

Holt (L. E.)

ARTIFICIAL FEEDING.

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Childhood."

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TO THE NEW YORK INFANT ASYLUM, AND TO THE
HOSPITAL FOR THE RUPTURED AND CRIPPLED.

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There are several fundamental principles which must be constantly borne in mind :

1. The food must contain the same constituents as woman's milk, viz., fat, proteids, carbohydrates, inorganic salts, and water.
2. These constituents must be present in about the same proportion as in good woman's milk.
3. As nearly as possible the different constituents should resemble those of woman's milk both in their chemical composition and in their behavior to the digestive fluids.
4. The addition to the food of very young infants of substances not present in woman's milk (e. g., starch) is unnecessary, contrary to the best physiology, and, if used in any considerable quantity, may be positively harmful.

In the artificial feeding of infants, cow's milk is selected, as it furnishes all the necessary elements, although not in the proportions required by young infants. In adapting cow's milk to infant feeding, it is necessary, first, to know the differences in the composition of cow's milk and woman's milk; and, secondly, to devise the simplest means of overcoming these differences, in order to secure an infant-food which closely

resembles average woman's milk in its percentages of fat, sugar, proteids, and salts. But this is not all. We cannot feed all infants exactly alike, even though they are of the same age and weight. Their food must be adapted to their powers of digestion. In breast-feeding it has long been a matter of common observation that an infant might thrive perfectly on the milk of one woman, and suffer immediately from indigestion when put on that of another, although both were equally healthy. In the selection of a wet-nurse it has sometimes been necessary to try a dozen before one could be found whose milk agreed with the infant, or, in other words, whose milk contained the different ingredients — fat, sugar, and proteids — in proportions exactly suited to the child's condition. Hence it is necessary to vary the proportions of the different constituents in order to meet exactly the requirements of the individual infant. If cow's milk disagrees with an infant, the proper method of procedure is to try and discover which of the elements of cow's milk is causing the disturbance, and to change the proportions until we have a milk which the child can easily digest. Reduced to its lowest terms, the problem of infant-feeding consists, first, in obtaining the elements of the food separately; and, secondly, in so combining them as to meet the needs of the case in hand. For this simplification of the problem the world is indebted to Rotch.

In feeding infants according to this plan, it is necessary to have a method of expressing in exact terms the composition of the food used. This can be done only by giving the percentages of the fat, sugar, proteids, and salts which the milk contains. The mere statement of the amount of milk or cream used conveys no definite idea, as these differ so much in their composition. Only by stating percentages can we record our own experience or compare our results with those of others. This new nomenclature, although perhaps a little difficult at first, is easily mastered, and is absolutely necessary in scientific infant-feeding.

THE MODIFICATION OF COW'S MILK FOR HEALTHY INFANTS DURING THE FIRST YEAR. — In modifying cow's milk for infant-

feeding, our calculations are based upon the composition of good breast-milk, as determined by the latest analyses :

	Woman's Milk, Average.	Cow's Milk, Average.
	Per cent.	Per cent.
Fat	4.00	3.50
Sugar	7.00	4.30
Proteids	1.50	4.00
Salts20	.70
Water	87.30	87.50
	100.00	100.00

We have, therefore, in cow's milk, an excess of proteids and salts, too little sugar, and of fat about the quantity required. Other conditions which must be considered are the presence of bacteria in cow's milk, its acid reaction, and the fact that its proteids are more difficult of digestion. The same is probably true of the fat in the condition in which we feed it, but to a much less degree.

Fat. — The average amount of the fat of cow's milk which a healthy infant can digest varies from 2 to 4.5 per cent. It is rarely necessary in health to go either above or below these proportions. Beginning with 2 per cent in the early days of life, the amount may be increased to 3 per cent at one month and to 4 per cent at four or five months. No other modification in the fat is necessary.

Sugar. — In woman's milk the percentage of sugar is remarkably constant under all conditions — between 6 and 7 per cent. In feeding cow's milk it is seldom required to have the sugar less than 5 and never more than 7 per cent. This is the simplest part of the modification. As the sugar in milk is simply lactose in solution, it is only necessary to calculate the amount required to be added to bring this up to the 6 or 7 per cent desired . . . It is more rational in theory, and certainly better in practice, to use milk-sugar rather than cane-sugar, since the former supplies what exists in woman's milk. It should be

distinctly understood that the purpose of adding sugar to milk is not to sweeten the food, but to furnish the proper proportion of a soluble carbohydrate necessary for the infant's nutrition. . .

Proteids. — The modification of the proteids is the most important change necessary in cow's milk, for it is the proteids which give most of the trouble to the infant digestion. In ordinary cases in health, a reduction in the amount is all that is necessary. But for very young infants it is not enough to reduce the proteids to the proportion present in average woman's milk — 1.5 per cent. In the beginning, and even during the first months, we must go considerably below this point, usually to 1 per cent, and for the first few weeks to 0.75 or even 0.50 per cent. The secret of success in feeding cow's milk, is to reduce the proteids at the start to a proportion which the infant can easily digest, and then gradually increase the amount. By the end of the first month the average child can take 1 per cent, by the fourth month 1.5 per cent, and by the sixth month 2 per cent. . . .

Inorganic Salts. — These, like the proteids, are excessive in cow's milk, and nearly to the same degree. When, therefore, milk is diluted as required by the proteids, the salts will be nearly in their proper proportion, and they may be dismissed from separate consideration.

Reaction. — The acidity of cow's milk may be overcome by the addition either of lime-water or bicarbonate of soda. Of the former there is required about one ounce to each twenty ounces of the food; of the latter, about one grain to each ounce of the food.

The subject of heating milk for the destruction of bacteria has been considered in a previous chapter (page 143).

MILK LABORATORIES.

There have been established in Boston, New York, and Brooklyn, milk laboratories which undertake to furnish "modified milk" of any desired proportions, upon the prescription of

physicians, exactly as drugs are dispensed by an apothecary. . . .

. . . . it is possible to vary the percentages of fat, sugar, and proteids in the milk to almost any degree desired, and to do this with very great accuracy. At the present time a separate modification of the inorganic salts is not attempted. The physician, in ordering the food, simply writes for the percentages of fat, sugar, and proteids desired, with the number of feedings for twenty-four hours, and the quantity for each feeding. The food-supply for an entire day is delivered each morning in the bottles from which it is to be fed. The laboratory also undertakes to heat milk to any temperature that may be desired. The following is the form in which prescriptions are written :

℞	
Fat	3 per cent.
Sugar	6 " "
Proteids	1 " "
Alkalinity, limewater	5 " "
Number of feedings	8
Amount for each feeding	4 ounces.
Heat to 167° F., 25 minutes.	

The establishment of the milk laboratory, for which the profession is indebted to Rotch, is a great stride in advance in infant-feeding, as it enables the physician to know what his patient is taking, at the same time making it possible to vary any one of the constituents of the food separately, even to a fraction of one per cent, until the combination is reached which is exactly suited to the infant's digestion. With the assistance of the milk-laboratory, infant-feeding can be done with something like scientific accuracy. The laboratory company has the direct oversight of the breeding, care, and food of cows and the handling of milk, to insure its purity, freshness, and cleanliness. The practical workings of the milk-laboratories are so satisfactory that we shall doubtless see them established in all large cities. . . .

After two years' experience I have found the laboratory of great value in difficult cases of infant-feeding, and it soon becomes almost as much of a necessity to the physician practising among young children as does the apothecary shop to the general practitioner.¹

As a general guide to the modification of milk for an average infant, the following table is introduced, showing the changes required with the age of the child : —

SCHEDULE FOR FEEDING AN AVERAGE HEALTHY INFANT FROM BIRTH UPON MODIFIED COW'S MILK, SHOWING PERCENTAGES OF FAT, SUGAR, AND PROTEIDS, AND THE DAILY QUANTITY.

No.	AGE.	FAT.	SUGAR.	PRO TEIDS.	DAILY QUANTITY.	
		Per cent.	Per cent.	Per cent.	Ounces	Grammes.
I.	First and second day	5.0	4-8	125-250
II.	Third to seventh day . . .	2.0	6.0	0.60	10-15	310-460
III.	One to four weeks . . .	2.5	6.0	0.80	20-30	620-930
IV.	One to three months . . .	3.0	6.0	1.00	22-36	680-1,110
V.	Three to four months . . .	3.5	6.0	1.25	28-38	870-1,180
VI.	Four to six months . . .	4.0	6.0	1.50	32-38	990-1,180
VII.	Six to nine months . . .	4.0	7.0	2.00	34-42	1,050-1,300
VIII.	Nine to twelve months . . .	4.0	6.0	2.50	38-45	1,180-1,400
IX.	Twelve to fifteen months . . .	4.0	5.0	3.00	40-50	1,240-1,550
X.	Fifteen to eighteen months . . .	4.0	5.0	3.50	45-50	1,400-1,550
XI.	Eighteen months (whole milk)	3.5	4.3	4.00	45-50	1,400-1,550

In ordering milk for an infant, not only its age but its weight must be taken into account. One that at four months weighs as much as the average child at eight months, will usually be found able to take the quantity of food and also the percentages advised for the latter age. Again there are some cases where the percentages of the milk may be increased more rapidly than in the schedule. As a rule, it is wise to increase the strength of the food just as fast as the child's digestion will permit.

¹ For fuller details regarding the Milk Laboratory, see Rotch, Archives of Pediatrics, February, 1893.

SCHEDULE FOR FEEDING HEALTHY INFANTS DURING THE FIRST YEAR.

AGE.	No. of feedings, 24 hours.	Interval between meals by day.	Night feedings (10 P.M. to 7 A.M.)	Quantity for one feeding.		Quantity for 24 hours.	
				Ounces	Grammes	Ounces	Grammes
3d to 7th day . . .	10	2	2	1-1½	30-45	10-15	310-460
2d and 3d weeks . .	10	2	2	1½-3	45-90	15-30	460-930
4th and 5th weeks .	9	2	1	2½-3½	75-110	22-32	680-990
6th week to 3d month.	8	2½	1	3-4½	90-140	24-36	740-1,110
3d to 5th month . .	7	3	1	4-5½	125-170	28-38	870-1,080
5th to 9th month . .	6	3	0	5½-7	170-220	33-42	1,020-1,300
9th to 12th month .	5	3½	0	7½-9	235-280	37-45	1,150-1,400

MODIFICATION OF MILK REQUIRED BY PARTICULAR SYMPTOMS.—Regarding the exact indications according to which the fat, sugar, and proteids of milk are to be varied in infant-feeding, much is yet to be learned. The following are the points which experience has thus far led me to depend upon:—

If the sugar is too low, the gain in weight is apt to be slower than when it is furnished in proper amount. The symptoms most frequently indicating an excess of sugar are colic, or thin, green, very acid stools, sometimes causing irritation of the buttocks. In some cases, where the sugar is in excess, there is much eructation of gas from the stomach, and regurgitation of small quantities of food.

An excess of fat is indicated by vomiting or the frequent regurgitation of food in small quantities, usually one or two hours after feeding. It is sometimes shown by frequent passages from the bowels, which are nearly normal in appearance. In some cases the stools contain small round lumps, somewhat resembling casein, but really composed of masses of fat. In rare cases an excess of fat may be the cause of colic. The most constant indication that too little fat is given is constipation, with dry, hard stools; but it should not be forgotten that such stools are sometimes seen when the fat is not too low. To increase the fat above 4.5 per cent in feeding infants under six months old, simply because of constipation, is, I think, a mistake. In point of fact, I have rarely seen any advantage in carrying the fat above 4 per cent.

The most reliable indication that the proteids are in excess is the presence of curds in the stools. This condition is also a frequent cause of colic, — indeed, of most of the colic of early infancy. Sometimes there is diarrhoea, but more frequently there is constipation, especially when the excess of proteids is great. This condition may be the cause of vomiting or the regurgitation of small quantities of food from time to time. Imperfect digestion of the proteids may cause the same symptoms as when they are in excess, and the same may be true of the fat and of the sugar. Often the difficulty may be, not that the proportion of the different elements of the food is actually in excess, but that more is given than the infant can digest at the time, and in any event the amount should be reduced.

It is not practicable, even were it possible, to modify the milk so as to meet every temporary symptom of discomfort an infant may have. In general the most important indications may be summarized as follows: if not gaining in weight without special signs of indigestion, increase the proportions of all the ingredients; if habitual colic, diminish the proteids; for frequent vomiting soon after feeding, reduce the quantity; for the regurgitation of sour masses of food, reduce the fat, and sometimes also the proteids; for obstinate constipation, increase both fat and proteids.

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