starch and cream. The only values to be remembered, therefore, are as follows:—

1 oz. of milk ...	represents	20 calories
1 " skim milk ...	"	11 "
1 " lactose or dextri-maltose	"	120 "
1 " flour ...	"	103 "
1 " cream (32 % fat)	"	87 "
1 " orange ...	"	15 "

Another method of checking the prescription of feeds is to calculate the amounts of milk and sugar required per lb. of body-weight in twenty-four hours.

It is calculated that for each pound of body-weight, $1\frac{3}{4}$ oz. of cow's milk with one added spoonful of sugar, or 2 heaped teaspoons of full-cream dried milk with 1 teaspoon of sugar, or $2\frac{1}{2}$ heaped teaspoons of dried "humanized" milk (no added sugar) are required in twenty-four hours (Paterson and Forrest-Smith). In each, the amount of water must be made up to the total fluid requirements, i.e., $2\frac{1}{2}$ oz. per lb. body-weight in the twenty-four hours.

No one of these methods of calculate

is in themselves to be relied upon as a "method" of feeding. The first does not deal with total quantities, the second does not treat of the quality or "balance" of the ingredients of the food, while the third does not take account of the relation of the weight to the age. It is often wiser, if the child's weight is not near the average for the age, to make the calculation of the requirements on a figure which represents the mean between the average weight for the age and the actual weight of the child in question. Each individual problem of feeding should be submitted to the first two tests taken in conjunction with one another, and not to one alone. Such a system of procedure ensures method in dealing with cases in practice and begets confidence and good judgment when confronted with difficult feeding cases which cannot be treated with any lasting success by haphazard methods.

I have not attempted to present outlying fields of thought on this subject, but have concentrated purely from a practical point of view on the common methods of feeding healthy or slightly ailing babies, deliberately leaving the discussion of some other types of feeding to be employed, in the case of feeble and ill babies, or in special circumstances, to a subsequent lecture.

THE HEART IN PULMONARY DISEASE.

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So frequently do pathological changes in the lung follow cardiovascular disease that the examination of a patient suspected of circulatory disorder is scarcely complete unless the respiratory system has also passed under review. Some of these changes, such

as pulmonary œdema or infarction depend upon exacerbations or complicating factors ; others, for example, hydrothorax and bronchitis, are contributory to the circulatory embarrassment and may demand special treatment. In general, the signs of secondary pulmonary damage are fairly obvious, though their exact interpretation may be difficult.

While the importance of respiratory signs in heart disease is generally accepted, it is not so widely appreciated how profoundly the cardiovascular system may be affected in certain pulmonary diseases. This is due in part to the fact that the state of the lungs affords an important clue to the clinical condition in cardiac disorders, while changes in the circulatory system secondary to diseases of the lungs occur late as a rule, if they occur at all. It is certain, therefore, that more subjects of lung disease than is generally realized die a cardiac death.

Embarrassment of the heart and circulation in pulmonary diseases arises from one of two main sources. First, an extrinsic burden may be laid upon the heart due to mechanical factors, such as obstruction in the lesser circulation, or to displacement or compression of the heart and mediastinum as often occurs in spontaneous and in open pneumothorax. Secondly, acute or chronic infections, such as pneumonia or tuberculosis, may cause intrinsic and serious impairment of the circulatory mechanisms. These infections may act by damaging the heart muscle, by attacking the pericardium or aorta, or by abolishing peripheral vasomotor tone, so causing circulatory failure.

This paper will therefore deal initially with the mechanical factors represented by chronic pulmonary disease and by disturbances brought about through alterations in the position of the mediastinum and through variations in intrapleural pressure. Pneumonia, as an ætiological factor in heart failure, will next be considered, and finally, the unusual involvement of the cardiovascular system in tuberculosis.