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INFANT FEEDING

J. S. FOWLER

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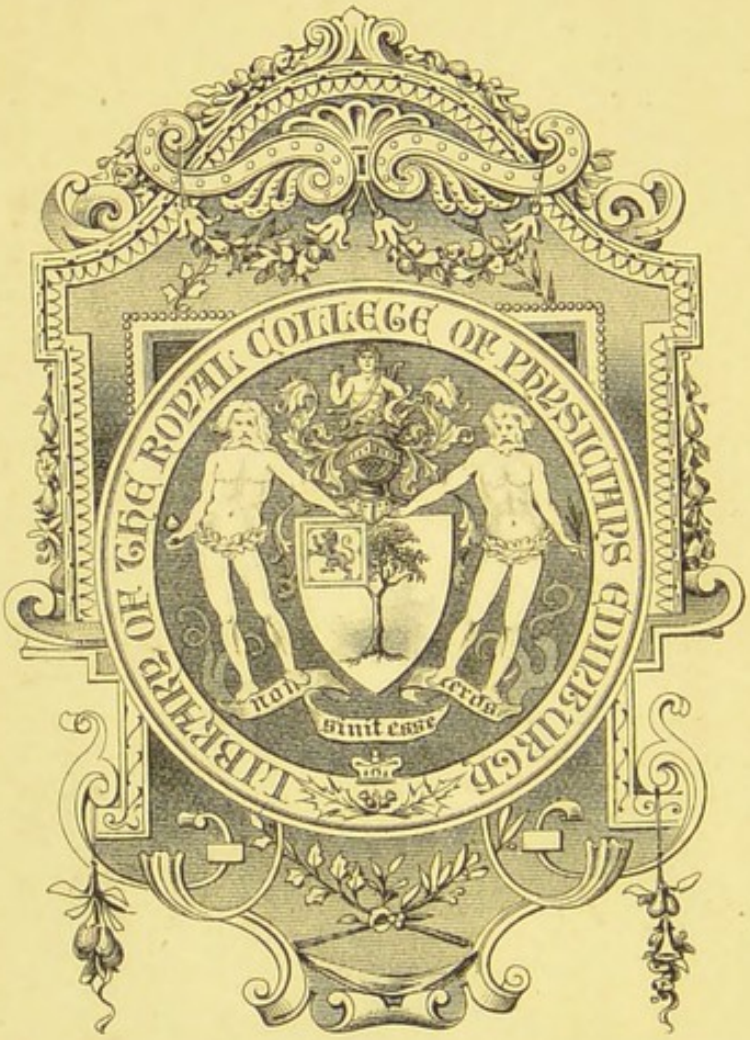

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INFANT FEEDING

A PRACTICAL GUIDE TO THE ARTIFICIAL FEEDING OF INFANTS

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PREFACE

The Lectures on which this book is based were delivered in connexion with the class of Diseases of Children in the University of Edinburgh, and to members of the Edinburgh Post-Graduate Courses in 1907 and 1908. In re-casting them for publication I have not attempted to treat the subject exhaustively, but have been content, for the most part, to speak of methods which I have personally tried and found useful. Considerable space has been devoted to matters of detail, and it is hoped that the information given is sufficiently definite, and the instructions sufficiently explicit, to justify the title selected for the manual.

I have very gratefully to acknowledge a number of valuable suggestions made by Dr. John Thomson while the lectures and book were in preparation.

J. S. FOWLER.

68, Northumberland Street, Edinburgh,
January, 1909.

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CHAPTER I

Introductory—Bio-chemical Properties of Milk—Composition of Cow's Milk—Digestive Functions in Infancy—Digestion of Milk Proteid—Human Milk.

THE signs of successful artificial feeding are, first, a normal development, and, in particular, gain in weight; second, absence of digestive troubles; third, freedom from rickets and other nutritive disorders towards the end of the suckling period.

Of these criteria, progressive gain in weight is the most important. No infant can be looked on as thriving satisfactorily, however well its food appear to suit it in other respects, unless there is a weekly increment of a quarter of a pound. Some infants, however, even although putting on weight, suffer considerably from colic, irregularity of the bowels, or vomiting; and since one of the functions of the food is to develop the immature digestive

powers and fit them for coping with an ordinary mixed diet, the occurrence of gastro-intestinal disorder is a sign of failure, irrespective of the infant's weight-curve. Again, it is common to meet with infants who, in spite of satisfactory gain in weight and freedom from dyspepsia, are pale and flabby, backward in dentition and walking, or show signs of rickets. In such cases, also, the feeding cannot be looked upon as a success.

Now it is not a difficult matter to feed a child artificially so as to attain a very large measure of success as judged by these criteria, yet it is the fact that improper feeding is extremely common, being indeed the principal cause of morbidity in the first year of life.

The reasons for this state of matters are not far to seek. The feeding of a baby is too often left to the discretion of an uninstructed mother or a comparatively uninstructed nurse, and medical advice is neither given nor sought until it is obvious that things have gone astray. But, as has been said, part of the function of a suitable diet is to promote the proper development of the digestive organs,

and therefore improper feeding not only causes indigestion for the time being, but will very likely have farther reaching effects on the evolution of the digestive powers. This is the explanation of the well-known fact that after the occurrence of a comparatively short attack of diarrhœa or the like, it may be weeks before the infant recovers the power of digesting food which previously presented no difficulty. If there is one branch of medicine in which the adage "Prevention is better than cure" holds specially true, it is in the management of little babies.

It is, therefore, a doctor's duty to bestow as much attention on the diet of the infant he has helped into the world, as on the means he takes to ensure the mother's safe delivery. Obviously, much must be left to mother and nurse, and it is impracticable in most cases to supervise the feeding except during the puerperium. All the more important is it, then, that during this time the mother should be properly instructed, and not left to fall back on the unskilled advice which will assuredly be showered upon her, whether she asks it or no. In

order to give this instruction effectively a medical man must have two sorts of knowledge: he must understand the general principles governing artificial feeding, and he must be thoroughly conversant with its practical details. Failure in one respect is failure in both. Ignorance of principles leads to haphazard selection of diet, and to random change when the first choice fails. An extreme instance of this is shown in Chart I. On the other hand practical knowledge of details is quite as essential. Unless a medical man knows how milk should be protected from contamination, how bottles should be cleaned, how much food an infant needs, how often it should be fed, he will be able neither to give the mother intelligible instructions, nor to anticipate the mistakes she is likely to make. A nurse, too, is apt to gauge a doctor's knowledge by his acquaintance with these minutiæ, and quickly perceives when he is at sea. If she finds him at fault, it is no wonder if she passively resists his methods in favour of her own.

Details such as we shall have to consider may sound trivial to some: let me plead this excuse.

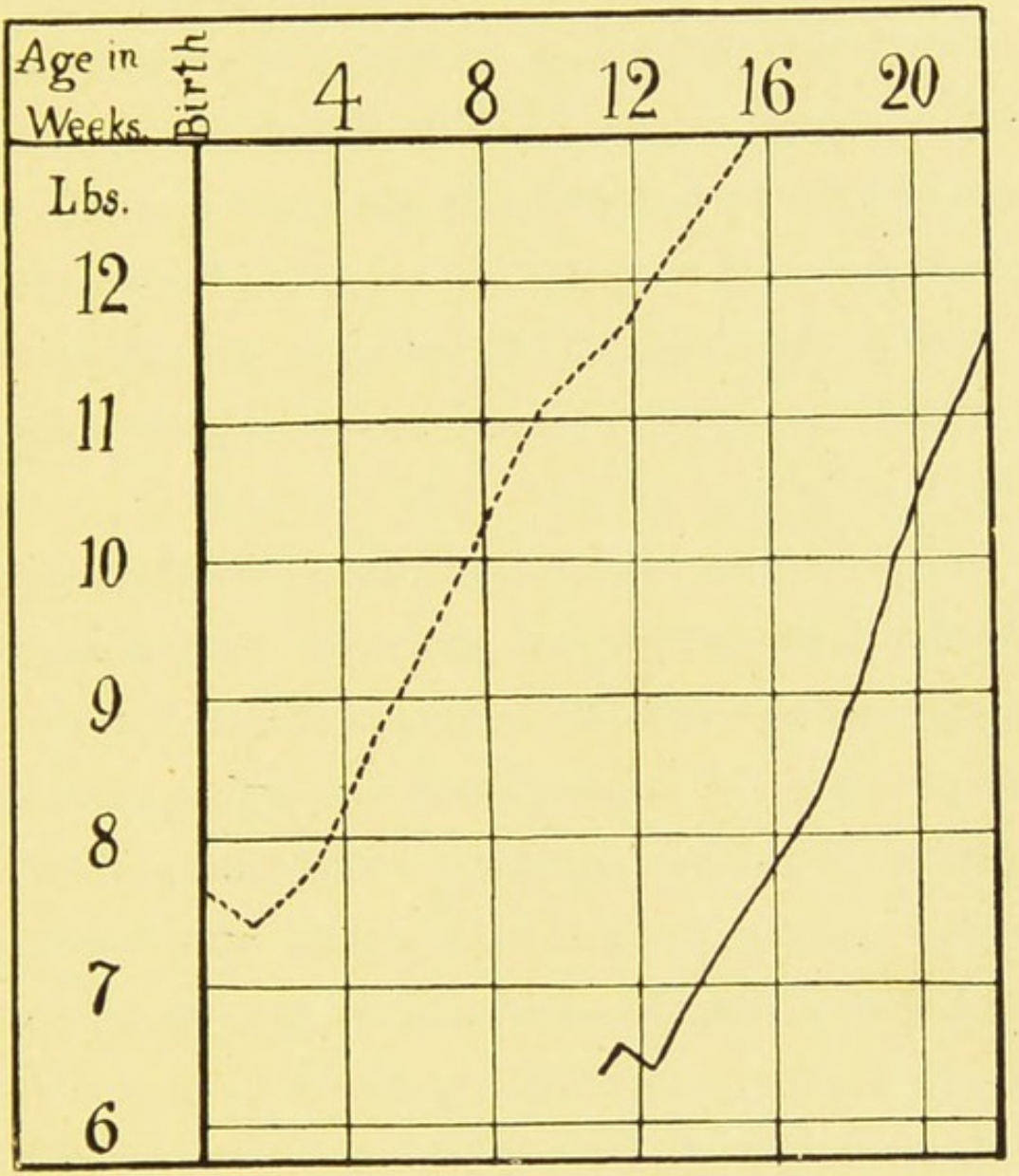


CHART I.—Infant weighing 6 lbs. 6 ozs. at 11 weeks. Had never thrived. On breast for a month, with boiled milk in addition. Thereafter was given in succession peptonized milk, peptogenic milk, boiled milk with patent barley and sugar of milk, then Bovril, Allinson's food, and albumin water. Constipated; said to be unable to retain more than 1½ ozs. Ordered a milk and water mixture, 1½ and then 2 ozs. every two hours, which was digested without difficulty. Steady gain in weight.

If there is one thing certain about nature's mode of nourishing infants it is that it provides them with a sterile milk. Part of the problem, therefore, of substitute feeding is the same as confronts the surgeon and accoucheur. No detail in technique is considered trifling if it tends to secure asepsis in surgery or midwifery ; the same applies, surely, to our subject.

The principles upon which the rational artificial feeding of infants depend rest upon what is known concerning natural feeding, concerning the digestive processes of infancy, and concerning the composition of substitute foods. There are, unfortunately, many gaps in our knowledge, and new facts which put a fresh complexion on the old are constantly being brought to light. We are far from finality in this direction, and it is by no means always easy to reconcile apparent contradictions between theory and practice. I think, therefore, that it is possible to fall into the error of attempting to copy too slavishly what we suppose to be nature's way of working, and that we must also look for guidance in a fourth direction, viz., to the

results. A great deal of information can be derived from the study of accurate records of the growth and health of infants on different diets. Such records of the progress of normal infants can better be obtained from private practice and in institutions such as crêches than in hospitals, where many of the patients suffer from gastro-intestinal disorder. It is matter for regret that more information of this kind is not available.

It is hardly necessary to dwell on the immense advantages which accrue to a baby if it is nursed on the breast, and the more experience we have of substitutes the more likely are we to become convinced of their inferiority to human milk. If the mother cannot suckle, a wet nurse is the best substitute, but for a number of reasons this is seldom a practicable alternative. Maternal nursing, however, except in so far as it affords guidance as to artificial feeding, does not fall within the scope of this book.

A fundamental matter to be grasped in connexion with the substitute feeding of infants is that it is quite impossible by any known means to provide

a food identical with woman's milk. There is no greater error than to fancy that by modifying cow's milk in some way or another, or by using a patent preparation of some description, a food can be obtained which is exactly equivalent to the milk of the woman, and may therefore replace it without influencing the nutrition of the infant. The more closely the subject is studied the more manifest does it become that human milk possesses specific natural properties which cannot be imitated artificially.

The complexity of the question arises from the fact that **milk is a vital fluid.** It seems certain that alteration or preparation of the milk in any way has far-reaching results—may have, indeed, effects which were not at all anticipated. Even so simple a change as to add a little lime-water or bicarbonate of soda, which is often done with the object of approximating the reaction of cow's milk to that of the woman, entirely alters the form in which the casein occurs, and greatly affects the digestion of that substance.

It is more than probable that milk possesses

certain bio-chemical properties which are specific in the milk of every species. From what is known concerning immunity it is believed that the body cells take up food molecules by specific side-chains, and probably, therefore, the milk of the parent animal contains its nutritive elements in a form specially adapted for easy assimilation by the side-chains of the offspring. Whatever may ultimately be discovered as to the exact state of affairs, however, it is quite certain that the variations in the milk of different animals are not purposeless, but serve definite requirements in developing the digestive organs of their young.[1]

The milk of the first few days after delivery, known as the Colostrum, is especially rich in the bodies known generally as antigens. These are the substances which have the power of stimulating the tissues to produce specific antibodies of the class of agglutinins and precipitins. Langer has shown that the blood of the newly-born calf contains no antigens, but that they appear in it within a few hours

[1] See Chapin's paper on this subject, *Medical Record*, New York, December 12, 1903.

after suckling. If, however, the calf be fed from the first on the milk of a cow which has been delivered a week or two earlier, it gets almost no antigens, for these are scanty in the milk of the later period of lactation in comparison with the colostrum. Some recent experiments of Moro are interesting as suggesting that maternal nursing is especially important during the early days of life. If guinea-pigs be separated from their mother at birth without ever having been suckled, and put beside a non-lactating animal so that they are otherwise under natural conditions, 80 per cent. die, no matter how carefully they are fed by hand. Of animals suckled for one day 60 per cent. can be reared artificially, and of those which are suckled for two or three days 90 per cent. can be reared.[1]

Milk, therefore, is a fluid endowed with very varied properties, and as a preliminary to studying the artificial feeding of infants, it is necessary to consider somewhat fully the most common substi-

[1] See discussion on the whole subject of the biology of milk in the *Verhandlungen d. 24ten Versammlung d. Ges. f. Kinderheilk.*, Wiesbaden, 1907, pp. 59 *et seq.*

tute food—Cow's Milk. We shall therefore discuss its composition, chemistry, and digestion, and then compare it with the milk of the woman.

COMPOSITION OF COW'S MILK

The composition of cow's milk varies so greatly under different conditions that any average which can be given is apt to be misleading unless this be borne in mind.

It varies according to the breed of cow, e.g., Jersey milk is exceptionally rich in fat. It also varies according to the intervals which elapse between successive milkings; the shorter these are, the richer the milk. As a rule, therefore, the morning's milk is not of such good quality as the evening milk on account of the longer night interval. The composition of the milk differs, too, according to which portion of one milking we examine. That which is first withdrawn (foremilk) contains little fat—2 per cent.; while the last milk, or strippings, may yield as much as 10 per cent. The proportion of fat increases steadily with the draining of the udder.

Table I gives a general idea of the composition of milk.[1]

TABLE I

	Fat.	Proteid.	Sugar.	Inorganic Constituents.
Poor milk . . .	2·5–3·	2·6	5·9	Chiefly CaO and P_2O_5 ·7
Medium milk . .	3·5–4·	3·4	5·6	
Rich milk . . .	4·–5·	3·9	5·6	
Jersey milk . .	5·2	3·9	5·2	—

(*Van Slyke.*)

It will be noted that the sugar varies least, and the fat most, while the variations in the proteid, though less than those of the fat, tend to rise and fall with them.

Milk has a specific gravity of from 1028 to 1034.

Microscopic Appearance.—Milk consists of an emulsion of fat globules ranging in size from ·9 to 20 μ, the majority being from 2 to 5 μ. They average five millions per cmm., but may rise to double. The milk of the first few days shows in

[1] See also Appendix, p. 198.

addition the characteristic colostrum corpuscles with droplets of fat in their interior, as well as mono- and polynuclear leucocytes.

The **Fats** of milk consist of the glycerides of stearic, palmitic, oleic, and butyric acid; they do not differ much in the milks of the woman and cow. The latter, however, contains relatively less oleic acid—that is, less fat of low melting point, and therefore ready digestibility.

Proteids.—It was formerly customary to classify these as casein, lactalbumin, lactoglobulin, and others; but while it is not yet certain whether all the different proteids have been detected, for practical purposes we may divide them into two groups: (1) casein, (2) soluble proteids. The former constitutes the curd of milk; the latter are present in the whey. There is still some doubt as to their relative proportions. Earlier analyses give a ratio of about 4 : 1, but there is reason to believe that this is too high. Probably a ratio of 3·5 of casein to 1 of soluble proteid is a more correct average (Van Slyke). The proportion which casein bears to the soluble proteid in cow's milk is certainly

larger than in human milk, although the difference is not so great as was formerly believed.

The **sugar** present exists in the form of lactose, which is identical in the milk of the cow and that of the woman. It is less liable than cane sugar to butyric fermentation.

With these, the three great food-stuffs in milk, the following facts should be associated. They will serve as landmarks to prevent our going far astray. **Fat** is comparatively abundant; it provides the body with fuel, and the quantity required for proper development cannot be allowed to vary much without serious harm. Too little fat favours the occurrence of rickets; too much is a certain cause of digestive disturbance. The proportion ought not to fall below 3, nor rise above 3·5 per cent. **Proteids** are required for the growth of cells. The indigestibility of the casein of cow's milk is one of the great difficulties we have to contend against. The **carbohydrates,** which yield energy, occur in the form of sugar; a healthy young animal neither needs, nor is capable of properly digesting, unconverted starch.

Salts.—Cow's milk contains ·7 per cent. of mineral matter, consisting chiefly of the phosphates of calcium and potassium, chlorides of potassium and sodium, along with a small quantity of iron and magnesium. The greater part of the calcium is not in solution, but exists in combination with casein.

Ferments, etc.—Milk contains a number of ferments, the exact nature of which is not well known. It cannot but be supposed, however, that they exert some function in the animal economy. They are destroyed by heat. On one of them, Catalase, the process of "Buddising" milk depends (*see* p. 35). Antibacterial alexines are also present. The antiscorbutic property of fresh milk will be alluded to in connexion with the question of sterilization.[1]

Not very much is yet known concerning the biological properties of milk, and there seems no ground for thinking that the deleterious effects of cow's milk on some infants are due, as has been suggested, to the albumin it contains acting as a

[1] See Appendix, p. 198, for table of constituents of milk.

foreign (heterologous) albumin. Its failings seem to be negative rather than positive. An interesting fact in this connexion is that some infants are apparently ill-supplied with complement, which is required to enable the food molecules to be assimilated by the cells; possibly the difficulty which is experienced in feeding certain infants artificially is connected with this fact in some way or other.[1]

DIGESTIVE FUNCTIONS IN INFANCY

Salivary Digestion.—The secretion of saliva is scanty at birth, but ptyalin is said always to be present. The salivary functions, however, are very imperfectly developed up to the age at which teeth appear. It is improbable that insalivation can be of practical importance in digestion during the early months of life, when the food is fluid and passes rapidly through the mouth.

Gastric Digestion. Capacity of the Stomach.—It is questionable how far it is justifiable to speak of the "normal" capacity of a distensible organ

[1] *Verhandlungen d. 24ten Versammlung d. Ges. f. Kinderheilk.*, Wiesbaden, 1907.

like the stomach. The following figures (Table II) given by Rotch, which are based on the weight of healthy infants before and after feeding may be used as a working guide. These figures refer to the size of the organ in babies fed two-hourly at

TABLE II

Age.	Capacity of Stomach.
Birth	·98 ozs.
4 weeks	2·35 ,,
8 ,,	3·22 ,,
12 ,,	3·96 ,,
16 ,,	4·57 ,,
20 ,,	5·28 ,,
6 months	5·71 ,,
7 ,,	6·18 ,,
8 ,,	6·95 ,,
9 ,,	7·54 ,,
10 ,,	7·89 ,,
11 ,,	8·07 ,,

(*Rotch.*)

first, later every $2\frac{1}{2}$, 3, and $3\frac{1}{2}$ hours. In Germany, however, the present practice is to disfavour such frequent meals, and some of the chief authorities now advise that even during the first month not more than five or six feeds be given during the

twenty-four hours. Under these circumstances larger quantities are withdrawn from the breast, and the "normal" capacity of the stomach must be greater, unless we suppose that the organ has already begun to empty itself before the completion of a meal.

Rennin and Pepsin are present from birth, and the secretion of **hydrochloric acid** begins soon after. It is uncertain whether lactic acid, and other organic acids arising from the splitting up of fat, are ever normally present in the infant's stomach. When the stomach contents are withdrawn during the height of digestion they have a strongly acid reaction, yet free hydrochloric acid can rarely be detected. In breast-fed infants it may not be present until one to two hours after a meal, and reaches a maximum in two and a half hours. In children fed on cow's milk an even longer time is required for its appearance—two hours at least. This is due to the great power which milk has of combining with, or fixing, free hydrochloric acid. Cow's milk possesses this property in a much greater degree than human

milk,[1] and this circumstance is of more than theoretical interest. One of the functions of free hydrochloric acid is to disinfect the stomach at the termination of digestion, hence when cow's milk is employed as a food, disinfection is at best ineffectively carried out. This, no doubt, is one of the reasons why artificially fed infants are so susceptible to gastro-enteric infection, and it is a strong argument for making the intervals between feeds as long as possible. Very little reliable information has been derived from analyses of the stomach contents in gastric or intestinal disorders.

Intestinal Digestion.—Little is known concerning the intestinal digestive processes in babies. The intestinal juice contains a ferment lactase which splits up milk-sugar. There has been much discussion as to whether at birth the pancreas secretes a diastatic enzyme. The latest researches seem to show that it does so [2] and that, accordingly,

[1] According to Escherich, 50 c.c. human milk fixes 8–9 c.c. $\frac{1}{4}$ normal HCl, while the same quantity of cow's milk fixes 15–16 c.c.

[2] Kerley, Mason, and Craig, *Arch. of Pediatrics*, 1906, p. 489.

an infant has some power of assimilating starch. This function, however, is very unimportant compared with those of splitting fat and proteid, and should not be taken as justifying the assumption that unconverted starches are suited to the digestion of a normal baby. The biliary and glycogenic functions of the liver are present from the fifth month of fœtal life.

The **fæces** are referred to on p. 150.

DIGESTION OF MILK PROTEIDS

The soluble proteids of milk present little or no difficulty in digestion, and need not be further discussed. Many of the chief problems of infant feeding, however, centre round the question of the digestion of casein.

A new and very interesting light has been thrown on this subject by the work of Van Slyke and Hart.[1] They have shown that the amount of work required for the digestion of milk is proportioned to the functional capacity of the stomach ; in other words,

[1] Van Slyke, *New York Medical Journal*, March 25, 1907 ; Southworth, *Medical Record*, New York, March 4, 1905.

milk is a food which is equally adapted to the needs of the immature and fully developed stomach, because, according to circumstances and without its original composition altering in any way, its digestibility is automatically adjusted to the power of each. It owes this unique peculiarity to the chemical properties of casein.

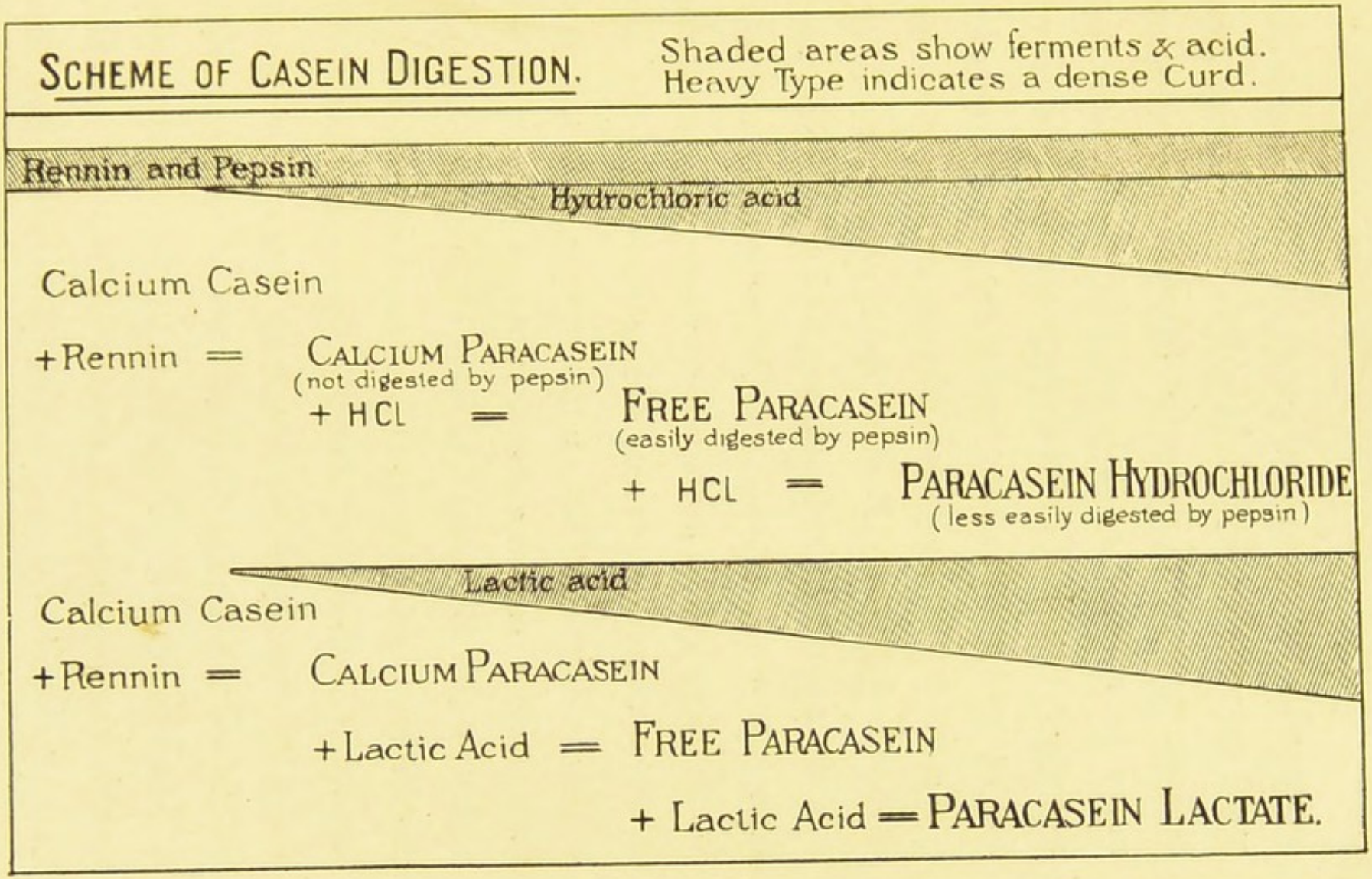
Casein is a phosphorus-containing proteid which exists in milk in combination with lime. This is called **Calcium casein** (caseinogen, etc., of older writers). The calcium casein molecule has the power of combining either with acids or bases. When milk enters the stomach it is acted on by rennin, by hydrochloric acid, and by pepsin ; the changes which ensue are represented in Table III.

For rennin action the presence of ionizable calcium (which is found in the milk plasma) is required ; it converts the calcium casein into **calcium paracasein,** *a soft flocculent curd, which is not digested by pepsin in the absence of acid.* This soft calcium paracasein passes readily from the stomach into the intestine. In young infants, whose stomachs secrete little or no hydrochloric

acid, gastric digestion is limited to the formation of this calcium paracasein. When the stomach begins to secrete hydrochloric acid further changes ensue, and the calcium paracasein is converted into **free paracasein,** which *forms a denser curd than its precursor and is digestible by pepsin.* Owing to its firmer consistence, it passes less readily from stomach to intestine, and therefore is exposed for a longer time to gastric digestion, and exercises both the secretory and motile power of the organ. With the growing power of the stomach more hydrochloric acid is secreted, and the free paracesein is converted into a **tough curd of paracasein hydrochloride.** This is more resistant to peptic digestion, but in consequence of its density it is retained in the stomach for an increased period, and therefore is exposed for a longer time to the action of gastric juice.

These three phases of digestion, of course, are not strictly separated from one another; the outer parts of the curd are first attacked, and thus we probably have in the stomach a mass the innermost part of which consists of calcium paracasein, while the

TABLE III.


SCHEME OF CASEIN DIGESTION.
Shaded areas show ferments & acid.
Heavy Type indicates a dense Curd.
Rennin and Pepsin
Hydrochloric acid
Calcium Casein
+Rennin =
CALCIUM PARACASEIN
(not digested by pepsin)
+ HCl =
FREE PARACASEIN
(easily digested by pepsin)
+ HCl =
PARACASEIN HYDROCHLORIDE
(less easily digested by pepsin)
Lactic acid
Calcium Casein
+Rennin =
CALCIUM PARACASEIN
+Lactic Acid =
FREE PARACASEIN
+ Lactic Acid =
PARACASEIN LACTATE.

exterior has been converted into free paracasein and paracasein hydrochloride. The broad principle is that the more hydrochloric acid present, the more is dense curd formed, and the greater both the effort required for digestion and the stimulus to the secretory and motor functions of the stomach.

Some further reactions of calcium casein are not without interest. Lactic acid acts on calcium casein in a manner analogous to hydrochloric acid. Hence if much of this acid be present in the milk (or develop in the stomach) a dense curd, consisting of paracasein lactate as well as hydrochloride, will result. The digestion of this excess of tough curd may well overtax the power of the stomach. When hydrochloric or lactic acid acts on milk outside the body, casein (not paracasein) hydrochloride or lactate is formed. If souring goes on outside the body to the point of complete coagulation, as in buttermilk, a finely divided curd of casein lactate is formed. This is less tough than the corresponding paracasein compound, and it is not, of course, further altered by the action of rennin. For this reason, and on account of the fine state of division

in which it exists, it is more easily digested than the paracasein lactate. This is the explanation of the fact that buttermilk is a digestible, partially soured milk, a highly indigestible food.

It was mentioned above that calcium casein combines with bases as well as acids. When lime water or bicarbonate of soda is added, a casein compound is formed which is incapable of being curded by rennin. This will again be referred to (*see* p. 99) in connexion with the practice of alkalinizing milk.[1]

[1] The exact chemical reactions of casein are still imperfectly understood. If we regard free casein as being capable of combining with either acids or bases, we may suppose some such reactions as these to represent what occurs :—

Bi-caseinate of calcium (Calcium casein)	+ CaOH	= Calcium caseinate.	Unaffected by Rennin.
,,	+ Na_2Co_3	= Calcium - sodium caseinate.	
,,	+ NaCitrate	= Sodium caseinate + calcium citrate.	
,,	+ HCl	= Casein hydrochloride.	

See a paper by Chapin, *Archives of Pediatrics*, January, 1907.

COMPOSITION OF HUMAN MILK

In comparison with cow's and goat's milk, that of the woman has the following composition :—

TABLE IV

	Human Milk.	Cow's Milk.	Goat's Milk.
Reaction to phenophthalein	Faintly acid	Acid	Acid
Reaction to litmus	Alkaline	Amphoteric	Amphoteric
Specific gravity	1032	1028–1034	1032
Water	85–90	85–86	85
Proteids	1·–2·	3·5	4·–5·
Fat	3·–5·	3·5–4·	4·8
Sugar	6·4	5·6	2·–5·
Ash	·14	·7	·7–1

It is thus poorer in proteids and mineral constituents, and somewhat richer in sugar than cow's milk, while the fat is about the same in both. The differences between the two foods, however, are much greater than any such comparison as the above shows; they may be summed up as follows :—

1. **Proteids.**—In human milk only a relatively small amount of proteid exists as casein. The proportion which this bears to the soluble proteid

has been variously stated, and is not exactly known, but in all probability the latter preponderates. In cow's milk, on the contrary, the ratio of soluble proteid to casein is as 1 to 3·5 or less. It follows from this that human milk forms less curd in the stomach; and the curd has the property of being flocculent, not dense. Both in quantity and quality, therefore, the casein of human milk is superior as regards digestibility to that of cow's milk.

2. **Lecithin,** which enters into the formation of the nervous system, is more abundant in human than in cow's milk.

3. **Minerals.**—Nearly all the salts of milk are less abundant, lime and phosphoric acid particularly, in human than in cow's milk.

4. Besides possessing specific biological characters, human milk is practically sterile when consumed; that of animals teems with bacteria by the time it reaches the purchaser.[1]

[1] See table, Appendix, p. 198.

CHAPTER II

Certain General Considerations—1. Clean Milk—Effect of Heat on Milk—Sterilization. 2. Quantities of Food. 3. Amount at each Meal, and Intervals. 4. Feeding Appliances, and Details of Feeding.

It is not, I think, practically possible, in the present state of our knowledge, to lay down a complete set of canons to which a food must conform if it is to be properly adapted to a baby's needs. Such a set of rules must be based largely on nature's method of nourishment, and all our substitutes differ essentially from this, in one respect or another.

There are, however, certain general principles involved in each and every method of feeding, viz., the need for clean milk free from germs; the proper quantity of food required; the apportionment of meals throughout the twenty-four hours;

and the proper use and care of feeding appliances. These form the subject of this chapter.

I. CLEAN MILK: STERILIZATION

If there is one fact which is certain about human milk, it is that it is practically free from organisms. Theoretically, therefore, a substitute food should be sterile, and practical experience amply confirms this. It is impossible to urge too strongly that one of the foremost, if not the very first, of the requirements in a substitute food is that it shall be free from germs. If this one thing be secured a very great deal of the risk and difficulty attending the rearing of the infant will be done away with. To obtain sterile cow's milk, however, without some countervailing drawback is not an easy matter.

The ordinary milk of commerce teems with bacteria, containing from half a million to a hundred million or more in the cubic centimetre. The chief organisms liable to infect milk are: (1) lactic acid producing bacilli; (2) butyric acid producing bacilli; (3) proteolytic bacteria; and (4) specific pathogenic organisms—*b. tuberculosis*, *b. typhosus*,

and the like. The lactic acid producing bacteria inhibit the growth of the second and third groups. They are easily killed by exposure to comparatively low temperatures, whereas the proteolytic bacteria may resist a temperature of 212° F. for half an hour. Milk which has been boiled, therefore, will not turn sour unless it is reinfected by lactic acid bacilli ; but it may become decomposed through the unrestrained action of proteolytic organisms. In practice, however, this seldom happens, as reinfection with lactic acid bacilli so readily occurs.

The amount of bacterial contamination is very greatly influenced by three circumstances—(1) by the conditions under which milking takes place and the amount of handling the milk undergoes ; (2) by the temperature at which it is kept ; and (3) by the length of time which elapses before it reaches the consumer. The following are some of the points which ought to be considered in selecting a milk supply for an infant.

In the first place it is obvious that the milk from a herd will be of fairly constant composition, and in so far preferable to that of a single cow. The

advantage of "one cow's milk" is therefore mythical.

Under present conditions in this country it is only exceptionally possible to procure milk equivalent to the "certified milk" of America. There, by rigid cleanliness in milking, by rapid chilling, cold storage, and quick transit, a milk is procurable which attains a standard of freedom from germs,[1] and is certified as "clean milk." If preserved at a low temperature this milk remains fresh for a considerable time, and may be used without artificial sterilization.

In this country there is no direct means by which the consumer can be assured that milk is obtained under proper hygienic conditions. I think, however, that the town dweller is most likely to get clean milk if he draws his supply from some more or less distant part of the country. It is obvious that in doing so he will never get milk within less than twelve hours after milking, while from a town

[1] The standard fixed is a maximum of 10,000 bacteria per cubic centimetre; actually, the Walker Gordon milk averages only 2,500.

supply he *may* get it within an hour or so. Possibly, too, the balance is in favour of town dairies in respect of greater ease and efficiency in supervision.[1] But against this we must put the fact that business rivalry makes it necessary for the purveyor at some distance to endeavour that his milk shall reach the consumer fresh and clean. If he does not, the milk will turn sour on his hands. The town dairyman can dispose of his milk at once, and therefore need exercise less care. The other advantages are all on the side of country milk: the cows can be pastured in the open, and are therefore healthier and less liable to tubercle than those confined in cowsheds. Cleanliness, too, is easier of attainment.[2]

[1] This is shown by the fact that according to the statistics of most urban authorities the incidence of tubercle is considerably less in town than in country milks.

[2] An interesting illustration of the beneficial action of purely commercial considerations is afforded by the extremely onerous terms which the Aylesbury Dairy Company exacts from the dairymen who supply them with milk. (Swithinbank and Newman, *Bacteriology of Milk*, Lond., 1903, Appendix Q). These far surpass in stringency any legislative enactment. The best guarantee the consumer can obtain of the quality of the milk he buys is afforded by the larger creameries and dairy companies.

The importance of chilling the milk to below 50° F. at least, *immediately* after milking can scarcely be over-rated. It should be handled as little as possible and sent in hermetically closed receptacles to the creamery, thence to be distributed in sealed vessels, preferably bottles. In most creameries the milk is cleaned in a separator, then partially pasteurized, and automatically bottled; it is delivered to the consumer without the pollution incidental to being poured to and from milk-cans in windy refuse-strewn streets. It is important to ascertain to what extent the milk has been heated at the creamery before delivery, as this may influence the subsequent home sterilization.

Sterilizing Milk.—The term "sterilized milk" is only relative; it is loosely employed, and this has contributed to the confusion which apparently exists as to its merits and demerits. It does not mean, as a rule, that the milk is sterile in the bacteriological sense of the word, but merely that the growth of germs has been temporarily inhibited. The chief reason for sterilization is the destruction of the organisms which would otherwise cause

diarrhœa. Even if the milk be derived from cattle which have passed the tuberculin test, it is as necessary as before to sterilize it for the former reason.

Tuberculosis.—Recent statistics show that about 5 per cent. of random samples of milk contain tubercle bacilli, the incidence being greater in country than in town specimens. Abdominal tuberculosis is unusually prevalent in Great Britain as compared to most other countries, and *post mortem* evidence shows that at least 25 per cent. of all cases of fatal tuberculosis in children are primarily abdominal. The Report of the recent Royal Commission confirms the existence of two strains of tubercle bacilli—the human, and the bovine variety. The latter, which is the more virulent, is especially met with in man in the lesions of abdominal tubercle. The same fact has been observed in Germany, where it is even more striking, inasmuch as primary abdominal tuberculosis is a rarity there—under 1 per cent. of post mortems on tuberculosis.

The conclusion is irresistible that the risk of tuberculous infection is very real and that infants should be safeguarded either by their milk being

sterilized, or by its being obtained from tuberculin tested cattle.[1]

Methods of Sterilization.—1. The addition of **preservatives** for this purpose is undesirable. Formalin in the strength of 1 : 10,000 to 1 : 40,000 checks the growth of the lactic acid bacilli, but not that of all pathogenic and proteolytic organisms. Pasteurized formalin milk is nearly sterile. Boric acid has also been used as a preservative.

2. **Buddised Milk**—The addition of hydrogen peroxide was introduced by Budde of Copenhagen, and Buddised milk is now an article of commerce. To kill the bacteria of milk at ordinary temperatures so much hydrogen peroxide is needed as to render the milk unpalatable. Budde found that by heating the milk with hydrogen peroxide at 122° F. this difficulty was overcome. Buddised milk is said to be sterile, and to remain so for from eight to ten days. The only organisms which survive Buddising

[1] John Thomson and Dingwall Fordyce, *Tuberculosis in Infancy and Childhood, its Pathology, Prevention and Treatment*, edited by T. N. Kelynack, pp. 115–119, London, 1908; J. S. Fowler, *ibid.*, pp. 27–34.

are some spore-bearing pathogenic organisms. This milk costs no more than ordinary milk of good quality. I have little personal experience of the use of Buddised milk in infant feeding. So far as taste is concerned it does not differ much from ordinary boiled milk. I have seen several cases of scorbutus in infants fed exclusively on Buddised milk.

3. **Sterilization by Heat** is the best, and most widely available method. Its advantages far outweigh its drawbacks. Putting aside commercial bottled sterilized milk, which, having been superheated (240° F.) and stored in sealed flasks, will keep indefinitely, but which is not at all a desirable food for infants, we have three separate varieties of home treatment—simple boiling, pasteurization, and "sterilization" at 212° F. in a water bath for periods varying from ten minutes to three-quarters of an hour.[1] It is not immaterial which of these

[1] In order to prevent misconception, let me say that here and elsewhere throughout the text the term "sterilization" is always used to mean "home sterilization," i.e., cooking in a waterbath at 212°, as opposed to simple "boiling" in a pan over the fire, and "pasteurization" at 155° F. for twenty minutes.

is selected, and in order to appreciate the differences between them it is necessary to know something about the effect of heat on milk.

EFFECT OF HEAT ON MILK

At 155° F. maintained for twenty minutes (pasteurization) nearly all germs, but not all spores, are destroyed. The whey proteids are not coagulated; the formation of curd by rennin is not interfered with; the milk is not altered in appearance.

At 161° F. the whey proteids are coagulated.

At 212° F. the soluble casein salts are precipitated as phosphates and citrates; the acidity of the milk is lessened; the fat globules coalesce to some extent; the taste of the milk is altered. Prolonged boiling greatly diminishes the formation of curd by rennin.

At 248° F. all spores are killed.

Prolonged heating at 162° F. is practically equivalent to heating at the boiling point for a shorter period. Tubercle bacilli may survive exposure to 149° F. for an hour; they are usually killed by exposure to 158° F. for the same time. Boiling de-

stroys them. When milk is heated in an open vessel a skin of coagulated proteid forms on its surface. Organisms entangled in the meshes of this coagulum may escape destruction. The most dangerous temperature so far as the growth of germs is concerned is from 68° to 140° F. After being heated milk should be rapidly chilled to 45° F.

In an open pan milk "rises" at about 170° F.; it actually boils at slightly over 212°. When a milk mixture containing limewater and sugar is heated to 212° it turns brownish from the formation of caramel; this does not occur when milk is heated alone.

PASTEURIZATION, STERILIZATION, AND BOILING

In order to **Pasteurize** milk satisfactorily an apparatus is required in which the temperature of the milk can be read on a thermometer. From the above figures it will be seen that little deviation from a temperature of 155° F. is permissible.[1]

[1] Some authorities advise "pasteurization" at a higher temperature—160° to 170° F.

Unless the temperature is raised to 145° the destruction of germs is not ensured, while if it rises to 162° the soluble proteid is coagulated, and one of the alleged advantages of pasteurization is lost. I say "alleged," because I do not think the point is of much importance. When whey is boiled (see p. 126) a very fine precipitate forms which is uniformly distributed through the fluid, and slowly deposits on standing. In this state of division the proteid cannot present much difficulty in digestion. To obviate the need for a thermometer, pasteurizers have been devised in which the proportion between the milk in the bottles and the water in the kettle is such that by removing the kettle from the fire when the water boils, and covering with a cosy for half an hour, the milk is supposed to be maintained at a fairly uniform temperature of 155–160° F. This modification has the further advantage that the milk is heated in separate, self-sealing bottles, which is hardly possible if the thermometer be used. I do not think, however, that the procedure is trustworthy. In any method of pasteurization there is always a possibility that in the central portion of

the milk, or in the scum which may form, some organisms may survive and infect the remainder. The advantages of pasteurization, viz., the non-coagulation of whey proteid, the preservation of the antiscorbutic property of fresh milk, and the unaltered taste, do not compensate for the uncertainty of the process as carried out in the home.

Sterilization is effected in a sterilizer, of which the Soxhlet pattern is a type. It consists of a kettle containing a rack holding ten bottles. The bottles are specially blown without any angles difficult to clean ; they are of tough glass which seldom cracks. The lip of the bottle is accurately ground flat, and after the milk is poured in a smooth rubber disc is applied as a stopper, and held in position by a loose metal cap. The kettle is filled with cold water to the level of the milk in the bottles, the rack is placed in it, and the whole maintained at the boiling point for forty minutes. After boiling, the frame of bottles is cooled in a draught of air, and then in cold water, so as to chill the milk quickly, whereupon, owing to the rapid condensation of the steam in them, the bottles hermetically seal themselves

by the rubber discs, which are sucked in and depressed in the centre. The milk is thus protected from subsequent air-borne contamination.[1] If by chance a bottle has not effectually sealed itself this is readily apparent, and the milk ought either to

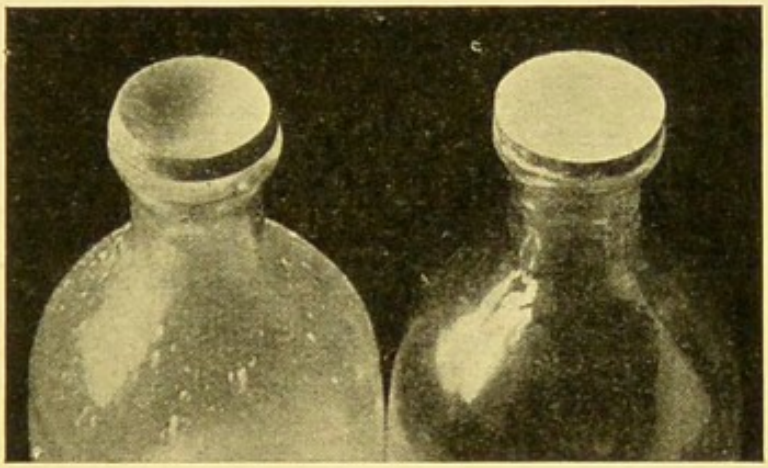


FIG. 1.—Sealed and Unsealed Bottles.

be used for the next feed or rejected. The whole twenty-four hours' supply is prepared at one time and should be stored in a cool place. Before a bottle is used it is warmed in hot water, the rubber disc removed, and a teat put on.

There is no doubt that this is one of the simplest and most effective methods of heating milk. The

[1] Sterilization is evidently fairly complete, for unopened bottles of milk keep perfectly fresh for a month at least.

process needs no supervision once the bottles are filled. There are great practical advantages in preparing the whole day's supply at one time, and this can only be done in separate, self-sealing bottles. The only drawback is the initial cost. The price of a Soxhlet sterilizer complete is 23*s.*, but this includes draining racks and other accessories which are superfluous. A minimum outfit consists of the kettle, frame with ten bottles, discs, and caps, a bottle brush, one or two teats, and a measure. All the parts are purchasable separately, and the above outfit costs about 17*s.* 6*d.*[1] The cost will be repaid by freedom from breakages, which are much less likely to occur than with ordinary bottles, which are both more expensive and more fragile.

The intention of the inventor of this apparatus was that the milk should be sterilized for forty minutes, but a less time suffices. When milk mixtures are being used it is probably better not to

[1] Soxhlet kettle and frame, 5*s.* 6*d.* ; 12 bottles, 2*s.* 6*d.* ; 12 discs, 2*s.* ; 10 metal caps, 5*s.* ; 5 teats, 1*s.* 3*d.* ; brush, 6*d.* ; measure, 6*d.* Total, 17*s.* 3*d.* May be obtained from any instrument maker.

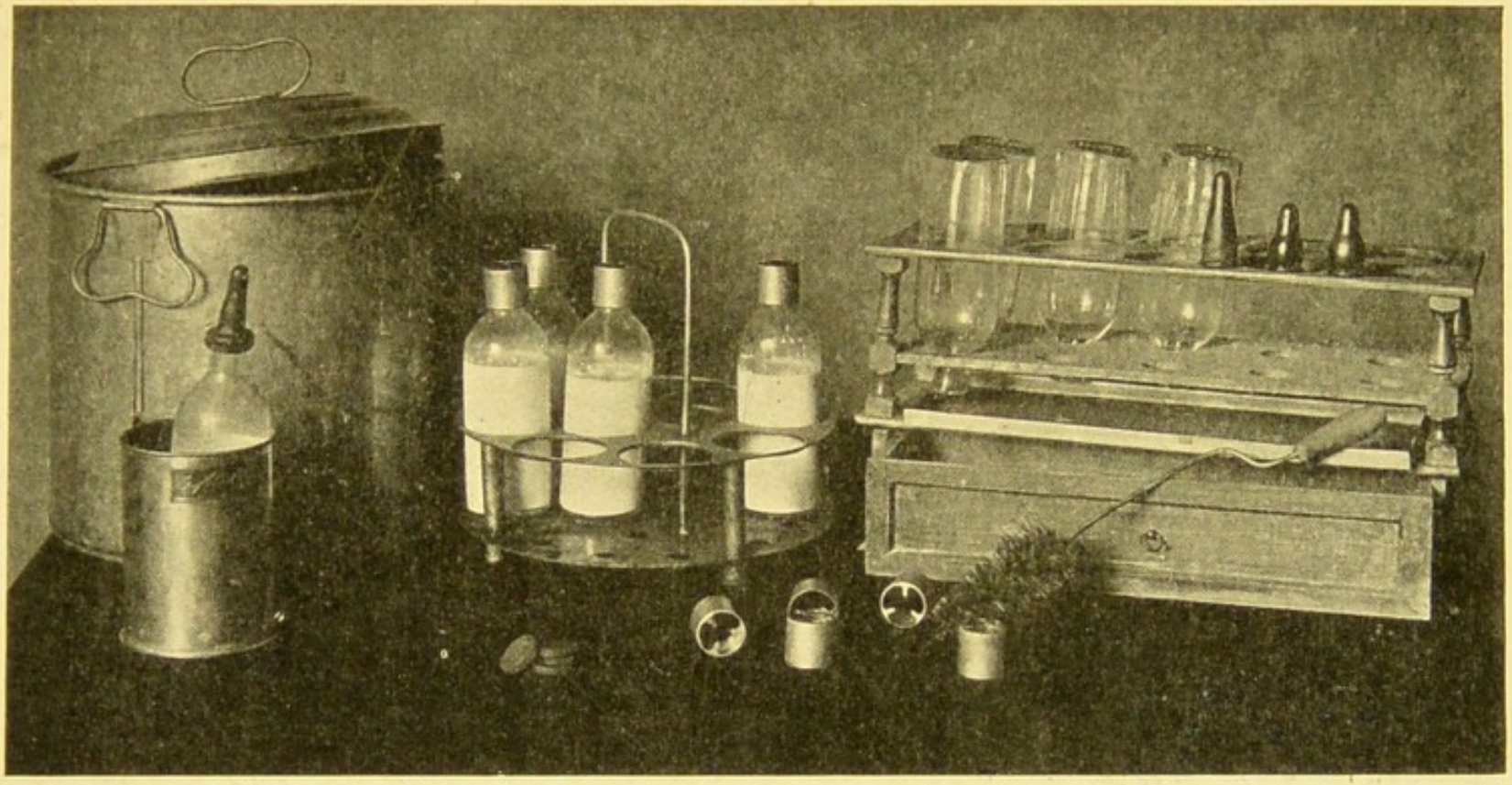


FIG. 2.—Soxhlet Sterilizer—kettle, frame with bottles prepared for sterilizing, drainage rack, warming pan, brush (not a good pattern), metal caps, teats, and rubber discs.

maintain a temperature of 212° F. for more than five or ten minutes ; in the warm months this may necessitate two sterilizations daily. If undiluted milk (Budin's method) is being given, the full forty minutes must be allowed.

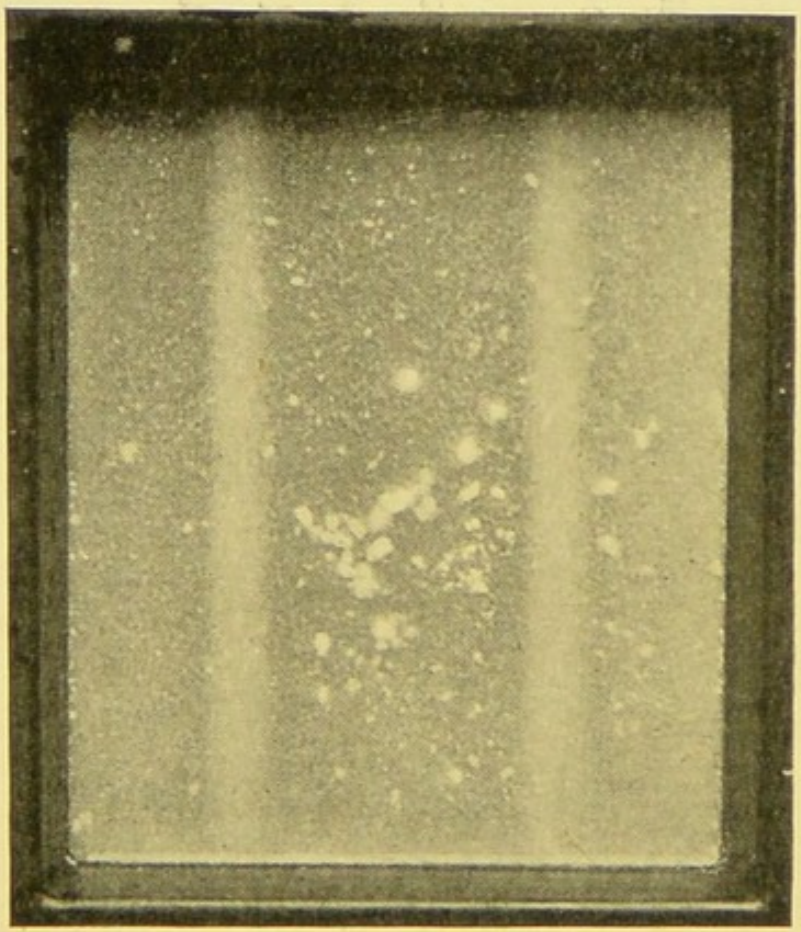
Boiling.—For many purposes this is ample ; it is the method which must be adopted among the poorer class. The milk must be allowed to boil, and not be taken off the fire when it " rises " in the pan. It should be allowed to boil for ten minutes, which is not quite so easy as it sounds ; every cook knows the constant attention which is required to prevent milk being burned and made absolutely undrinkable. After being boiled it should be poured into a (previously scalded) wide-mouthed jug, covered, chilled as rapidly as possible, and stored in a cool place. Another plan is to boil the milk in a jug which will stand heat placed in an ordinary pot, using the latter as a water bath.

Choice of a Method.—Pasteurization was introduced to meet the objections raised against heating to 212°, and these must be shortly referred to. Scurvy has been ascribed to the use of sterilized

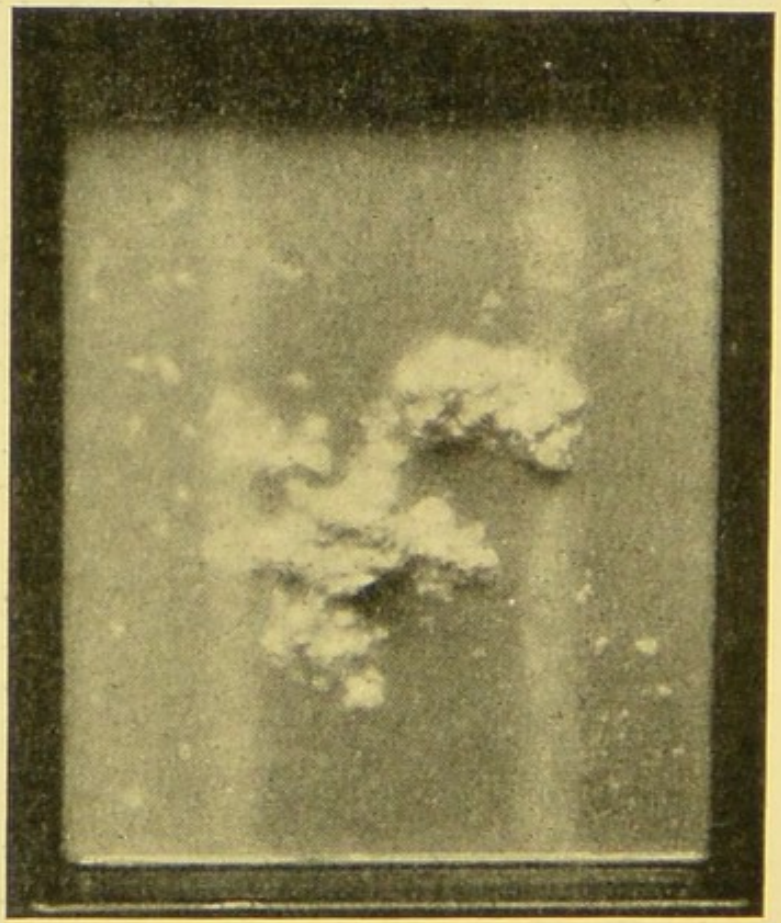
milk, and said not to occur when pasteurized milk is employed. Far too much has been made of this question. We know little of the actual cause of scurvy, further than that it occurs most commonly in infants fed otherwise than on fresh milk or on the breast. It is most common in children fed on patent foods, but it has followed the use of pasteurized milk, and has even been seen in breast-fed babies. It is certainly not proved that sterilization *per se* can cause it; some authorities believe that it is dependent on improper composition of the food, or staleness of the milk. It is very rare in France, where sterilized undiluted milk is much used, and is apparently less common in Edinburgh than in London and elsewhere. The remote possibility of a malady, which is, moreover, one of the most readily curable of all diseases, should not be allowed to stand as an argument against sterilization, and I do not think that the supposed retention of the antiscorbutic properties after pasteurization carries much weight.

The question has arisen, whether cooking milk interferes with its digestibility and nutritive value.

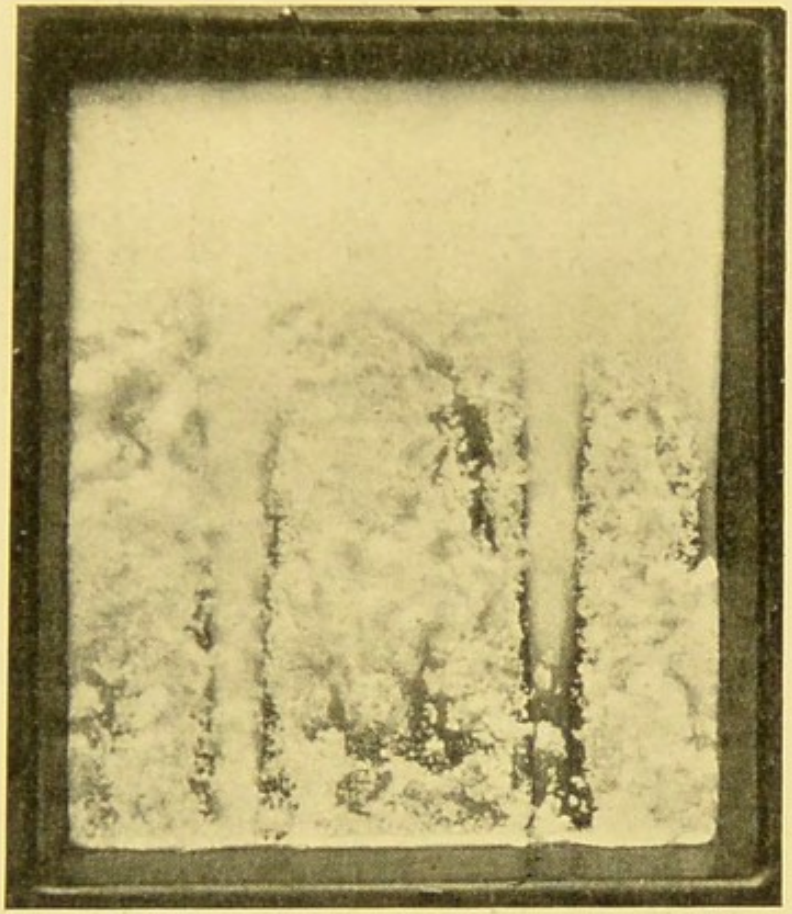
FIG. 3.



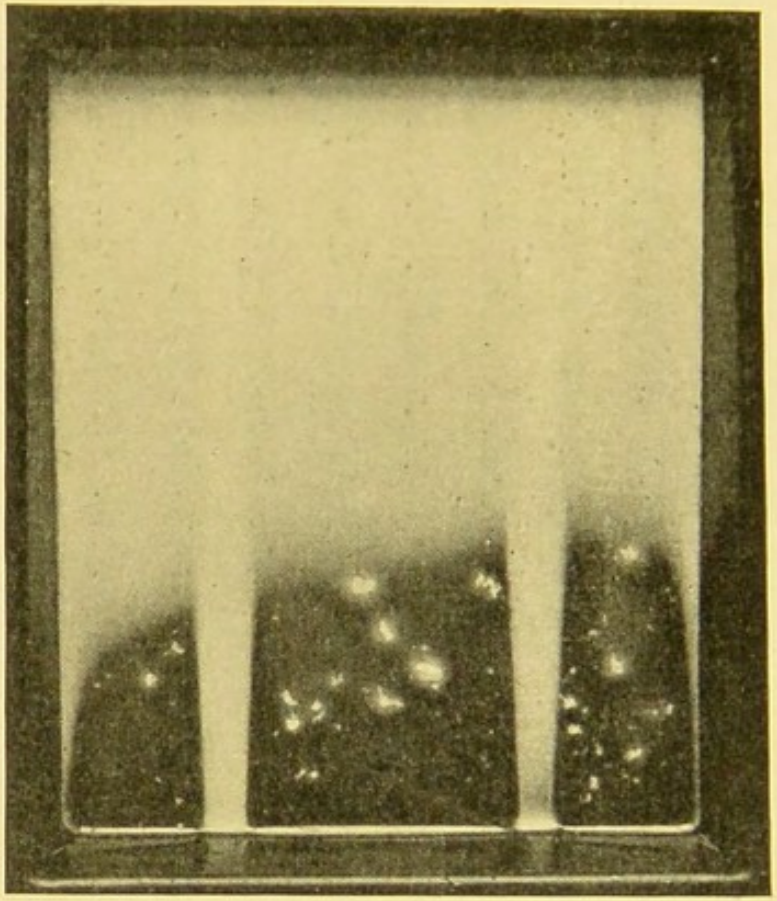
1. Human Milk.



2. Raw Cow's Milk.



3. Cow's Milk boiled for 2 minutes.



4. Cow's Milk heated at 212° in Sterilizer for 45 minutes.

Explanation of FIG. 3. In each case a tube containing 1 oz. of milk + 5 drops of rennet and 5 drops of 1 per cent. HCl was placed in a water bath of 95°–100° F. and gently shaken from time to time. At the expiry of half an hour the contents of the tube were poured into a black vulcanite developing dish, and photographed. No 1 yielded a fine, not very abundant curd; No. 2 a single massive curd; No 3, a copious, but much softer curd than No. 2: in No. 4 comparatively little curding took place.

As to the first, facts point the other way. It is a mistake to lay too much stress on test tube experiments, which can never reproduce natural conditions, but it seems certain that the curd of boiled milk is softer than that of raw milk. Prolonged boiling precipitates the lime salts, and greatly diminishes the amount of curding produced by rennet (Fig. 3). It is more difficult to speak with certainty on the second point. In pasteurization the coagulation of the whey proteid is avoided. In milk boiled in an open vessel a skin of coagulated albumin forms, and the milk loses by so much. In milk sterilized in a close vessel the skin does not form. The coagulated proteid is suspended throughout the milk in a state of fine division, and is probably little inferior in digestibility or nutritive value to the natural whey proteid.

On the other hand, the ferments of milk are destroyed, the fat emulsion becomes less perfect, and the lime salts are thrown down by boiling. That these changes may impair the nutritive value of milk cannot be denied, and some babies after prolonged feeding on boiled milk show signs of failing nutrition,

and rapidly improve when a change in the diet to fresh milk is made.

On the whole, therefore, pasteurizing has no real advantage: the choice lies between boiling and sterilizing. When expense is not an objection, a Soxhlet's sterilizer should be used, and if it be intended to give undiluted milk from birth, it is essential. Among the poor, boiling the milk for 5–10 minutes immediately after it is received is (in temperate climates) perfectly safe and satisfactory, provided the milk has been kept clean and not more than twelve to fifteen hours has elapsed since milking. When the weather is very hot, or during epidemics of diarrhœa, more stringent precautions are required.

I wish again to emphasize the very great need for securing, by whatever means, a sterile food for the infant. It is the one direction in which we can most closely follow nature. We are only now beginning to learn from surgeons how to apply asepsis in medicine,[1] and a baby should be regarded as exposed

[1] See an interesting paper on this subject by Edsall, *American Journal of the Medical Sciences*, April, 1908.

to the possibility of bacterial infection each time he is fed. It would be absurd, perhaps, to demand that every feed should be given with aseptic precaution, but we should at least strive to obviate ordinary sources of contamination. I am sure that the frequency with which cow's milk causes gastro-intestinal disorder depends far more on bacterial infection than on its inherent indigestibility. No one will deny that germ-free milk (could it be procured) is preferable to milk which has been cooked; but in the absence of this ideal, it seems to me that to do anything to foster an opinion which has tended to prevail both in lay and medical circles in late years, viz., that raw milk in any form is superior to artificially sterilized milk, is to assume a serious responsibility, and to commit a very grave error.

II. QUANTITY OF FOOD REQUIRED BY AN INFANT

Many investigations have been made as to the amount of food actually taken by thriving infants, and it has been found, as might be expected, that individual variations are so great as to preclude the laying down of absolute rules. To some extent the differ-

ences are due to differences in weight, for on the whole small infants require relatively more food than larger ones, to compensate for the greater heat loss from their proportionately larger superficies. Thus Budin [1] found that infants weighing 5 lbs. or under require about $\frac{1}{5}$ of their body-weight of human milk daily, while those above that weight require only $\frac{1}{6}$–$\frac{1}{7}$. Differences in weight, however, do not wholly account for the variations observed; active lusty babies probably need more food than their lethargic brothers, and, moreover, variations in assimilative power probably exist, though they elude measurement. Turning to infants fed artificially, it is found that some will thrive on so little as $\frac{1}{10}$th of their body-weight of cow's milk in the twenty-four hours, while others apparently require nearly twice that amount.

In ordering the diet, therefore, we are guided as to the total daily quantities by (1) the body-weight

[1] *The Nursling*, London, 1907, pp. 29 *et seq.* Heubner states that the quantity is during the first three months $\frac{1}{6}$th, during the second $\frac{1}{7}$th, and during the third about $\frac{1}{9}$th of the body-weight.

and age; (2) the weight curve; (3) the appetite; and (4) in some cases by a knowledge of the energy value of the food. The following rules do not apply to newly-born babies, which need very little food during the first week.

1. **Body-weight and Age.**—As a general average, a quantity of milk equal to $\frac{1}{7}$th of the body-weight may be tried. In the case of a two months' old baby weighing 9 lbs. this would mean 20 ozs., or eight feeds of $2\frac{1}{2}$ ozs. The weight alone, however, is an insufficient guide, and when the baby is considerably below the average weight, quantities approximating rather to what an infant of normal weight requires should be given.

2. **The Weight Curve.**—This is by far the most reliable indication. It is quite impossible to speak too strongly of the paramount importance of regular weekly weighings. There is no other means of assuring oneself that a baby is really thriving satisfactorily, and no other means of immediately detecting any falling off. No doctor, mother, or nurse who has once adopted the practice of systematic weighing will ever voluntarily give it up.

Two patterns of weighing machines are in use—the spring balance and the beam scales. The latter is the better in all respects. A good form is shown in Fig. 4. The beam has a double graduation, the upper reading in half ounces when the pan is used,

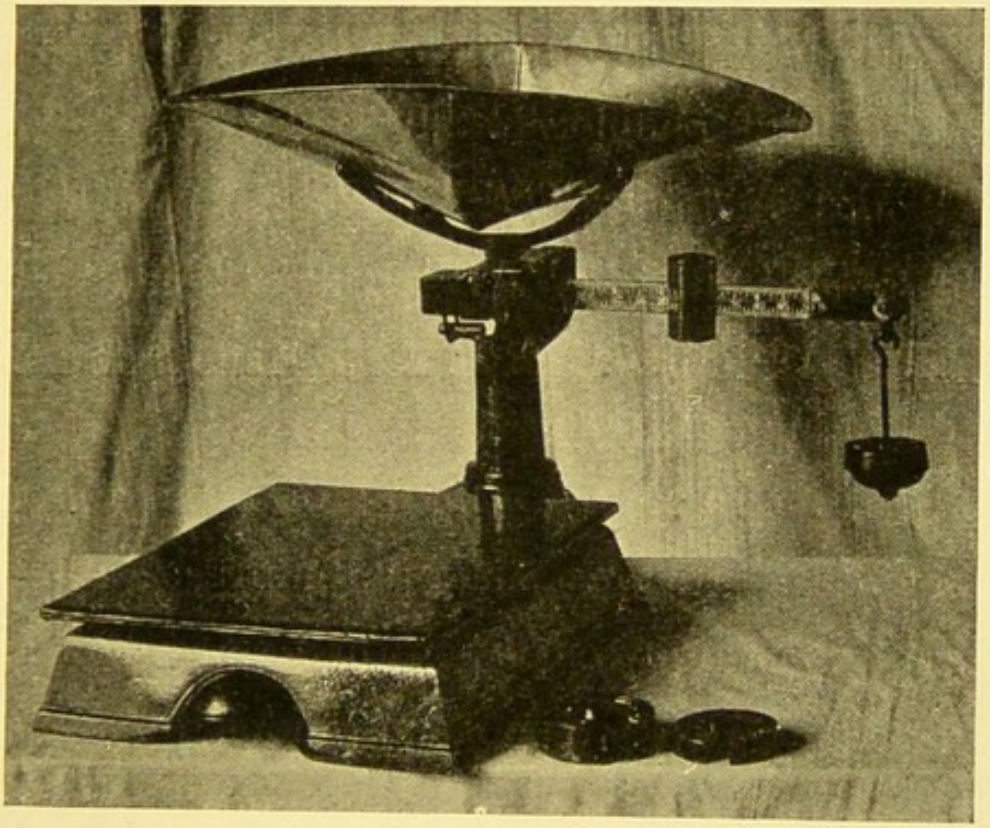


Fig. 4. Infant Weighing Machine.

the lower in lbs. and quarters when the platform is used. A baby should be weighed unclad at the same hour each week. A convenient time is just before being bathed. The weight should be recorded on a chart, such as is shown in Figs. 5 and 6 ;

the graphic method shows the progress at a glance. For the first five or six months the normal weekly

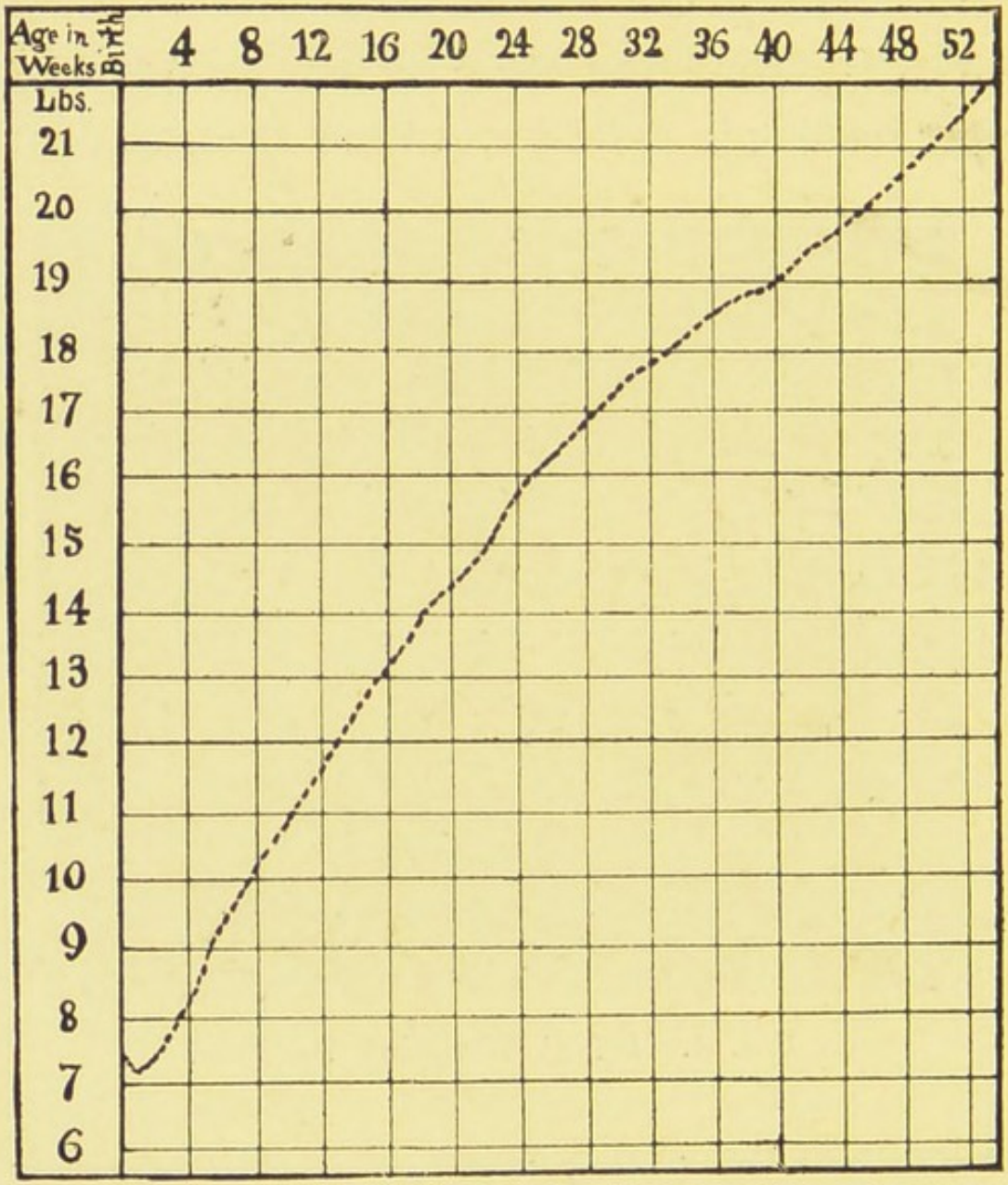


FIG. 5.—Chart for recording Weight. Dotted line shows normal curve (Crozer Griffith). Such charts can be purchased, or made as described on p. 209.

gain is 5 to 8 ozs ; thereafter the rate of growth is less.

Practically, then, having begun with a given

quantity of milk and finding it to agree with the digestion, we note the weight at the end of a week;

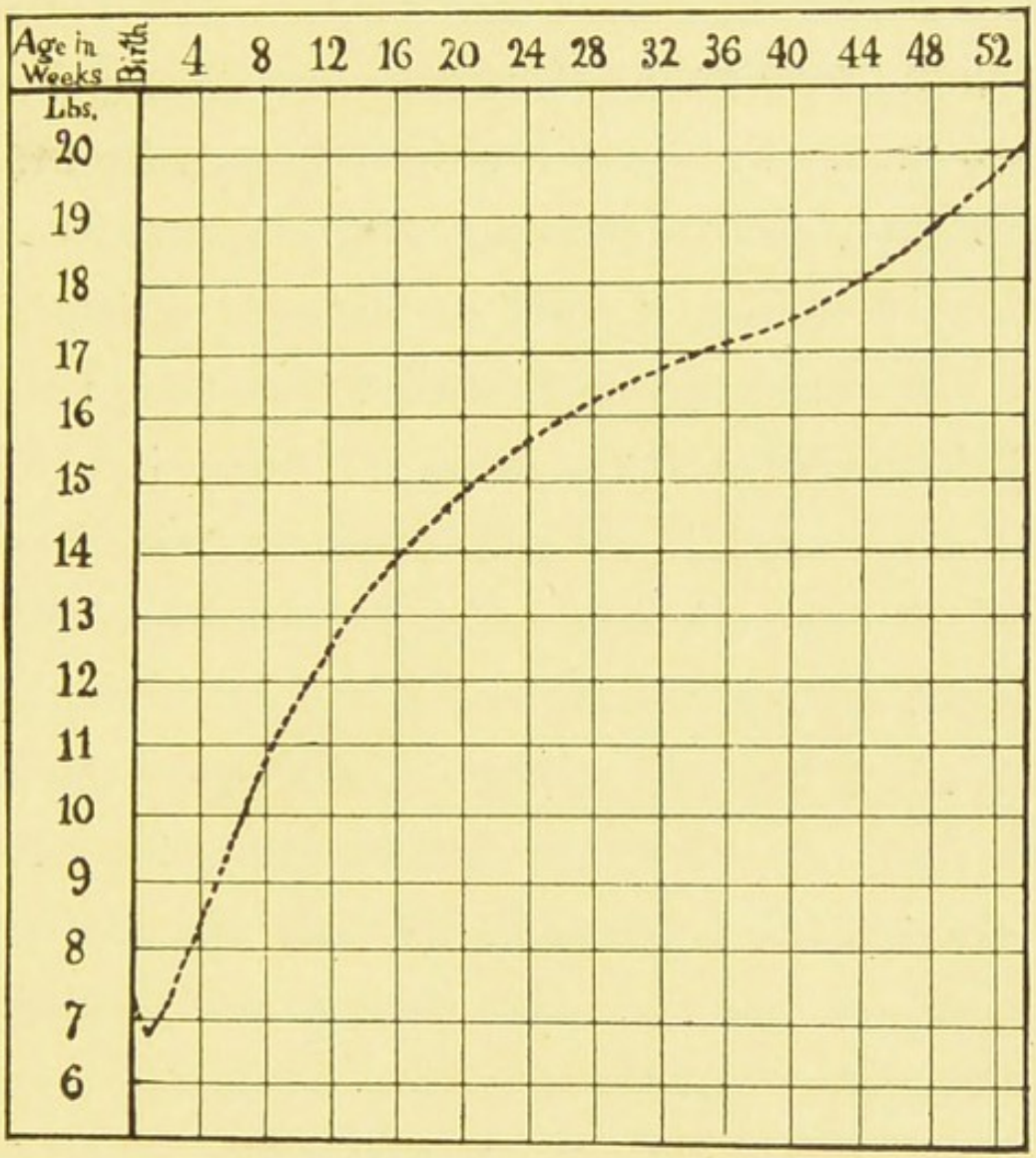


FIG. 6.—Weight Chart. Emmett Holt's Curve.

if it be satisfactory there is no reason to change; if it has not risen, or only risen slightly, we increase the quantity of food. It is not, as a rule, needful to add much; 2 or 3 ozs. in the twenty-four

hours will usually suffice. It should also be noted that the weight-curve of an artificially fed baby is less regular than that of one which is on the breast. An infant may gain 8 or 10 ozs. one week, and only 4 or 5 the next ; it may remain stationary for two or three days, and go on apace in the next half-week. Unless, therefore, a child is obviously seriously ill it is inadvisable to weigh oftener than once a week.

3. **The Appetite.**—After a young infant has finished a meal it should appear contented, and, tired with the effort of sucking, fall asleep. When it is not getting enough food it will either fret after its bottle is finished, or begin to cry before the next falls due. An observant mother will quickly learn to discriminate between hunger and other forms of discomfort, and provide the proper remedy—thousands of infants, of course, are reared on this principle. The difficulty is that while these signs can be relied on so long as the food agrees, they are simulated by indigestion, or fretfulness from any other cause. They are, too, signs which the doctor can seldom notice for himself.

4. **Caloric Value of Food.**—The daily intake

of a normally thriving breast-fed infant is from 90 to 100 calories per kilo of body-weight. In an artificially fed infant it is somewhat higher—110 to 120. The energy value of diet expressed in calories affords only a standard of quantity: a food may yield a superabundance of calories, and yet be unsuitable otherwise—e.g., when a large proportion of the calories is derived from sugar, and little from fat. It is not possible to get more information from a calorie standard than will answer the question: Is the infant being supplied with enough energy or fuel? [1]

The energy value of foods is calculated by multiplying the proteid and carbohydrate percentage by 4·1, the fat percentage by 9·3. The sum of the products gives the number of calories per hundred grams. Multiplying this by ten gives the calories per litre, which is practically equivalent to 35 ozs. The caloric values of some of the more commonly

[1] For further information, see Czerny and Keller, *Des Kindes Ernährung*, Leipsig, 1906, Bd. I. cap. XIV–XIX; Czerny and Steinitz, "Diseases of Children" in Noorden's *Metabolism and Practical Medicine*, English edition, London, 1907, vol. iii.

employed foods are shown in Table V, others may easily be found by the above calculation.

TABLE V.

Food.	Calories per Oz.
Human milk	19–21
Cow's milk	18–20
Cream (12 per cent. fat)	41
Butter-milk	8
Butter-milk with 1 tablespoonful of flour and 2 tablespoonfuls of sugar per litre	17·5
Whey	6·8
Albumin water (1 egg to 10 oz.)	1·4
Condensed milk (1 teaspoonful of Nestle's milk to 6 tablespoonfuls of water)	18
Raw meat juice	2·3–8·
Peptogenic milk	23
Do. do. (half cream)	20
Scott's oat flour	116
Quaker oats	115
Savory and Moore's food	113
Mellin's food	108
Benger's food	105

The case-records which follow show the number of calories taken by children in various states of nutrition, calculated on this plan. If we convert Heubner's figures of 100 and 120 per kilo (the

"Energy Quotient") into English measures we get forty-five and fifty-two as the number of calories per lb. required by normally thriving breast-fed and artificially fed children respectively, and this standard is used in these Tables.

Case 1.—Healthy infant, suffering from malnutrition from inadequate breast milk. Weaned, and given a mixture of equal parts cow's milk and water. With an EQ of only forty the weight was stationary.

Age.	Weight.		Average Weekly Gain.	Energy-Quotient.
Weeks.	Lb.	Oz.	Oz.	
8	7	9	—	40
9	7	9	+ 0	53
10	7	15	+ 6	60
12	9	10	+ 13	52
14	11	4	+ 13	52
18	13	14	+ 10½	—

Case 2.—*Malnutrition and vomiting from improper feeding.*—Given equal parts of milk and water. The quantity ordered at first was low, on account of the vomiting. Satisfactory gain in weight only with EQ of 53–55.

Age.	Weight.		Average Weekly Gain.	Energy-Quotient.
Weeks.	Lb.	Oz.	Oz.	
4	7	2	—	26
5	7	1	− 1	41
6	7	3	+ 2	55
7	7	8	+ 5	55
8	7	14	+ 6	54
10	8	10	+ 6	54
12	9	8	+ 7	53

Case 3.—Normal infant. Initial gain on EQ of 46; loss as it fell to 43; subsequent steady gain with EQ 50 to 59.

Age.	Weight.		Average Weekly Gain.	Energy-Quotient.	Milk in 24 Hours.
Weeks.	Lb.	Oz.	Oz.		Oz.
3	6	8	—	46·5	15
4	7	0	+ 8	43	15
5	6	15	+ 1	57	20
6	7	10	+ 11	57·8	22
7	8	2	+ 8	53	22
9	8	12½	+ 5¼	59	26
12	9	14	+ 6⅓	58	28
16	11	13	+ 7¾	57	34
20	13	12	+ 7¾	52	36
22	14	6	+ 5	50	35
24	15	2	+ 6	47·7	36

Case 4.—*Malnutrition from improper feeding.*—Slight diarrhœa. Given equal parts of milk and water. Loss when EQ was only 36, and again delayed growth at seventeenth week, when EQ fell to 50.

Age.	Weight.	Average Weekly Gain.	Energy-Quotient.
Weeks.	Lb. Oz.	Oz.	
10	8 6	—	36
12	8 2	— 2	62
14	9 6	+ 10	55
16	9 11	+ 2½	51
17	9 12	+ 1	72
18	10 4	+ 8	—

From these cases of feeding infants in whom there was no obvious digestive disturbance upon diluted or undiluted cow's milk, it will be seen that the energy value of the food corresponded very closely with Heubner's standard, satisfactory gain in weight going along with an EQ of about 50–54, there being only one instance of growth during a week in which it fell below 50.

Taking cow's milk at 20 calories per oz. we find

that for each pound of body-weight 2½ ozs. of milk is required to yield an EQ of 50—i.e., a quantity between $\frac{1}{6}$ and $\frac{1}{7}$, practically the same as has been estimated for breast milk by the other method of calculation (v. p. 51) by Heubner and Budin. The principal, perhaps the only, advantage of a knowledge of calories is that it enables us to compare milk mixtures containing varying quantities of cream, water, sugar, etc. The calculations are not difficult. For example: a child weighs 16 lbs.; we wish to give six feeds of 7 ozs. to yield an EQ of 50 (50 × 16 = 800 calories in all).

Cow's milk . . .	31 oz.	× 20 =	620
Cane Sugar . . .	1½ oz.	× 109 =	163
Cream 12 per cent. .	½ oz.	× 41 =	20
Water	9 oz.	. . .	0
	42		803

When foods other than milk are given, e.g., malted cereals—probably a somewhat higher EQ than 50 is needed.[1]

[1] J. S. Fowler, *Edin. Med. Jour.*, January, 1908.

III. QUANTITIES REQUIRED AT EACH MEAL, AND INTERVALS

Two rules must be enforced : (1) the baby *must* be fed at regular hours ; (2) there should be one long interval during the night.

Intervals.—Up to nine months old it is customary in England for a baby to be fed at intervals of two, two and a half, and three hours. When feeding is two-hourly ten feeds are required, when two-and-a-half-hourly, eight, and when three-hourly, six. The day may be divided up thus :—

	a.m.				p.m.					
10 2-hourly feeds	6,	8,	10,	12,	2,	4,	6,	8,	10,	12.
	a.m.				p.m.					
8 2½-hourly feeds	6.30,	9,	11.30,		2,	4.30,	7,	9.30,	12.	
	a.m.			p.m.						
6 3-hourly feeds	7,	10,	1,	4,	7,	10.				

Two-hourly feeds are only needed during the first month. From the sixth week onwards the interval should be increased to two and a half hours, and by the end of the third month three-hourly intervals should be the rule. One of the most common errors is to continue feeding a baby every two hours for an

unnecessarily long period. While this may not be injurious when an infant is being suckled, it is otherwise in bottle-fed children. The firmer curd of cow's milk does not pass so rapidly out of the stomach as that of human milk, and on two-hourly feeds the organ is probably never empty. The great power of cow's milk in fixing hydrochloric acid (see p. 19) is a further reason for long intervals. A third reason for avoiding superfluous feeds is that we diminish the number of times a baby is exposed to infection. This applies particularly to night feeding. In giving a baby its bottle certain simple precautions as to cleanliness must be strictly observed, and there is no doubt that these are most likely to miscarry when a tired nurse is roused twice, or even thrice, from her sleep to feed her charge. For all these reasons it is well to assure oneself that proper intervals are observed.

We are governed by the capacity of the stomach as regards the **quantities at each meal.** The following chart, constructed from Rotch's figures (see p. 17) shows the growth of the stomach during the first year. A practical rule is to give an ounce for

each month up to the age of seven months. The dotted line in the chart shows the size of the feeds taken by a normally thriving infant whose feeding was regulated solely by reference to the weight curve. The two curves substantially agree.

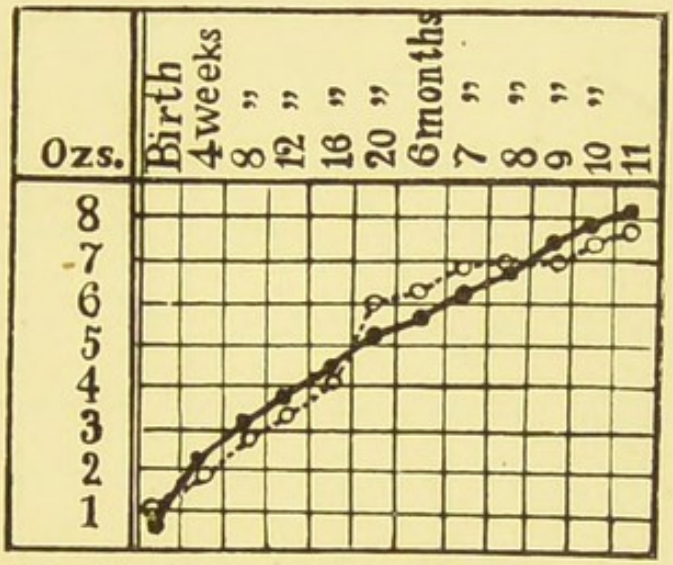


CHART II.—Growth of Stomach during first year.

The above data refer, of course, only to normal infants. In various morbid conditions we may be driven to depart from these rules. Weakly, undersized babies, for instance, may be able to take only a small quantity at a time, and must therefore be fed more frequently. An example is shown on Chart III. The baby was puny and sucked feebly ; it had no digestive disturbance and the mother's milk was good and abundant. By temporarily

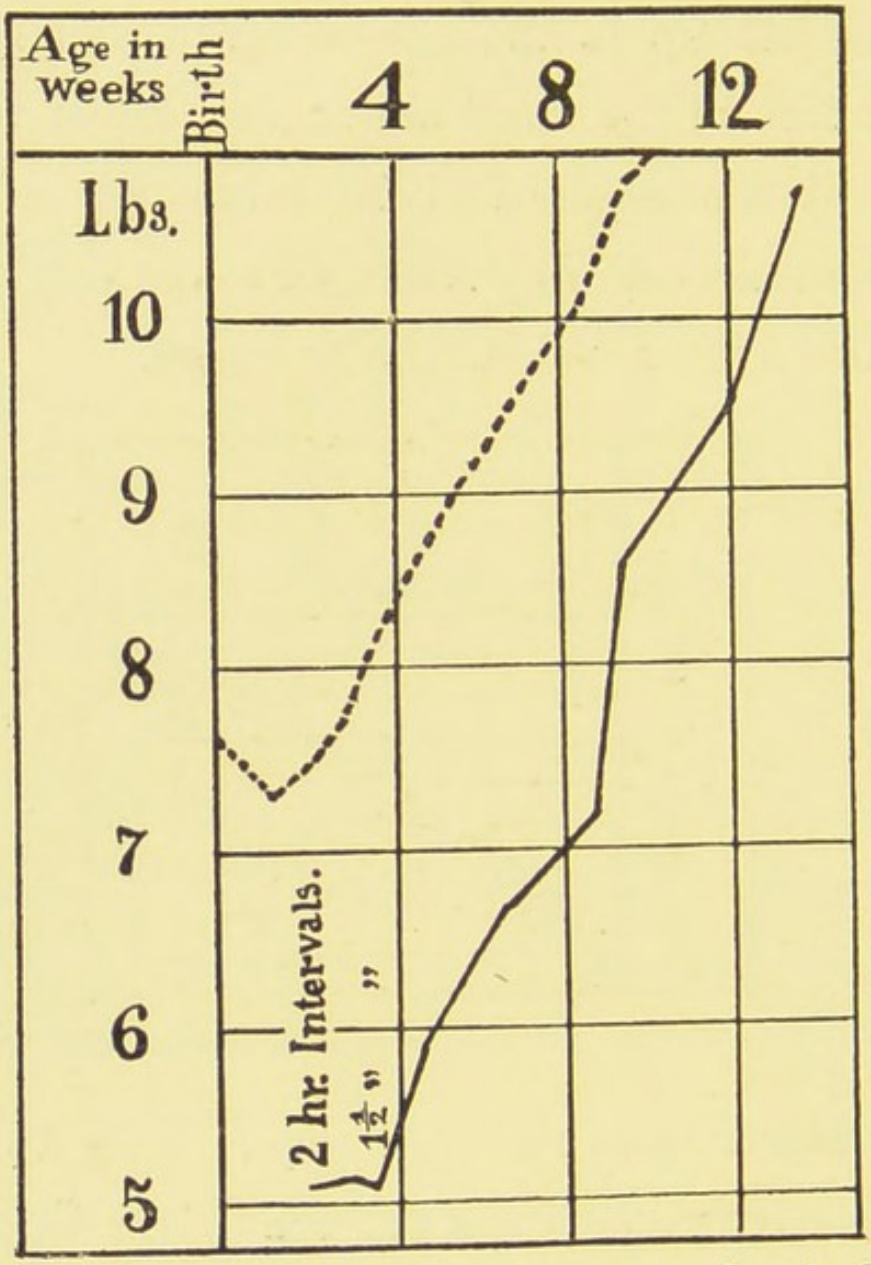


CHART III.—Premature Infant, showing result of shortening intervals between feeds.

diminishing the intervals more nourishment was afforded, and the weight curve rapidly rose.

IV. FEEDING APPLIANCES

In this connexion, it is worth while recalling the **mechanism of natural suckling.** The act calls

for considerable effort on the baby's part, so that by the end of a meal he is tired, and falls asleep. Secondly, the muscular actions involved play a part in the development of the mouth and jaws. Normal suckling consists of two sets of acts : suction and chewing (Pfaundler). The effect of sucking is to draw milk from the acini of the breast into the sinus lacteus, which lies just behind the nipple ; the act of chewing compresses this and expels the milk into the mouth. When the pressure of the jaws is relaxed the sinus refills, partly by suction, partly by the resilience of its walls. This mechanism is more closely imitated when a closed feeding-bottle is used than when there is a valvular opening. In the latter case only suction, in the former both suction and chewing are needed.

1. **Bottles.**—Two forms of bottle are admissible : the Soxhlet type (Fig. 9) and the boat-shaped bottle (Fig. 8). Of these the first is preferable. Its special advantages are : (1) the shoulder slopes gradually to the mouth, (2) the bottom angles are rounded, (3) it stands securely upright and so is easily warmed in an ordinary pan, (4) it stands heat

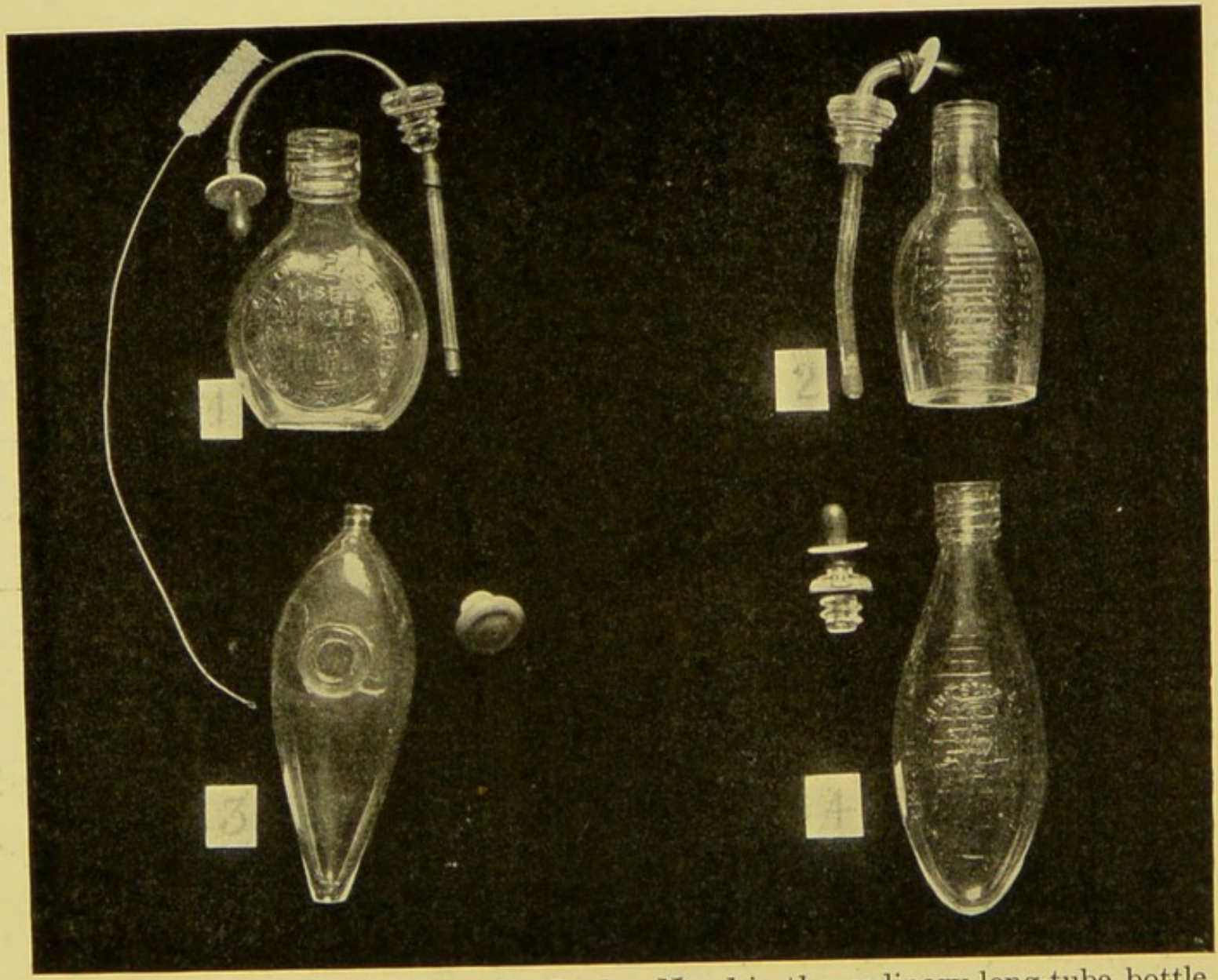


FIG. 7.—*Defective Forms of Feeding Bottle :* No. 1 is the ordinary long-tube bottle, now falling into disuse. No. 2 is seldom seen ; it is nearly as bad. No. 3 has too small a mouth to admit a brush and the interior cannot be cleaned from the lateral aperture. It is an old pattern, revived. No. 4 has a screw fitting, and a teat which is difficult to clean.

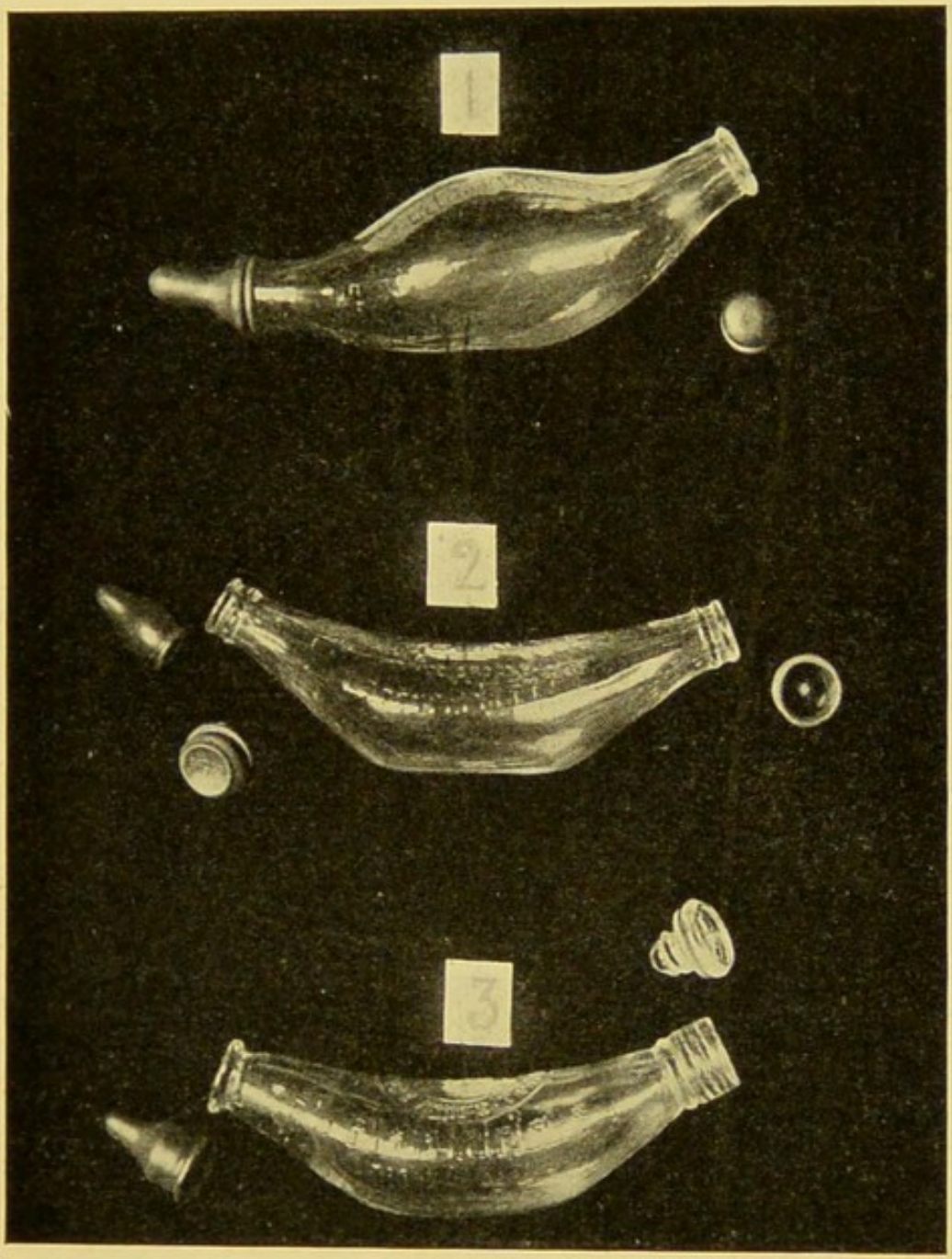


FIG. 8.—*Boat-shaped Bottles :* No. 1 is so constructed that when held level the teat is filled with milk, hence air is not swallowed. It is of smooth glass and readily cleaned. No. 2, the ordinary pattern, is quite satisfactory. No. 3 is spoiled by the addition of a screw fitting.

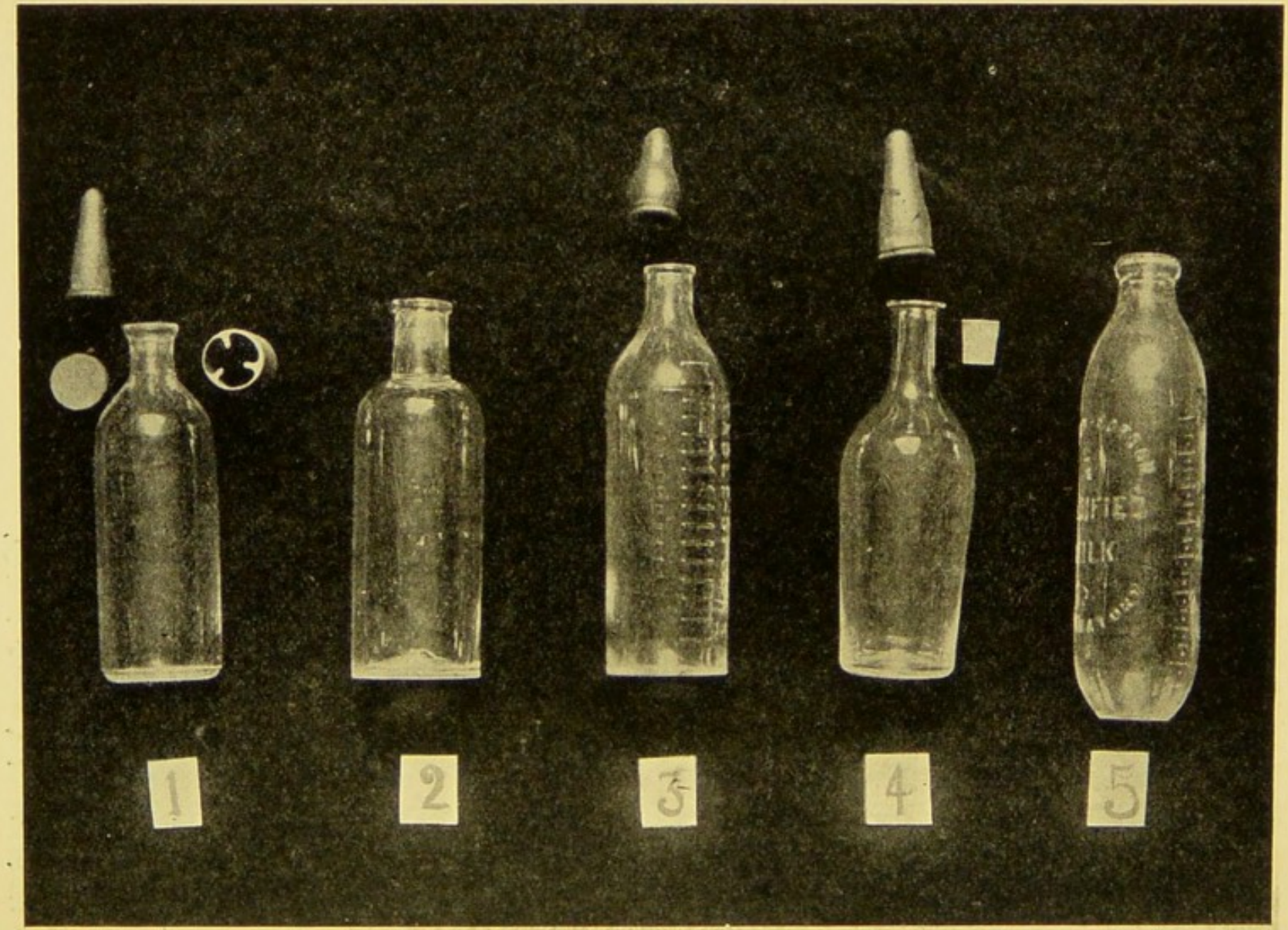


FIG. 9.—*Plain Type of Feeding Bottle.*—No. 1 Soxhlet bottle, rubber disc, metal cap and teat. Note sloping shoulder and rounded bottom angle. No 2 is defective in the shoulder and bottom angle, and No. 3 in the bottom angle only. No. 4 (Dr. James Carmichael's pattern) has a rubber stopper and is easily cleansed. Its sole drawback is that it is rather more costly than the others. No. 5, the Walker-Gordon bottle, cheap and good.

well. It is thus easily cleaned. Fig. 9, Nos. 2 and 3, show faulty patterns of this bottle. Soxhlet bottles are very cheap, costing only a few pence, according to size. The boat-shaped bottle can be thoroughly and easily cleansed by a stream of water. One end is closed by a rubber valve by which the flow of milk can be regulated. This is a quite unnecessary complication. The cheap form sold at 6*d.* is as serviceable as others at double the price. These do not stand heat so well as the preceding, and they cannot be warmed in an ordinary pan. A special slipper-shaped receptacle can be procured for the purpose.

Whatever form of bottle be selected the teat should simply fit over the mouth, and not be attached by a plug or screw. The thread of the latter is not easily cleaned. Bottles with long tubes are illegal in some American States, and their use ought to be prohibited everywhere. All complicated bottles, and those with bends or angles which it is difficult to get round with a bottle brush, are bad and should be avoided.

2. **Teats** ought rather to be firm than yielding

in order that the effort to compress them may exercise the jaws. They are most easily cleansed if wide enough to go over the neck of the bottle. The opening is either a small hole or a tri-radiate incision ("leech bite teat"). The former is better, as the slits of the leech bite soon gape and let too much milk through. Sometimes there is a little difficulty in finding a teat to suit a baby—either the hole is too small, and the infant turns away in disgust after a few ineffectual efforts, or too large, which leads to rapid gulping.

Cleansing the Mouth.—If scrupulous care be taken to avoid infecting the milk, bottle, and teat, it is not necessary to cleanse the mouth after a meal. In newly-born, feeble infants the mouth may be very gently sponged with a soft rag dipped in weak sterile saline solution, but in ordinarily vigorous babies this is at least superfluous. Attempts to cleanse the mouth are more likely to do harm than good by abrading the mucosa and destroying the natural flora of the cavity. The so-called Bednâr's, or butterfly, stomatitis may be caused by roughness in swabbing the mouth.

Practical Details of Feeding.—The following hints on points of detail may prove helpful, and will serve as a recapitulation of part of the preceding pages. Trivial and obvious as some of them appear, it is surprising how often they are neglected. It is a well-founded belief that the health of a baby depends just about as much on the sort of mother he has, as on the skill with which his diet is regulated by a doctor.[1] To realize this is to appreciate how important these details are, and a little time spent in giving such explanations to a young mother will not be thrown away.

The milk for the baby should be boiled or sterilized as soon as it is received. When simple boiling is adopted, milk must be got fresh twice a day. After being boiled, it should be poured into a jug which is then covered with two or three thicknesses of muslin or a piece of linen. It should be chilled

[1] This is strikingly brought out in an investigation by Park and Holt (*Archives of Pediatrics* December, 1903). From observations on 652 infants with reference to the effect of season, quality of milk, and surroundings on the health, they formed the opinion that the most important factor in securing good results is "intelligent care."

as quickly as possible, and stored in the coolest place in the house, away from sinks and drains.

Vessels which are used for containing milk ought to have mouths wide enough to admit the hand for cleansing. Enamelled iron ware is cheap and

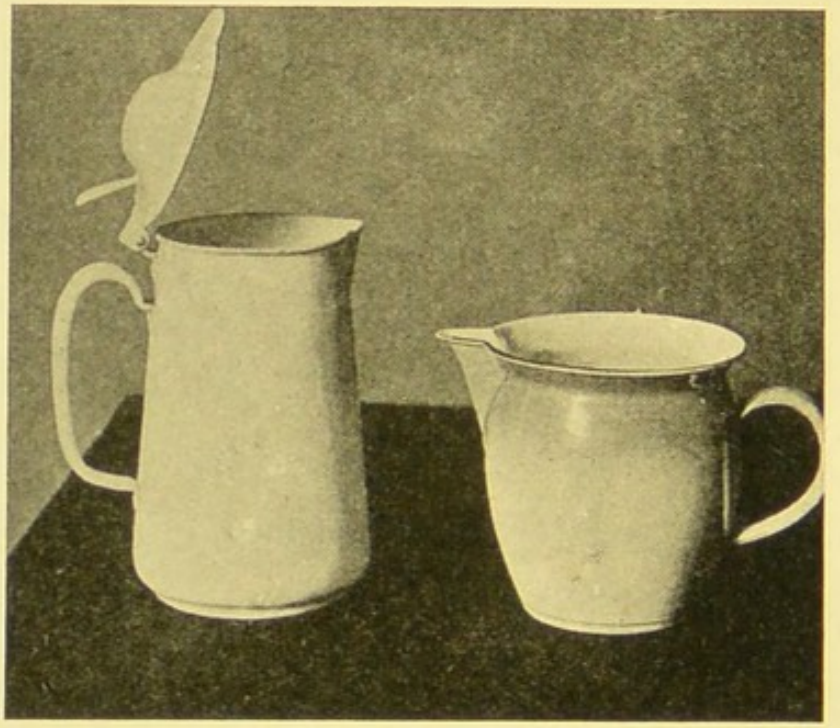


FIG. 10.—Enamelled Iron Nursery Ware. Milk can be boiled by placing the covered jug with milk in a kettle, and is protected from subsequent contamination.

satisfactory. Ornamented, fluted, and embossed china and glass jugs are difficult to clean and should not be used. The nursery ought to have its own special milk utensils, hence it is well that these should have some distinctive character.

When modified milk is being used the mixture may either be made in bulk sufficient for 12–24 hours, and boiled, or the milk alone may be boiled. If complicated mixtures are used the former plan must be adopted; if a simple milk-and-water mixture is given I prefer the latter. When cream is added this should be done before sterilizing.

Before giving a feed the nurse should wash her hands. The baby's napkin should be changed after, not before, a feed. The bottle is warmed in a pan over a spirit lamp, and the teat is at the same time boiled. The proper temperature for the bottle is easily estimated by holding it in the hand; the common practice of tasting a drop or two is bad. When milk and water is being given a simple way of warming the mixture is to add boiling water to the cold milk.

The contents of an unfinished bottle ought never to be reheated for use a second time. The practice of preparing the night feed at bedtime, and keeping it hot over a food-warmer is fundamentally wrong—it is simply incubating bacteria. After use the teat

should be rinsed and kept in clean water ;[1] the bottle should be scalded out with the hot water in which it was warmed and kept filled with water. It should not be allowed to dry before thorough cleansing as hardened particles of milk are very difficult to remove.

At least two bottles should be in use, and it is best to have one for each feed. Before a bottle is used a second time it should be thoroughly scrubbed with soap and plenty of hot water. The ordinary bottle brush sold by chemists is a flimsy affair, a better one can be got at the ironmonger's. The Soxhlet brush is not a good pattern. Care should be taken that the brushes are kept clean, and not allowed to lie about sinks, etc., where contamination may occur.

Practically, feeding intervals must be calculated from the beginning of one feed to the beginning of the next. It is not easy to apportion two-and-a-half hourly feeds regularly throughout the twenty-four hours—they are apt to clash with domestic arrange-

[1] If these rules are attended to the teats need not be everted and cleaned with a brush, and will last much longer.

ments, hence it is well to make the period during which they are in force as short as possible. It is best to take as a fixed point for starting the day's routine of feeds some convenient forenoon hour—say 10 a.m. The best of babies clamours for a meal when he awakes, and he is not a machine, always to wake at the proper time. The first meal of the day, therefore, is necessarily a movable feast, and to insist on strict intervals will dislocate the day's routine of sleep and outing. To avoid this, the second feed should be made the starting-point of the day.

A baby should be wakened to be fed if necessary. The ordinary duration of a meal ought not to exceed 15–20 minutes.

CHAPTER III

Feeding a Normal Infant from Birth—1. With Diluted Milk—2. With Undiluted Milk (Budin's Method).

EVERY one who has considered the matter at all must have been struck by the conflict of opinion as to the most suitable diet for an infant. It is agreed that cow's milk in some form should be the staple, and there unanimity ends. Part of this diversity of opinion proceeds from the fact that clear distinction is not always drawn between a normal, healthy baby, and one whose digestion has been upset in one way or another. I doubt whether many otherwise healthy infants come into the world endowed with unnaturally feeble digestions; much more often, assuredly are these feeble digestions the result of faulty feeding.

A cardinal rule, therefore, is to take notice of

the earliest and most trifling signs of the food disagreeing, and to remedy these early, before harm is done.

As bearing on the selection of a method, the unique property of milk of adjusting its digestibility to the activity of the digestive organs (p. 22) should be remembered. It is this property, doubtless, which compensates for the differences which exist between the most skilful modifications of cow's milk and the food which nature has elaborated.

We shall therefore first consider the feeding of the normal infant from birth.

For the first two or three days a baby requires little or no food. It is undesirable to begin artificial feeding too early, and there ought always to be a serious endeavour to rear the child on the breast. The special importance of the colostrum period (p. 10) shows that if the baby can be suckled for even a week it is no small gain. Assuming however, that artificial feeding is decided upon, there is no reason for undue delay. It is usual to give a little sugar and water occasionally during the first twenty-four or thirty-six hours; probably

plain boiled water is better. Forty-eight hours after birth the regular feeding may be begun, though, as a rule, the proper routine of meals will not be completely established before the end of the first week. A vigorous baby will not suffer from a considerably longer fast, but a small puny infant is not fitted to stand the loss of six or eight ounces without detriment. Artificial feeding, therefore, should begin, according to circumstances, between the third and sixth day.

1. FEEDING WITH DILUTED MILK

The object of diluting cow's milk is to approximate its constitution to that of human milk. For purposes of calculation woman's milk is taken as containing proteid, 1·5 to 2 per cent., fat, 4 per cent., sugar, 6 per cent.; cow's milk as proteid, 4 per cent., fat, 4 per cent., and sugar, 4 per cent. As all methods of modification are based on these figures they should be thoroughly familiar.

In both assumptions the margin of error is sufficient to annul any over-refinement of calculation.

The functions of diluents will be described in

the ensuing chapter; for the present it is enough to say that either water or barley water may be chosen. The latter is believed to favour the formation of a light curd. To begin with, we may order ten feeds at two-hourly intervals, each composed of $\frac{1}{2}$–$\frac{3}{4}$ oz. of milk with an equal bulk of diluent. The mixture will have a composition of proteid 2 per cent., fat 2 per cent., and sugar 2 per cent. It is needless at present to correct the fat percentage, but the sugar should be brought up to 5 or 6 per cent. by the addition of milk or cane sugar to the extent of $\frac{1}{30}$–$\frac{1}{25}$ of the bulk of the food—to every 10 ozs. of mixture, therefore, add $\frac{1}{3}$–$\frac{2}{5}$ of an ounce. Milk sugar is preferable as less likely to ferment, but there is not much to choose between the two, and the latter is extensively used where economy is an object.[1] In the great majority of cases this diet will suit perfectly well, and the infant will thrive. The points which require attention both at the outset, and whenever any change in the diet is made are (1) the character of the motions; (2) whether the baby seems satis-

[1] Milk sugar costs 1*s*. to 2*s*. per lb.

fied; (3) whether there is vomiting; (4) any signs of colic; and (5) the weight from week to week.

The motions should number two or three in the day, and be of the character described on p. 150. No attention need be paid to the occasional gulping up of a mouthful of milk during or soon after a meal; it is due to flatulence, and is often caused by the hole in the teat being too large and allowing the infant to swallow the milk too quickly. Habitual regurgitation of a part of a meal is a sign that the stomach is being overloaded. Vomiting occurring at a later stage of digestion shows that the food does not suit. The cry of pain (from colic) is quite unlike that of hunger. A hungry baby whines persistently, especially just after a bottle, and again towards the end of an interval, whereas pain is manifested by a more paroxysmal piercing cry. Colic also causes the baby to draw its legs up on the abdomen, and is often relieved by the passage of flatus, or a liquid, often greenish, motion, with whitish masses of curd or fat in it. Prolonged attacks of loud crying, accompanied by stretching out of the legs, should suggest the examination of

the anus (in a *good* light) for fissure, which is a common and readily curable affection in babies.

As a rule it will be necessary, by reason of increasing appetite and need for food, to increase the diet about the third week, and this may be done either by giving larger quantities or using less diluent. Believing as I do that there are several advantages in educating a baby as early as may be to tolerate undiluted milk, I prefer the latter course. We may then give a mixture of two parts (1 oz.) milk and one part ($\frac{1}{2}$ oz.) water, adding the 3 per cent. of sugar required to bring that up to between 5 and 6 per cent. It is as well to begin by at first substituting only two or three bottles of the stronger for the weaker mixture in order to discover by comparison whether they agree or not. In any case, it is a sound rule in infant feeding to make only one change at a time ; it is therefore inadvisable to alter both the bulk and composition of the diet simultaneously.

During the first few months growth goes on apace, and the food requires to be augmented considerably. About the sixth week or so it is well to alter

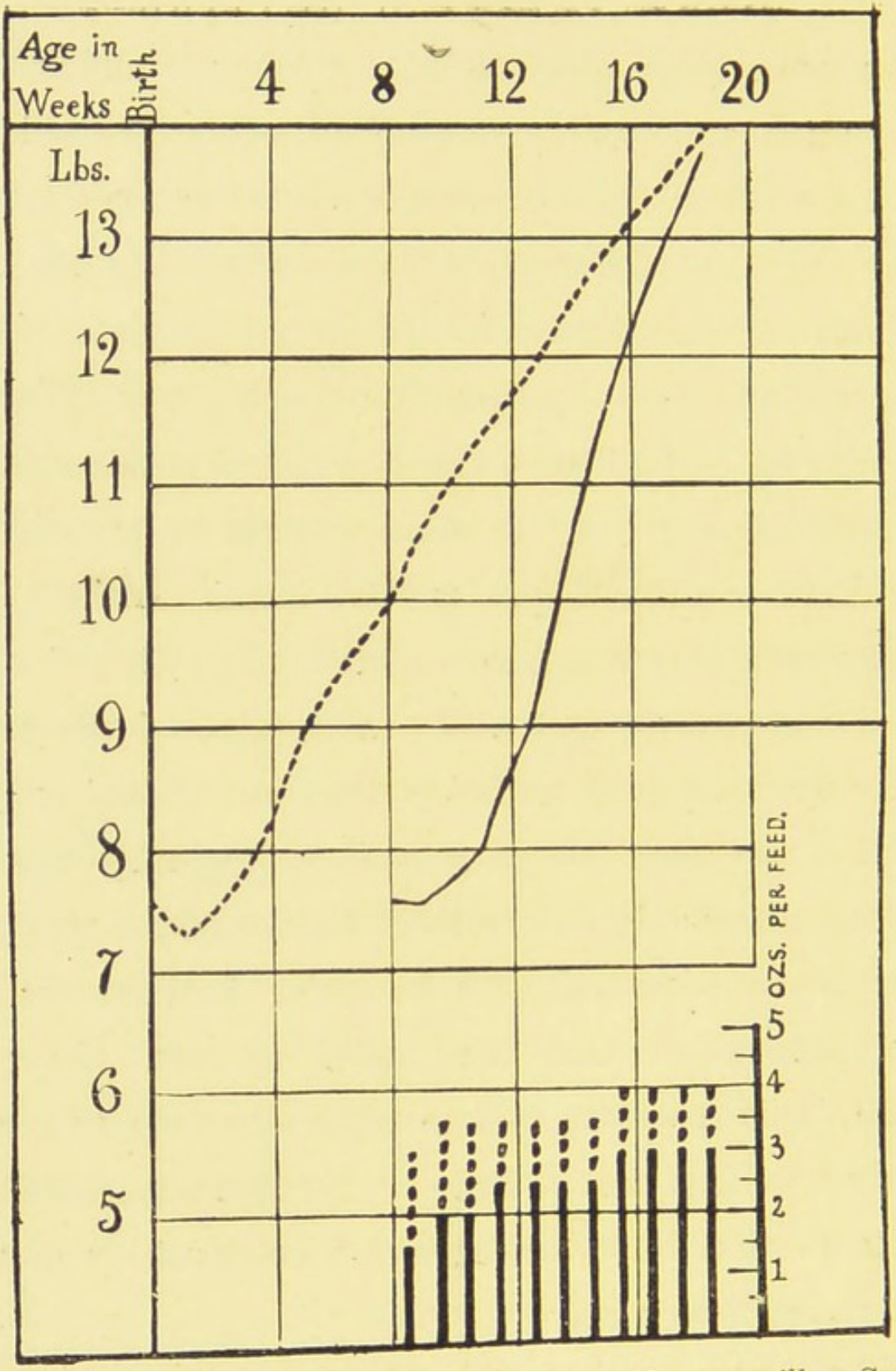


CHART IV.—Weaned on account of failure of breast milk. Satisfactory gain on diluted milk. (Note that in this and subsequent charts solid vertical lines indicate milk, interrupted vertical lines, diluent.)

the diet again, with the same precautions as before, giving now thrice as much milk as diluent. Towards the end of the third month undiluted milk may be given.

As an alternative to this plan many prefer to keep to the dilution 1 : 1, and to add cream. This will be discussed subsequently (p. 117). Cream is an article of very uncertain composition; its proteid and sugar are the same as in milk, its fat may be anything between 10 and 50 per cent.; it is far from sterile; it is expensive. If, however, a milk-cream mixture is used the fat ought never to be higher than about 3·5 per cent. Too rich mixtures (4–5 per cent.) are fertile causes of digestive disorder.

The principles of such a method of feeding as this are (1) to begin with comparatively low proteid, since that is the constituent of milk most likely to give trouble; (2) to make the preparation of food as easy as possible for the mother and so lessen the chance of mistakes; (3) to be guided as to alterations by the needs of each individual baby; and (4) to make changes one by one, looking on each as experimental.

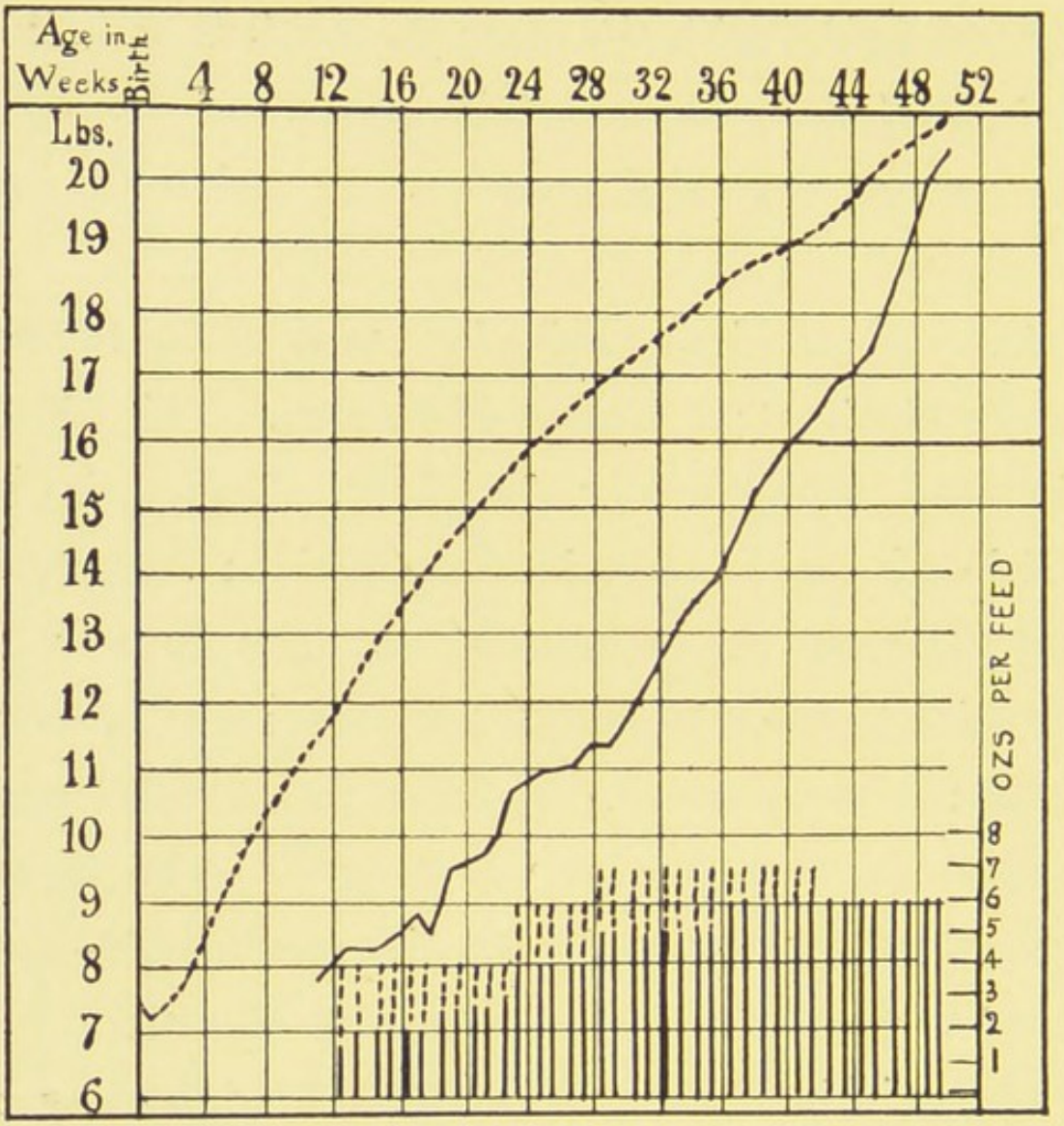


CHART V.—Illustrating Feeding with Diluted Milk.

2. FEEDING WITH UNDILUTED MILK (BUDIN'S METHOD)

In France sterilized undiluted milk is extensively employed as a food for infants from birth. The method was introduced by the late Professor Budin,[1] and succeeds in a great many cases. Like

[1] Budin, *The Nursling*, trans. Maloney, London, 1907.

many others, I was for a long time prejudiced against a diet which so markedly differed in composition, particularly as regards proteid, from human milk.

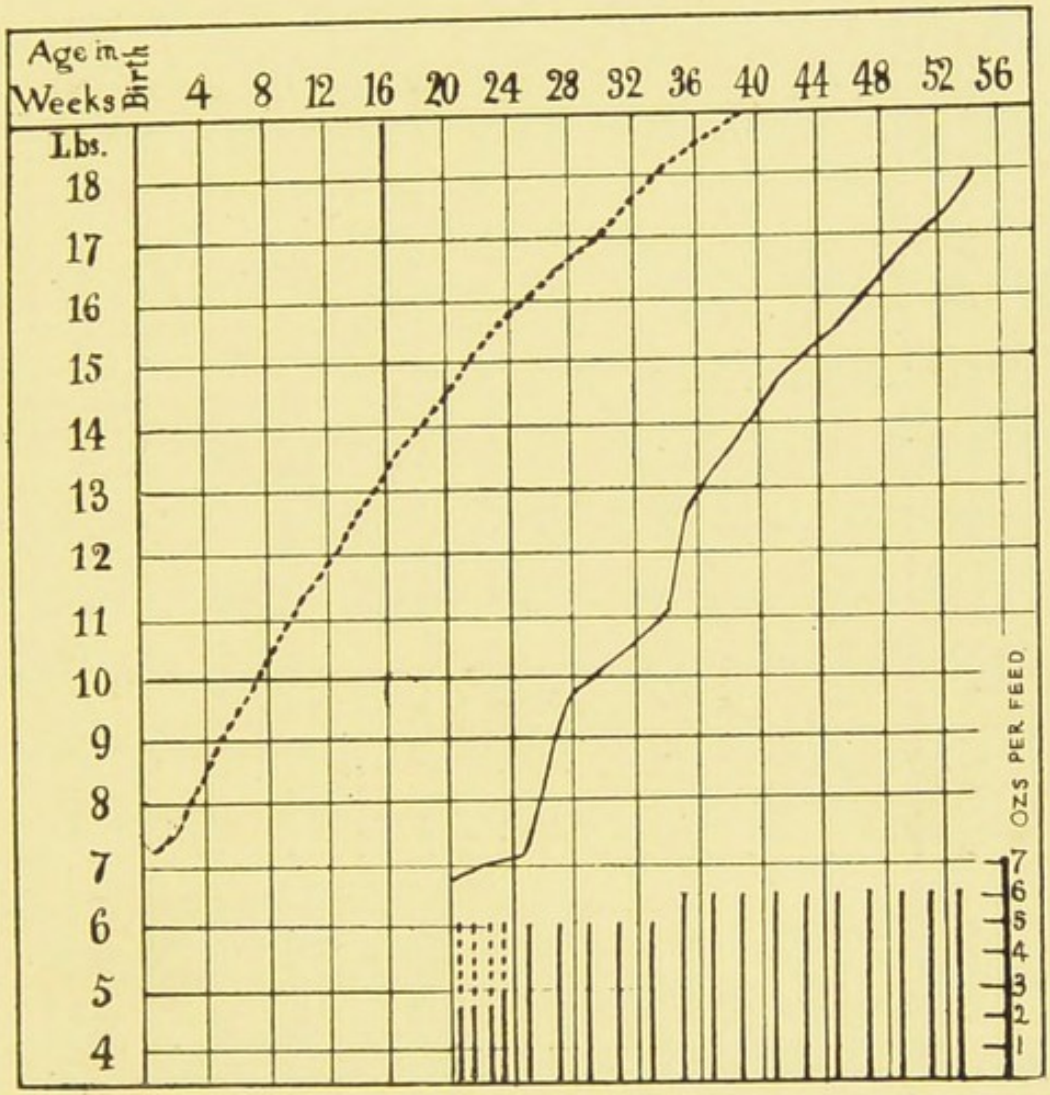


CHART VI.—Illustrating Improved Weight-curve when whole milk substituted for dilution.

Some years ago, however, on comparing the weight curves of a series of infants treated during a number of years in the out-patient department of the

Edinburgh Sick Children's Hospital, I was struck by the fact that on the whole those who had been given undiluted milk, or strong milk mixtures,

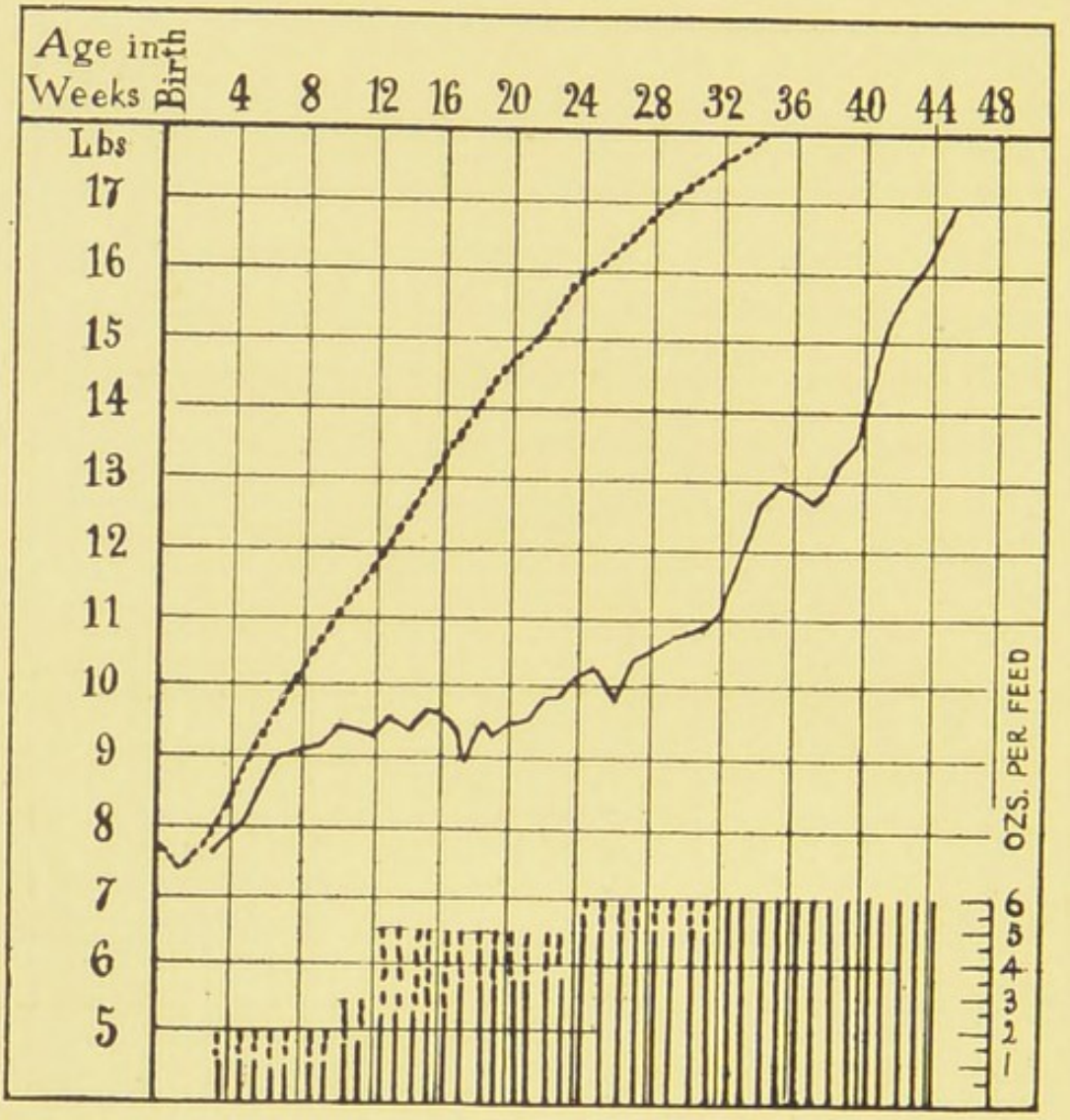


CHART VII.—Illustrating Improved Weight-curve when whole milk substituted for a dilution.

showed much the most satisfactory weight curves. The patients were not selected in any way; all the "feeding cases" which attended regularly

for more than a week or two were taken. This led me to try Budin's method, and I am now satisfied that **when properly carried out** it has many advantages.

The following rules should be strictly adhered to in feeding infants on undiluted sterilized milk.

1. The method should only be adopted in the case of infants who are free from digestive disorder. When a baby is suffering from the consequences of improper feeding it is unreasonable to expect him to tolerate undiluted milk. It is a rare occurrence for a young infant admitted to the Sick Children's Hospital with gastro-intestinal disorder to be able to digest unmodified milk even during convalescence.

2. While the average normal infant usually supports undiluted milk from birth, in the case of puny, premature infants it is safer, as Budin himself points out, to dilute the milk during the first week or two.

3. The milk must be sterilized at 212° F. for forty minutes in a Soxhlet or similar apparatus.

4. The feeds should be small. Neglect of this is perhaps the most common cause of failure.

5. The quantity of milk given is regulated by results—by the weight ascertained at weekly intervals.

We may begin by giving ten 1 oz. feeds daily, at two-hourly intervals. This in the case of a seven pound baby is rather less than one-tenth of the body-weight, and as a matter of experience it is generally found that a baby will consume from $\frac{1}{10}$–$\frac{1}{7}$ of its weight of milk daily. At the end of a week the child is weighed, and should it not have gained, the day's allowance of milk is raised—not otherwise. Large additions are not needed; an increase of 2 or 3 ozs. in the daily ration is usually enough to produce the desired result. The maximum daily quantity of milk required during the first year is under, not over, 40 ozs.

In feeding a baby in this way the nurse should remember that owing to the smallness of the feeds the baby is apt to finish the bottles too quickly, and should be warned against allowing this to occur.

It is advisable gradually to shorten the period

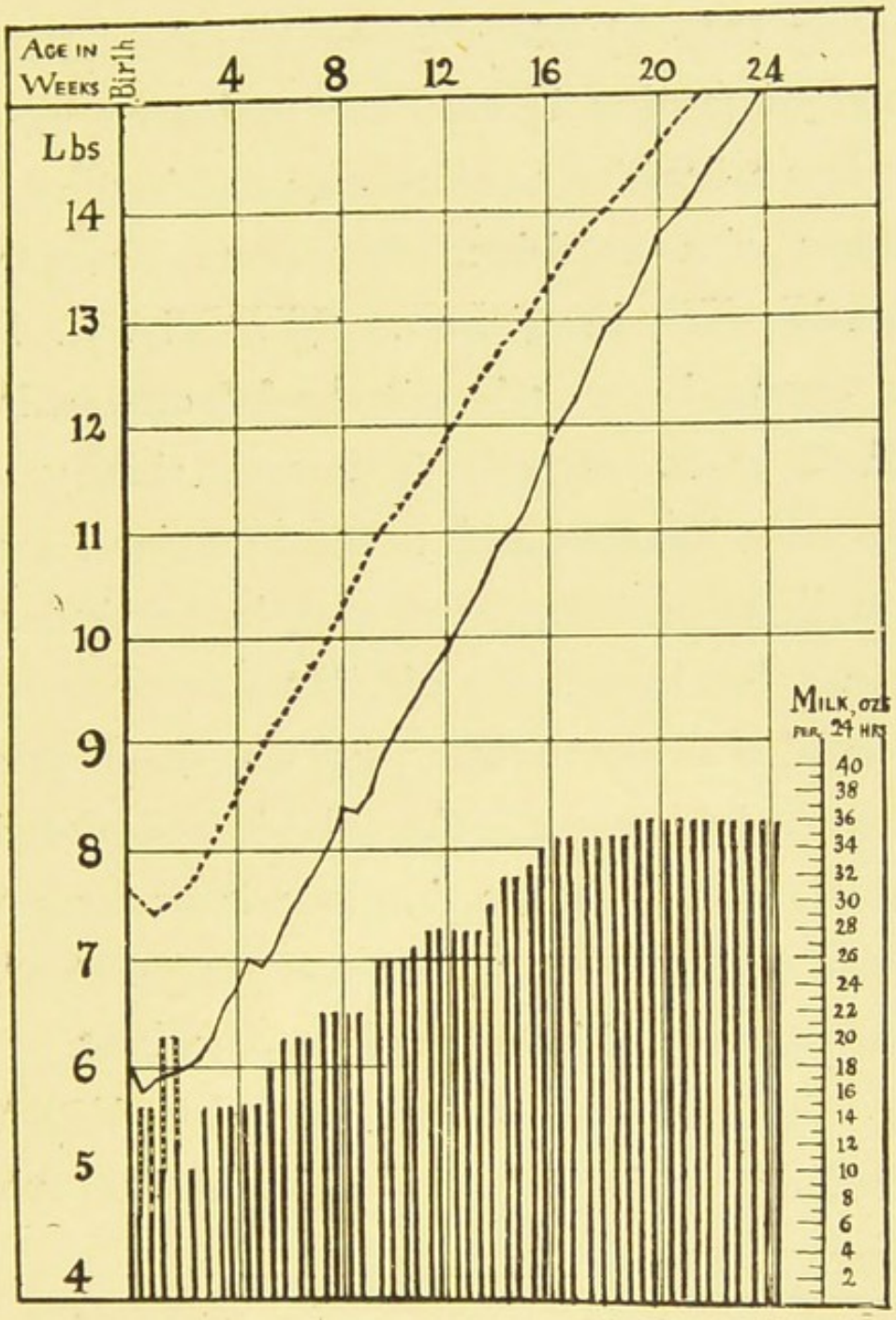


Chart VIII.—Weight curve, and total quantities of milk consumed, in case fed by Budin's method.

of sterilization. By the end of the third month it may be reduced to thirty minutes, and by the eighth or ninth month ten minutes is enough.

Among the objections brought against Budin's method of feeding is that the prolonged heating engenders a liability to scorbutus, and in some way interferes with nutrition. Scorbutus, however, is extremely rare in France. Personally, I have never known it occur in a baby fed on undiluted sterilized milk. On the contrary, children fed in this way have seemed to me to thrive remarkably well, to be firm fleshed and, in particular, to show not the least trace of rickets.

It is also objected that the excess of proteid is a cause of dyspepsia. Marfan,[1] indeed, describes a special form of indigestion associated with constipation and the passage of large putty-like stools as characteristic of infants fed on pure milk. Probably this is due, not to the method itself, but to overfeeding, against which Budin utters special warning.

Still, it may well be asked, how does an infant's stomach manage to digest milk proteid which is excessive in amount and different in quality from that of human milk. I think that the reasons

[1] *Traité de l'allaitement*, Paris, 1899, pp. 316 *et seq.*

are these. It is possible that sometimes when diluted milk is given enough hydrochloric acid may be present in the stomach to produce a tough curd of paracasein hydrochloride, while when undiluted milk is used the hydrochloric acid is relatively insufficent to do this. In the one case a small firm curd forms, in the other a more flocculent, though larger one. I have certainly observed the substitution of undiluted for diluted milk followed by the cessation of colic and curdy stools. Secondly, the small size of the feeds, and the avoidance of overfilling the stomach with fluid is, I think, a possible factor. Thirdly, the prolonged heating, which is an essential feature of the method, precipitates the lime salts and thus materially softens the curd produced in the stomach.[1] This, I think, is the chief factor (cf. Fig. 4).

[1] Dr. Dingwall Fordyce finds that *in vitro* the curd of sterilized milk is more flocculent than that of raw milk, but is more resistant to artificial gastric digestion. He suggests that when milk treated thus is employed, the process of gastric digestion is to a large extent superseded, and that the flocculent curd passes readily through the pylorus. *Scottish Medical and Surgical Journal*, October, 1907.

The advantages of Budin's method are : (1) the satisfactory growth and absence of flabbiness and rickets, (2) simplicity, (3) complete assurance that the food is sterile, (4) economy. Its chief drawbacks are the cost of the sterilizer, and the probability that unless the mother controls a natural impulse to give large quantities of milk the digestion will suffer.

Few infants, even the most healthy, escape indigestion altogether. Gastric flatulence is common and is often due simply to air gulped down in the act of sucking. This can be largely prevented by careful feeding, and by regulating the flow of milk from the bottle. Slight attacks of crying from flatulence are usually relieved by a dose of dill water ($\frac{1}{2}$–1 drachm). Fretfulness without any obvious sign of indigestion, except perhaps a slightly constipated motion, is often relieved by a dose of castor oil. How it acts I do not know. In doses of $\frac{1}{2}$–1 drachm it seems to operate more as a sedative than a purge, and it certainly soothes a baby and often sends him to sleep within a few minutes of being administered—long before it can possibly

have entered the intestine. Minor degrees of constipation, shown by the passage of firm motions accompanied by straining, may be relieved by a soap suppository or a rather larger dose of castor oil. Attacks of colic accompanied by crying and slightly greenish stools are usually checked by one or two doses of grey powder (gr. i) and sodium bicarbonate (grs. iii–v). Finally, when there is loud crying, especially if it is accompanied by straining and stretching out the legs, fissure of the anus should be looked for. Fissures usually heal promptly if a little white precipitate ointment (grs. v to ʒi) be applied two or three times a day.

None of the above symptoms necessitates any immediate interference with the diet provided they yield at once—within twelve or twenty-four hours—to these simple measures. If they perpetually recur, or become worse, the bounds of health are overstepped, and other measures must be taken.

Drinking Water.—A healthy baby neither needs, nor cares, to drink water. Its food already supplies it with enough fluid. In disease it is an-

other matter, but it is useless to give water to normal infants until bottle-feeding is a thing of the past.

Dumb Teats.—It is both useless and objectionable to permit a baby to acquire the habit of sucking a "comforter." When these are used they ought to be attached by a piece of tape to the frock so that they may not roll on the floor, and they ought to be boiled frequently.

CHAPTER IV

Diluents, and the Addition of Alkalis—Citrated Milk—Peptonized Milk—Milk Modifications to imitate Human Milk—Percentage Feeding—"Top Milks"—The Use of Whey—"Humanized" Milk—Butter Milk—Condensed Milk—Albumin Water—Raw Meat Juice—Proprietary Foods.

I. DILUENTS: AND THE ADDITION OF ALKALIS, ETC.

Instead of water, diluents which modify the components of milk qualitatively as well as quantitatively are often used.

1. **Cereal Decoctions.**—Barley water is one of the most common. It acts to a large extent mechanically, and is thought to favour the occurrence of a loose curd. As ordinarily prepared it contains less than 1 per cent. of starch, so that it is more demulcent than nutritious. Some autho-

rities advise a malted cereal in place of barley, and I have sometimes found that a weak decoction of

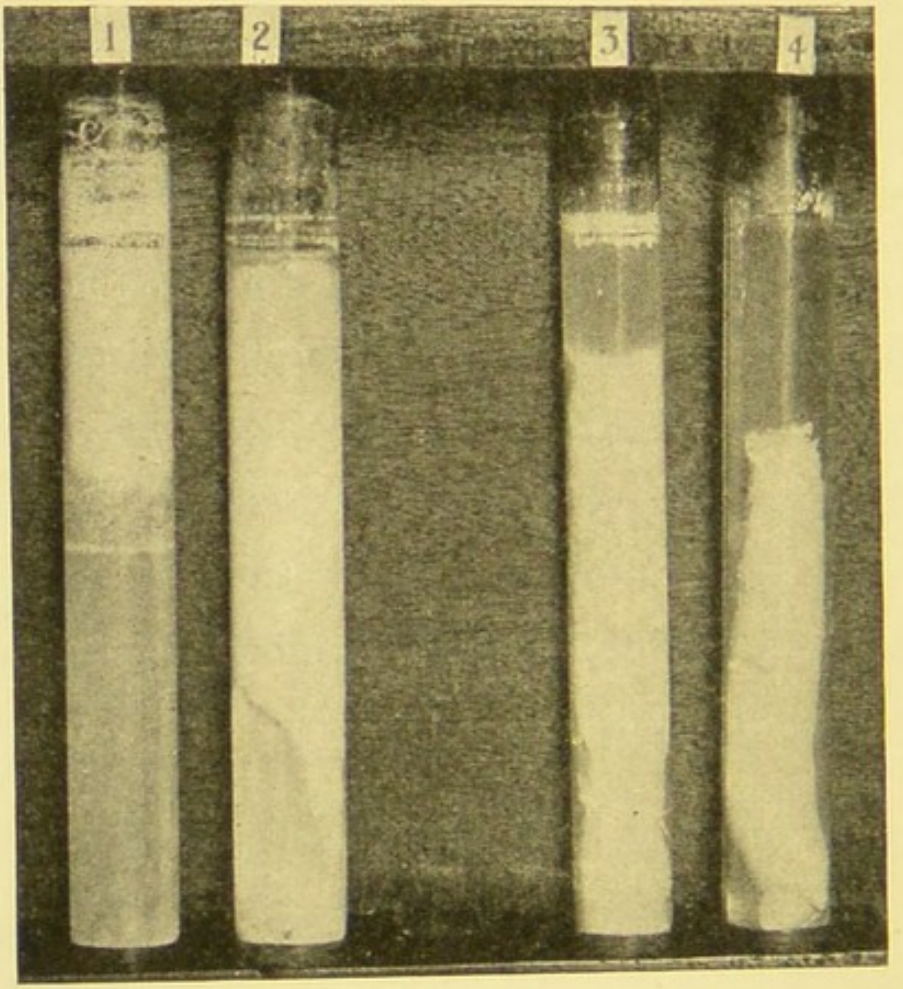


FIG. 11.—*Effect of Dilution with Water :* (1) Human milk giving soft, light, curd. (2) Raw cow's milk; solid curd. (3) Boiled cow's milk; curd somewhat smaller. (4) Equal parts boiled milk and water ; curd less, but still very dense. One ounce in each tube, with 5 drops rennet and 5 drops 1 per cent. HCl.

a malted food, such as Mellin's or Savory and Moore's, agreed better than barley water. Such mechanical diluents as thin solutions of gelatin,

rice water, etc., have no advantage over barley water. All simple diluents retard coagulation by lowering the concentration of the calcium salts in the milk.

2. **Addition of Alkalis.**—Experience has shown that milk is rendered more digestible by the addition of sodium bicarbonate or lime water, and the explanation formerly given was that these substances acted by neutralizing the acidity of cow's milk, and assimilating its reaction to that of human milk. Human milk, however, is not alkaline but faintly acid. The action of alkalis is really a little more complicated than was formerly supposed. They form definite compounds with casein on which rennin has no action (*see* p. 25) and they neutralize the acidity of the gastric juice. Lime water and bicarbonate of soda are not quite interchangeable terms so far as their action on milk is concerned. Lime water swells the mucoid proteid, and thus has some mechanical effect; it inhibits the action of rennin to a considerable extent; it is feebly antacid. Bicarbonate of soda inhibits rennin action much less, but is much more powerfully antacid.

Three grains of sodium bicarbonate are equal in acid neutralizing power to 50 c.c. of lime water (Hutchison), while in rennin inhibitory power 50 c.c. of lime water is equal to 35 grs. of bicarbonate of soda. It is generally held that as regards rennin, the addition of 1 oz. of lime water to the pint is equivalent to the addition of 1 gr. of the bicarbonate to the ounce of milk. The latter mixture of course has a much greater antacid action. The main difference between the two substances, therefore, is that lime water has a specific action on the curd, while sodium bicarbonate acts chiefly by neutralizing the gastric juice. In both cases rennin action is delayed, and more milk passes unchanged into the intestine. When milk is thoroughly alkalinized by the addition of 2 grs. of sodium bicarbonate to the ounce probably gastric digestion is to a great extent cut out. In lower degrees of alkalinization with bicarbonate a porous curd forms on account of the evolution of bubbles of carbonic acid gas in its interior.

Probably, therefore, where there is evidence of gastric indigestion with vomiting of curd, soda

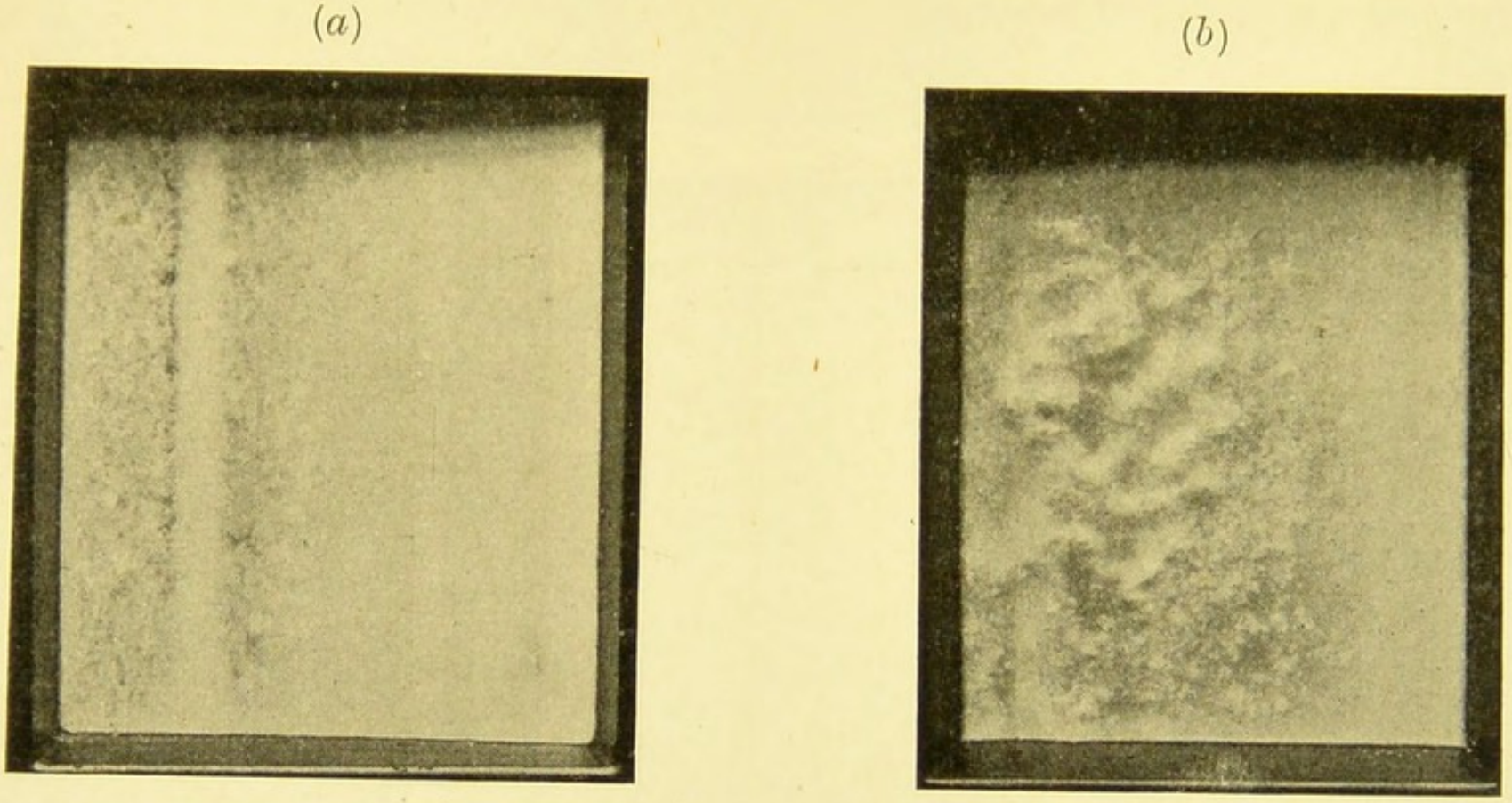
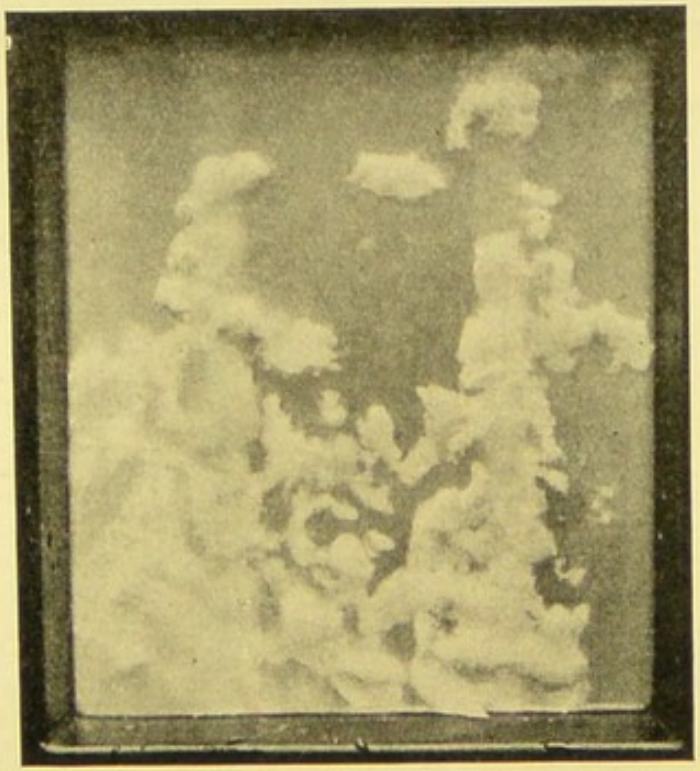
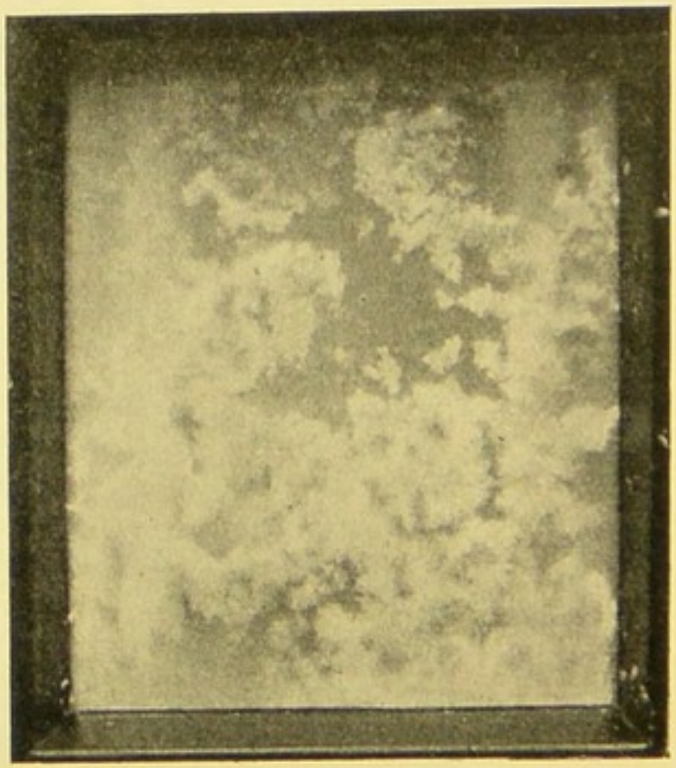


FIG. 12.—Addition of sodium bicarbonate, 1 gr. to 1 oz. On incubating at 95°–100° F. for half an hour with 5 drops rennet and 5 drops 1 per cent. HCl no curd formed. The first sign of curding was with 20 drops HCl, the fine curd (*a*) developing; with 25 drops a heavier curd (*b*) resulted.

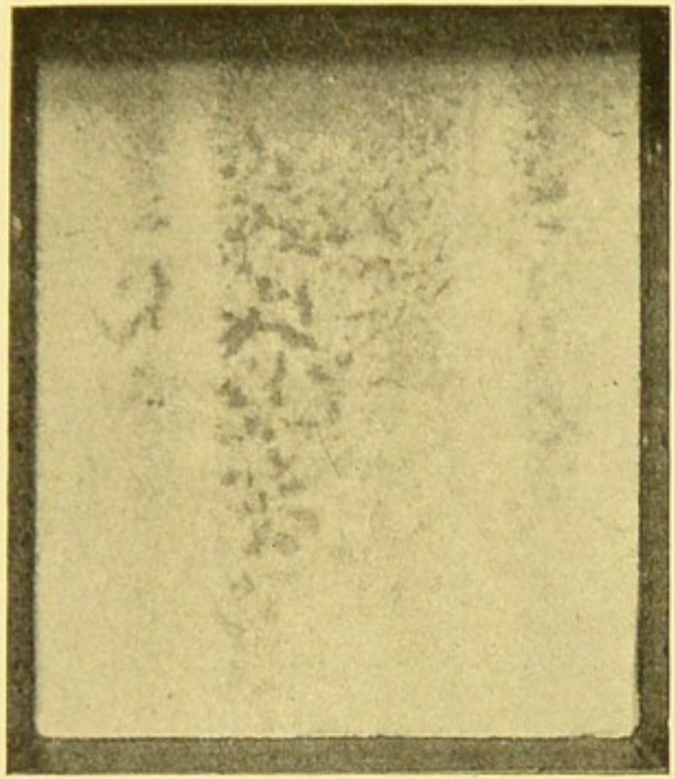
No. 1. 5% Lime Water.



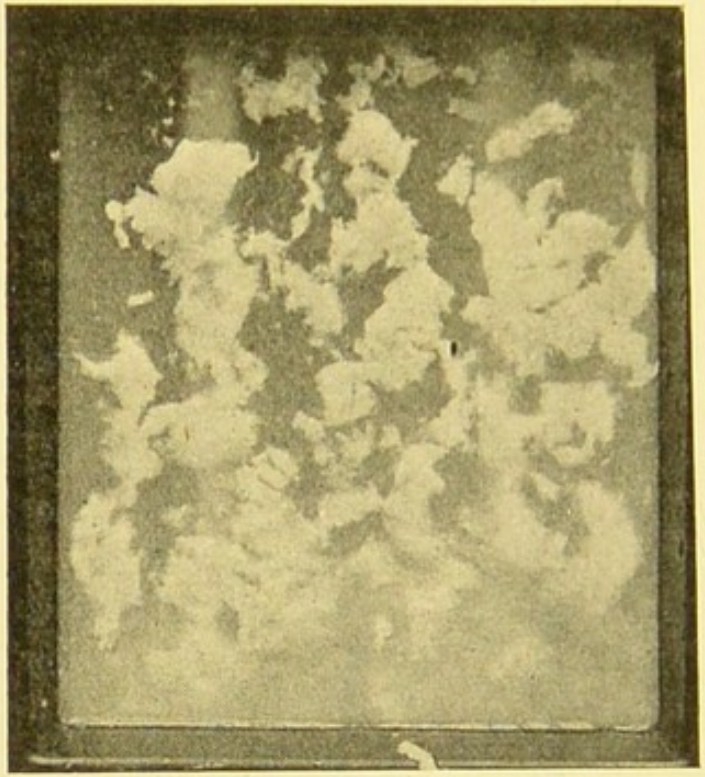
No. 2. 10% Lime Water.



No. 3. 20% Lime Water.



No. 4. 40% Lime Water.



No. 5. 40% Lime Water
+ 10 drops 1% HCl.

FIG. 13.—*Effect of adding Lime Water.*—Nos. 1 to 4 incubated at 95°–100° F. with 5 drops rennet and 5 drops 1 per cent. HCl; No. 5 with 10 drops 1 per cent. HCl. Shows progressive diminution in amount of curd. Note the large jelly-like curd with small quantities of lime water = swelling of mucoid proteid (cf. curd of raw milk, Fig. 3). Curding takes place in the presence of much smaller quantities of acid than in the case of additions of sodium bicarbonate.

should be used; when the indigestion is intestinal, with passage of curd, lime water is better. It is customary to allow 1 grain of bicarbonate to every ounce of milk, and from 1–6 ozs. of lime water to every pint.

Magnesia.—By adding fluid magnesia we not only alkalinize the milk, but give a laxative. One or two drachms may be added to each feed.

3. **Sodium Chloride.**—The addition of a pinch of sodium chloride to each bottle is advocated by Jacobi; it is believed to assist in the assimilation of milk.

4. **Sodium Citrate.**—When sodium citrate is added to milk, curding from rennin action is lessened or entirely checked. Wright [1] was the first to draw attention to this, and since Poynton's paper [2] appeared citrated milk has been very widely employed, and is generally recognized as of great value. The citrate is prescribed in a solution of 1, 2, or 3 grains to the drachm; a drop of chloroform is added to each 4 ozs. to prevent moulds growing

[1] *Lancet*, July 22, 1893.

[2] *Lancet*, August 13, 1904.

in it, and the direction given is that to each feed a teaspoonful is added for every ounce of milk it contains. It is usual to allow 1 gr. of citrate to

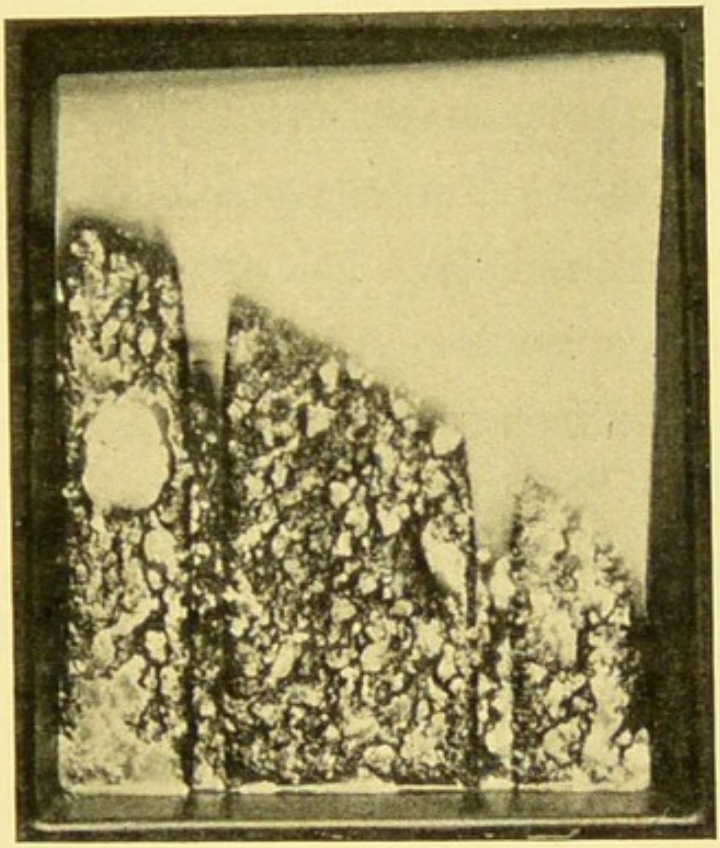


FIG. 14.—Citrated Milk, 1 gr. to 1 oz., incubated at 95° for half an hour with 5 drops rennet and 5 drops 1 per cent. HCl. Comparatively small amount of soft curd. With 2 grs. to 1 oz. no curd formed under same conditions.

each ounce of milk, and as the feeds are increased the amount of citrate added to each bottle must be raised correspondingly. One grain to the ounce does not entirely hinder curding, but produces a

soft curd on the addition of rennet and hydrochloric acid. *In vitro* 2 grs. to the ounce prevents curd formation altogether. Sodium citrate is believed to act by precipitating the soluble calcium salts which are necessary for rennet action to take place. Poynton[1] states that "sodium citrate combines with the caseinogen and produces a sodium compound [cf. footnote, p. 25]. This is of lower molecular weight than the calcium compound, and hence of less density. The calcium salts of the milk combine with the citric acid to produce calcium citrate, which, much diluted by the stomach contents, is absorbed into the system and not lost to the economy." The theory has been criticized,[2] but there is no doubt as to the facts. Citrated milk is certainly often tolerated when milk alkalinized with sodium bicarbonate disagrees.

Choice of a Diluent.—In ordinary cases the choice lies between water and barley water, and it is not material which is taken. Minor degrees

[1] *Brit. Med. Jour.*, October 21, 1905.

[2] See a paper by England, *Jour. Amer. Med. Assoc.*, October 20, 1906.

of constipation may be alleviated by magnesia. Lime water has a slightly constipating effect, and may be used when there is a tendency to loose stools with passage of curd. When there is vomiting of hard masses of curd the milk should be alkalinized with bicarbonate of soda. Sodium citrate is the most effective addition in cases of flatulent colic associated with the passage of undigested stools, crying, and general discomfort. It finds a sphere of usefulness in enabling a baby to digest a stronger milk mixture than would otherwise be possible, and its low price is a great recommendation.

In modifying milk so as to prevent curd formation it must be remembered that we are in so far eliminating gastric digestion. The function of curd is probably to exercise the musculature of the stomach, and fit it for dealing with solid food. It is well, therefore, to look on all these as temporary expedients, and by their gradual discontinuance to aim at educating the stomach to digest unmodified casein.

II. PEPTONIZED MILK

A very convenient way of preparing a peptonized milk which is well borne by many infants who have difficulty in digesting, or do not thrive upon, ordinary dilutions, is to use peptogenic milk powder, which consists of a peptonizing ferment, bicarbonate of soda, and milk sugar sufficient to raise the amount in cow's milk to the proportion in human milk. Prepared according to the directions, it has a percentage composition of :—

Proteid, 2·09 ; Fat, 4·38 ; Sugar, 7·26 ; Mineral matter, ·26. (Chittenden.)

In composition it thus closely resembles human milk, and the resemblance is increased by the partial peptonizaiton of the proteid. On the addition of rennet and hydrochloric acid peptogenic milk yields a soft, flocculent curd. It is, however, alkalinized with sodium bicarbonate, so that it is probable that in many cases it practically escapes the action of the gastric juice. The percentage of fat is somewhat high, and as a general rule it is advisable to begin with only half or a quarter of the

full quantity of cream, or, if there has been marked gastro-intestinal disorder, to omit it altogether.

On the whole, children do not thrive as well on

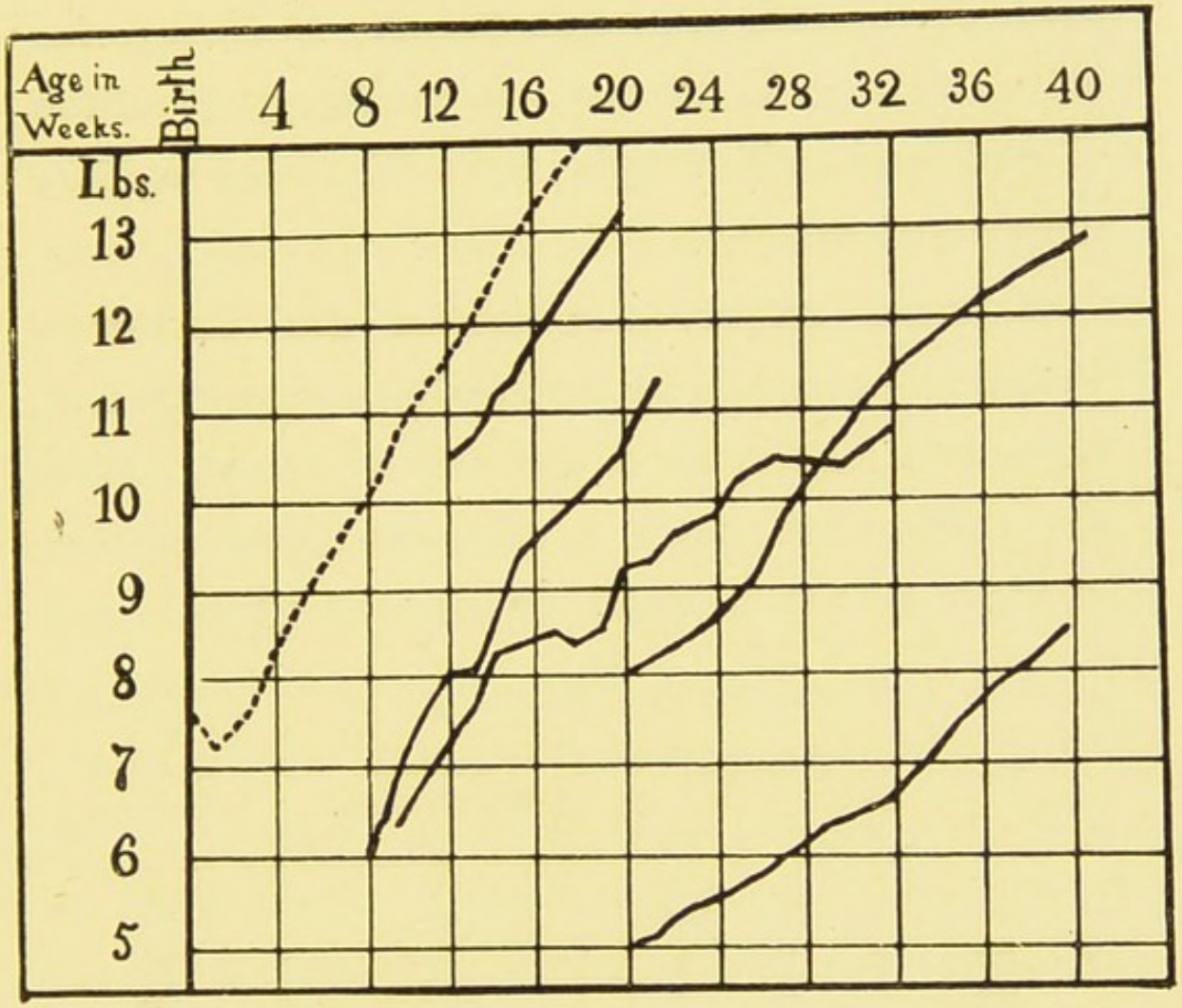


CHART IX.—Five curves of cases fed on Peptogenic Milk. Only two are satisfactory.

peptogenic milk as on ordinary milk mixtures. Though they put on weight fairly steadily, they are very slow in making up what they have lost, and seldom show a good steep curve rising rapidly to

normal. Examples of the results of feeding on peptogenic milk powder are shown on Chart IX. The relatively slow gain is not due to insufficient food, as the following case shows. In fact, owing to the richness in fat and sugar ordinary quantities of peptogenic milk supply more than the requisite number of calories.

Marasmic infant; Constipation and Occasional Vomiting.—Given peptogenic milk, at first with half, then with all the usual quantity of cream. From the thirty-sixth week a milk-and-water mixture, yielding an EQ of about 48, was substituted.

Age.	Weight.		Average Weekly Gain.	Energy-Quotient.
Weeks.	Lb.	Oz.	Oz.	
22	8	1	—	72
23	8	6	+ 5	82
24	8	12	+ 6	80
25	8	12	+ 0[1]	80
26	9	1	+ 5	77
28	9	10	+ 4½	72
31	10	10	+ 5¼	65
39	12	11	+ 2¼	—

[1] Diarrhœa.

Peptogenic milk is, however, a very useful food for young infants with poor digestive powers. It should be discontinued as soon as possible, not because there is any reason to think that predigestion will enfeeble the digestive function, but because it does not seem particularly well adapted to promoting normal growth. Another reason for its discontinuance (at least among the poor) is its price ; to feed a baby on peptogenic milk costs from 3*s*. to 5*s*. additional per week.

In place of peptogenic milk, peptonized milk, prepared with ordinary zyminizing powders, may be used. So far as appearances *in vitro* go, milk peptonized in this way for ten minutes yields a soft flocculent curd very like that of peptogenic milk. If, therefore, peptogenic milk is not tolerated, as shown by the appearance of undigested milk in the stools, it is useless to give milk which has been peptonized for a short time. Milk which has been digested for half an hour gives, *in vitro*, no coagulum on the addition of rennet and hydrochloric acid, and sometimes succeeds where peptogenic milk fails.

The two forms of predigested milk at our dis-

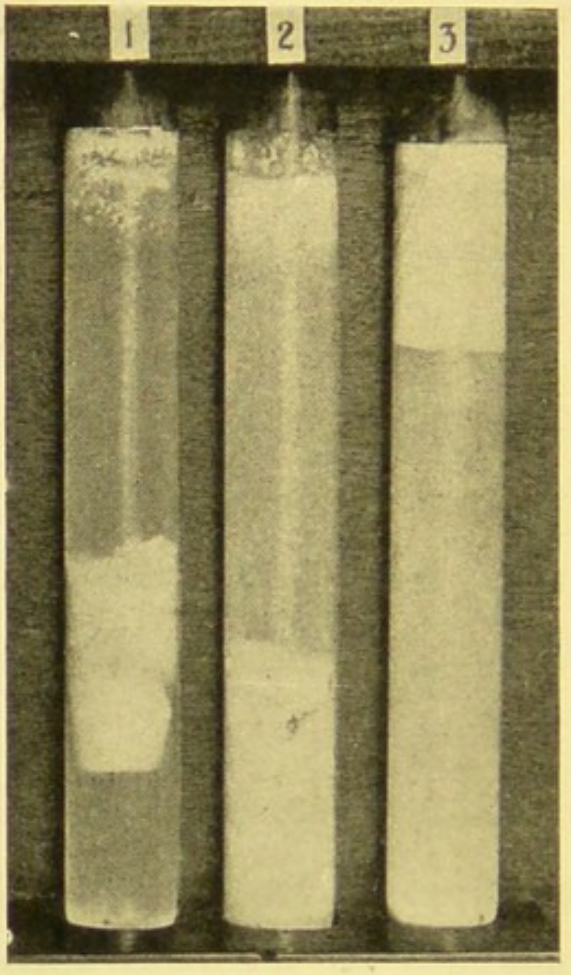


FIG. 15.—*Effect of Peptonization on Formation of Curd:* 1. Peptogenic milk. 2. Milk peptonized with Fairchild's powders for 10 minutes. 3. Ditto, for 30 minutes. All treated for half an hour with 5 drops rennet and 5 drops 1 per cent. HCl at 95° F. The curd in 1 and 2 is almost the same; in 3 no curd has formed (the white layer at the top of the tube is cream).

posal, therefore, are (1) peptogenic milk, and (2) milk peptonized for half an hour in the usual way with Fairchild's peptonizing or zyminizing powders.

III. MODIFICATION OF COW'S MILK IN ORDER TO IMITATE HUMAN MILK—PERCENTAGE FEEDING

In strictness much of what has preceded falls under this heading, but it is convenient here to discuss various plans for so diluting, or adding to, cow's milk as to give a mixture of percentage composition like human milk.

Beginning with the simple addition of water, the

methods culminate in what is commonly known as **percentage feeding**—a method still largely employed in America, and one which can only be carried out in its entirety where special milk laboratories for dispensing prescribed mixtures exist.

It is impossible to think of percentage feeding without recalling the name of Professor Rotch, whose work in improving milk supplies, on milk laboratories, and on the feeding of babies has earned him a well-deserved reputation throughout two continents.[1]

It is important to grasp clearly the principles underlying the evolution of percentage feeding. In the first instance the object was to construct a food chemically the same as what nature yields. As analyses of human milk multiplied, the standard set up for copy varied, and, coincidently therewith, the composition of its imitations changed. At the same time, by the aid of milk laboratories and more or less complicated processes of home modification, it became possible to obtain a wider

[1] Meigs was the founder of the system of percentage feeding, but to Rotch is due the credit of its later development. A sketch of its history, by the latter, will be found in the *New York Med. Jour.*, March 23, 1907.

and more exact range of milk mixtures than heretofore. Soon, however, it was apparent that human milk was an extremely variable food, not only in different women, but at different periods of lactation and even at different stages of one nursing. The theoretical basis of the method was thus shifted, and there is, I think, no doubt that the success percentage feeding has attained is due, not so much to any fidelity with which it imitates human milk, as to the power it places in the hands of the physician of exactly regulating the dosage of the various milk constituents. Percentage feeding as practised to-day seems to proceed on experimental lines. A mixture is ordered which experience has shown to be likely to suit; it is then altered or not according to the indications which arise, and the changes made are precise, not unknown.

Laboratory milk mixtures are not generally available in this country, and I have had no opportunity of using them.[1] Even the rather compli-

[1] They are obtainable in London from the Walker-Gordon Laboratory, 79, Duke Street, Grosvenor Square, and from Welford and Sons, Ltd., Elgin Avenue, W.

cated methods of home modification in vogue in America have not become popular here. In England the need for exactness to within half or a quarter per cent. has never been admitted, and even in America the demand for absolute precision seems to be less than a few years back. Nevertheless it is most desirable to cultivate the habit of thinking of milk mixtures in percentages, realizing, of course, that these are comparative, not absolute, values.

CALCULATION OF PERCENTAGES

For purposes of calculation cow's milk is taken as having a composition of :—Proteid 4 per cent., fat 4 per cent., sugar 4 per cent.

In order to calculate the percentage composition of a given dilution, divide the sum of the constituents of all the volumes of milk by the total volume of the mixture. Thus

Milk, 1 ; water, 1 = 4 ÷ 2 = 2 per cent. proteid, fat and sugar.

Milk, 2 ; water, 1 = 8 ÷ 3 = 2·6 per cent. proteid, fat and sugar.

Milk, 3 ; water, 2 = 12 ÷ 5 = 2·4 per cent. proteid, fat and sugar.

Milk, $3\frac{1}{2}$; water, $1\frac{1}{2}$ = 28 ÷ 10 = 2·8 per cent.

The common error is to divide only by the number of volumes of diluent instead of the number of volumes the total mixture contains.

It is usual to add cream and milk sugar to the diluted milk to raise the percentage of these substances. Twelve ounces (approximately 100 drachms) is a convenient quantity of the mixture to deal with, each drachm of milk sugar or fat added being equal to 1 per cent. Fat cannot be added as cream with any degree of exactitude. Ordinary gravity cream may be looked upon as containing 12 per cent. of fat ; in other words each ounce of cream will equal 1 drachm of fat—the amount which is required for every 1 per cent. by which it is desired to strengthen 12 ozs. of dilute milk. If the cream is poorer in fat—10 per cent.—add 1 oz. to every 10 ozs. of the mixture ; if richer—16 per cent.—add 1 oz. to every 16 ozs. of the mixture and so on, for each 1 per cent. of additional fat desired. It is apparent that in doing this the

calculation is vitiated by the volume of cream added, but as it is seldom necessary to add more than 2 per cent. of fat the error is not great. If centrifugal cream (40 to 50 per cent. fat) be used the error is less on account of the smaller quantity needed.

Another method of obtaining percentage mixtures will be referred to in connexion with the use of top milk. For the present all that I wish to indicate is the desirability of acquiring the habit of thinking about milk mixtures in terms of their percentage composition.

1. PERCENTAGE FEEDING WITH MILK, CREAM, SUGAR, AND DILUENT

Composition of Cream.[1]—Cream differs from milk only in its fat content ; it contains practically the same amount of proteid and sugar as the milk which yields it. It therefore follows that in adding cream to a mixture we are also augmenting the

[1] Cream containing a definite percentage of fat is procurable from the Walker-Gordon Laboratory.

proteid. The fat varies greatly according to the richness of the cream—from 8 or 10 per cent. in poor cream to 40 or 50 per cent. in separated cream. It is usually laden with bacteria.

The following instances will suffice to show the method. The general principle is to begin with low proteid and fat, and gradually to raise these. Our materials are milk, good dairy gravity cream, assumed to contain 12 per cent. of fat, and milk-sugar. We wish to begin with a mixture containing.

Proteid, ·75 ; fat, 2 ; sugar, 6.

To reduce the proteid dilute 3 ozs. milk with 13 ozs. water, which will give ·75 (12 ÷ 16 = ·75). The mixture is now deficient in fat to the extent of 1·25 and in sugar to the extent of 5·25, therefore to every 12 ozs. of the mixture add $1\frac{1}{4}$ ozs. of cream and $5\frac{1}{4}$ drachms of sugar (say $\frac{3}{4}$ oz.). The resulting mixture will have approximately the desired composition.

In another case we wish to give—

Proteid, 1·5 ; fat, 2·5 ; sugar, 5.

Dilute two parts of milk with three parts of water

(8 ÷ 5 = 1·6, which is near enough for practical purposes) to reduce the proteid. The mixture lacks fat by 1 per cent., hence add to 12 ozs. 1 oz. of cream; and sugar by 3·5 per cent., hence add 3½ drachms (say ½ oz.) of milk sugar.

With a little practice it is easy enough to prescribe milk mixtures in this rough way, and one gains thereby a more definite idea of what is being given than by thinking only of so many ounces of milk and teaspoonfuls of cream in each bottle.

2. THE USE OF "TOP MILK"

Another and probably better way of attaining the same object is by the use of top milk, as advised by Chapin and others. It depends on the fact that when milk is allowed to stand for six or eight hours in a tall vessel until the cream rises, a definite distribution of fat throughout the different strata of milk takes place, and by collecting different quantities from the upper layers of the milk, or by siphoning off the lower part, creams of any desired composition can be obtained at will. The

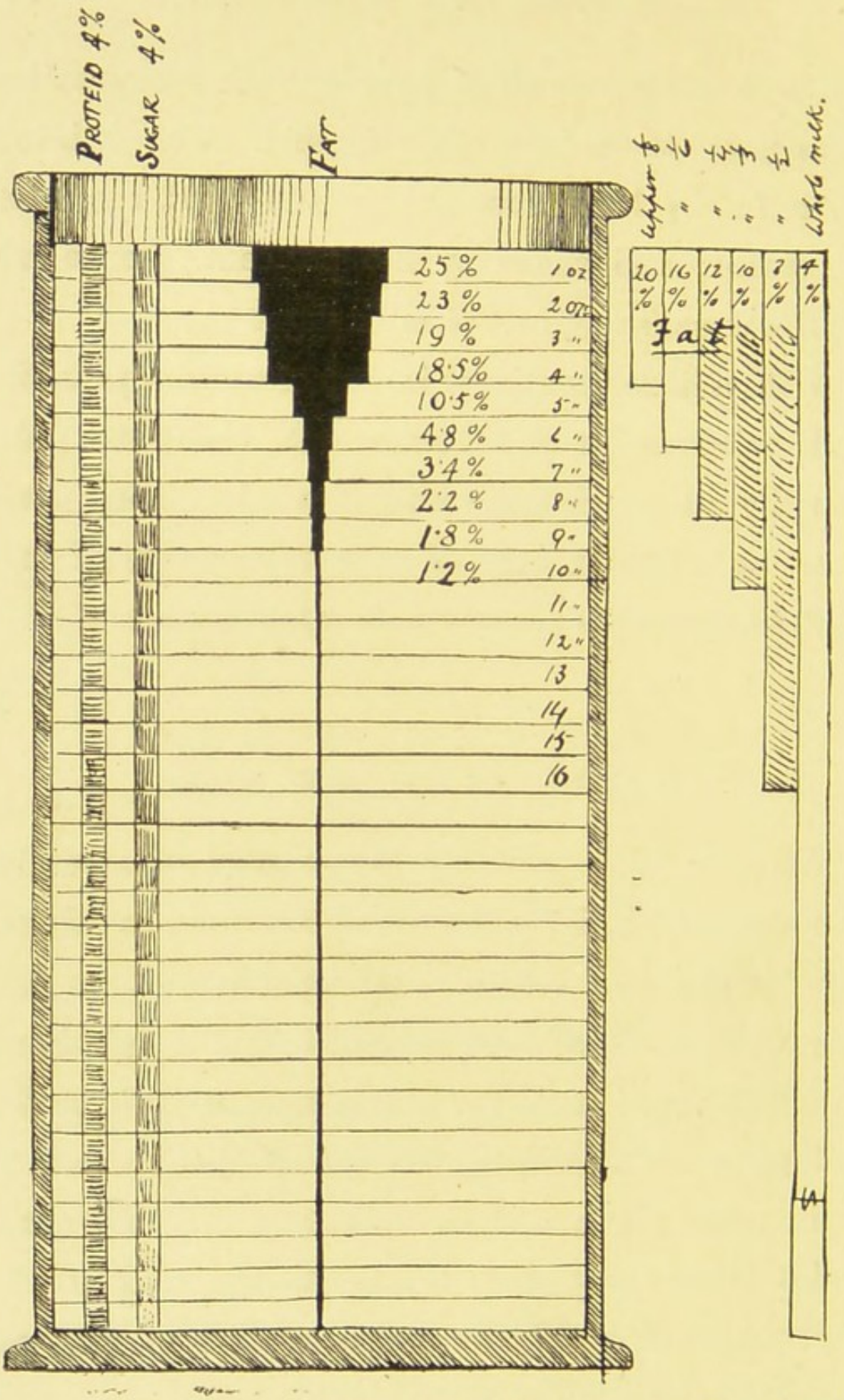


FIG. 16.—Distribution of constituents of milk after standing for 6 hours. (After Chapin's figures.)

percentage of sugar and proteid remains constant at 4.

The principle of top milks will be readily understood from the diagram (Fig. 16), which shows the proportion of fat in each ounce of milk in a 32 oz. jar after the cream has risen. The upper $\frac{1}{8}$ is made up of 20 per cent. cream; upper $\frac{1}{5}$ of 16 per cent. cream; upper $\frac{1}{4}$, 12 per cent. cream; upper $\frac{1}{3}$ of 10 per cent. cream; upper half, of 8 per cent. cream. To remove the upper layers of cream a dipper (Fig. 17) of 1 oz. capacity is used.

FIG. 17.
Chapin's Milk Dipper.

The accompanying is a simple scheme [1] showing how top milks are used. The composition of the food at different ages is a modification of Rotch's "Theoretical Basis for feeding a healthy infant." [2]

[1] Detachable copies of this table will be found at the end of Appendix.

[2] *Pediatrics*, 5th ed. London, p. 196.

Milk containing 4% fat. 1 oz. milk sugar=2 level tablespoonfuls.

	Proteid.	Fat.	Sugar	Ratio of Proteid to Fat.
Upper fourth	4	12	4	1 : 3
,, third	4	10	4	2 : 5
,, half .	4	8	4	1 : 2

Diet During :—					Top Milk.	Dilu-ent.	Sugar.
1st week .	·5	1·5	5	Proteid-fat ratio 1 : 3 (upper fourth milk)	1	7	1 oz. to pint
2nd ,, .	·65	2·	6		1	5	,, ,,
3rd ,, .	·8	2·5	6		1	4	,, ,,
4th–8th week	1·	3·	6		1	3	,, ,,
3rd month .	1·25	3	6	Proteid-fat ratio 2 : 5 (upper third milk)	1	2	,, to 24 oz.
4th ,, .	1·4	3·5	7		6	11	,, to pint.
5th month .	1·7	3·5	7	Proteid-fat ratioi 1 : 2 (upper half milk)	3	4	,, ,,
6th–10th ,, .	2	4·	7		1	2	,, ,,

It will be seen that from three top milks only—upper fourth, upper third, and upper half, it is possible by simple dilution and the addition of sugar to prepare mixtures which have approximately

the desired composition. The sacrifice of absolute accuracy to simplicity is probably less than the inexactitude which necessarily results from variations in the richness of the milk.[1]

THE USE OF WHEY

Percentage Feeding with "Split Proteids."—A further refinement introduced into percentage feeding consists in an attempt to render cow's milk proteid qualitatively as well as quantitatively like that of woman's milk. This is done by the addition of enough whey to raise the soluble proteid to the level of or above the casein. The calculations are necessarily elaborate, and several tables, and mechanical devices on the principle of the slide rule, have been constructed to simplify matters.

Humanized Milk.—The principle of diluting with whey is a very old one, and various "humanized milks" of this kind have been recommended. A simple method of preparing humanized milk is as follows:—Allow a pint of milk to stand until the

[1] It should be remembered that in this country the percentage of fat in milk is often nearer three than four

cream has risen ; skim it, and set the cream aside. To the skimmed milk add rennet, and when it curds strain off the whey. Boil the whey (to destroy the rennet) and add it, with the cream, to a pint of fresh milk. Sterilize as usual. In this mixture the proteid is reduced by nearly half, and the ratio of casein to soluble proteid is lowered—it is, in fact, milk with half its casein removed. At one time I frequently used milk humanized thus, but have not done so now for a number of years. It is troublesome to prepare, and with children with delicate digestions (who alone require such mixtures) the same result can be obtained more simply otherwise.

" Humanized milk " is obtainable commercially (Fig. 18).

Whey.—Whey is an article of the greatest value in feeding infants. Beginning with whey, to which some milk-sugar has been added, the nutrition can be maintained wonderfully well for a time, and by cautious additions of cream or milk we can gradually educate the child's digestive powers to deal with a more suitable food.

Whey is prepared by adding a teaspoonful of rennet to a pint of fresh milk and keeping at a temperature of about 90–95° F. until curding takes

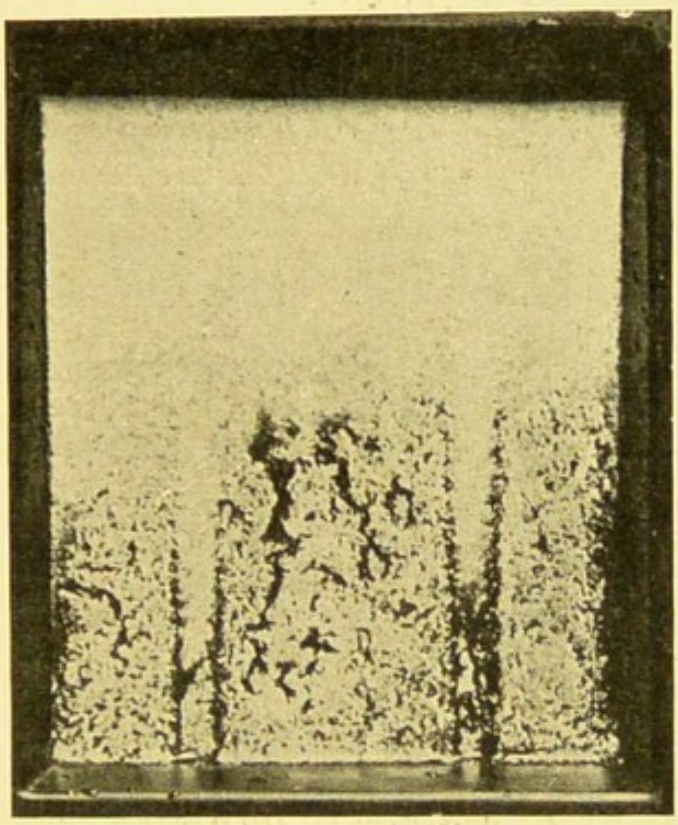


Fig. 18.—Commercial "Humanized" Milk; 1 oz. incubated for half an hour at 95° F. with 5 drops rennet and 20 drops 1 per cent. HCl. Copious, but very fine coagulum. With smaller quantities HCl no curd; milk is evidently alkalinized.

place. When firm, the curd is broken up thoroughly with a fork, and the whey decanted, or strained off through one or two thicknesses of muslin. Fresh, not boiled milk, should be used, as a better

curd forms. After the whey is strained, it should be pasteurized or boiled to kill organisms and destroy the rennet. Boiling coagulates the soluble albumin, while pasteurizing has no such effect. This, however, is not of much consequence. The coagulum which forms when whey is boiled remains suspended in the liquid in a state of such fine division as not to be difficult of digestion (Fig. 19). On the other hand, if the milk be boiled before rennet is added the coagulum of whey proteid must get entangled in the meshes of the casein curd, and probably in part remains behind upon the strainer.

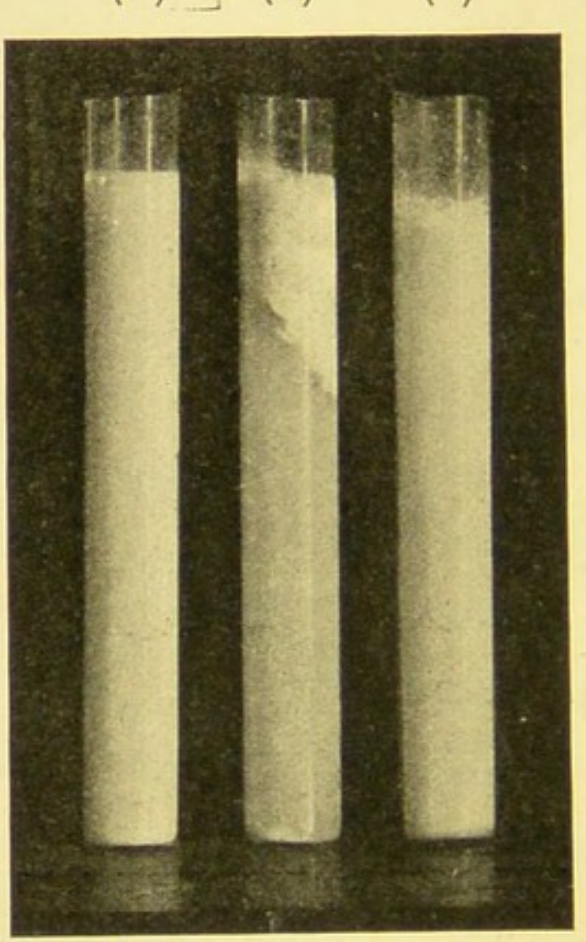


FIG. 19.—Whey—(*a*) unboiled, (*b*) boiled, showing light coagulum which separates, but (*c*) diffuses through whey on shaking.

Whey has the following composition :—

Water	93·64	—	From 10 oz.
Proteid	·82	(·7 to 1)	of milk
Fat	·24	(·24 to ·3)	7 oz. of
Sugar	4·65	(4·5 to 6)	whey can
Mineral	·65	—	be obtained

(*Hutchison.*)

White Wine Whey.—In making wine whey sherry instead of rennet is used to coagulate the casein. Myers and Still [1] point out that as curding is due to the acidity of the wine, cheap cooking sherry should be used rather than a table wine. Prepared according to their method,[2] sherry whey contains—

Proteid, ·45; fat, ·95; sugar, 5; alcohol, 2·5 per cent. by weight.

It differs from whey chiefly in being richer in cream, which is due to the less perfect coagulum not entangling so much of the fat in its meshes, and in containing alcohol, which enhances its fuel value. One ounce of sherry whey is equivalent to about 25 drops of brandy.

Sherry whey is often useful in gastro-intestinal

[1] *Lancet*, January 12, 1907. [2] Appendix, p. 210.

disorder, and in weakly infants who cannot digest casein. It may be given in small feeds, somewhat frequently—half an ounce every half-hour—increasing both quantities and intervals as the case improves.

On the whole, I generally prefer to order plain whey, and give brandy separately if need be. Alcohol is an extremely valuable food and drug in acute diarrhœa, but its dosage requires to be carefully regulated by results, and this is not very easy when it is given in the form of wine whey. As a rule, also, by the time it is safe to give a child attacked by acute diarrhœa milk in any form, the need for alcohol is over.

BUTTERMILK

In Holland buttermilk has been used as an infant food since the eighteenth century, and has some very enthusiastic advocates.[1] In my hands it has not shown all the virtues which have been ascribed to it, and it is certainly not a panacea for all digestive

[1] Tugendreich's monograph (*Berliner Klinik*, Heft 219, September, 1906) is a useful summary.

troubles, but at the same time it is occasionally very serviceable. I cannot lay down any absolute rules as to the class of case in which it should be given, further than to say that it may be tried with fair prospect of success in any form of chronic gastro-intestinal disorder, and that sometimes the results are eminently good. Children like it, or at least soon become accustomed to it; the stools improve, and the weight goes up. I have never needed to continue it for more than three or four weeks, so that I have not seen the failure of nutrition described after its prolonged use. Possibly the reason why my results have not been better is that I have had to depend on the ordinary commercial article, while in countries where it is in greater demand it is specially prepared for the feeding of infants. I have also used it only in patients admitted to the hospital, and these, as a rule, are bad cases, in which home treatment has failed.

Buttermilk has an average composition of—

Proteid, 2·6; fat, ·6; sugar, 3.

It contains lactic acid in abundance, and swarms with lactic acid bacteria. For a regular daily

supply of fresh buttermilk (it should not be used when over twenty-four hours old) we must go to a large creamery ; in small dairies butter is not made every day. Commercial buttermilk thus procured showed a very constant degree of acidity from day to day [1] ; it is advisable to test the supply in this way before recommending it. The difficulty of obtaining it fresh and of good quality is probably the chief reason why it is not more used.

Looking to the disastrous effects of giving milk which is turning sour, it may at first sight seem irrational to use milk which has undergone lactic acid fermentation. The contradiction, however, is only apparent.

In the first place, sour milk contains all sorts of bacteria ; in buttermilk the lactic acid bacteria have overcome all the rest. Secondly, whereas the action of gastric juice on partially soured milk produces an abnormally tough curd (paracasein

[1] The average of five samples tested at the Laboratory of the Royal College of Physicians was ·711 per cent. lactic acid, the individual figures being ·756, ·738 (twice), ·711, and ·630.

lactate), in buttermilk all the casein is already converted into a finely divided curd (casein lactate) on which rennin has no further effect (p. 24).

Buttermilk differs from fresh milk in four particulars :—

1. Its proteid and sugar are low, and its fat very low.

2. The casein is coagulated in the form of casein lactate.

3. It contains much lactic acid.

4. It swarms with lactic acid bacilli.

An explanation of its success has been sought in each of these, but I think that it is chiefly to its low fat, and to the absence of coagulable casein that we must look. The lactic acid has been thought to aid digestion. Of this there is no evidence, and the fact that good results have been got from alkalinized buttermilk is against its having much to do with it. More plausible at first sight is the suggestion that its effects depend on the inhibition of abnormal intestinal fermentation by the lactic acid bacilli. As a matter of fact, however, it is always given pasteurized or boiled. I have not found that raw buttermilk agrees with babies, and

this is the common experience. The conclusion is unavoidable, therefore, that buttermilk is useful by reason of its peculiarities as to proteid and fat.

Method of Preparation.—The sugar requires augmentation by 3 per cent.; this is effected by adding an ounce of cane sugar to every pint and a half of buttermilk. It is also customary to add half an ounce of flour. The reason for the latter will be apparent to any one who tries the experiment of boiling buttermilk and sees the gritty, indigestible agglomerations of curd which form. Flour is added to prevent this; it is stirred into a thin paste with a little of the sweetened milk, and then the remainder is added. The whole is boiled, being diligently stirred the while, so as to keep the curd in a fine state of division. I have not tried enriching the fat by adding cream, as I regard the low fat as advantageous. If the stools give evidence of carbohydrate decomposition (*v.* p. 156) lactose may be substituted for cane sugar.

The quantities required are very much the same as in the case of other foods. In making a change from buttermilk to fresh milk it is advisable to proceed

cautiously, as diarrhœa may be set up. The following tables show the progress of two marasmic infants with chronic gastro-intestinal disorder, who thrived fairly well on buttermilk modified as above.

The low energy value of unmodified buttermilk is apparent.

CASE 1

Age.	Weight.		Average Weekly Gain.	Energy-Quotient.	Food.
Weeks	Lb.	Oz.	Oz.		
19	9	8	—	54	Boiled buttermilk.
20	9	10	+ 2	70	,, ,, (with flour and sugar)
21	10	2	+ 8	64	Do.
22	10	6	+ 4	62	Do.
23	10	8	+ 2	61	Do.
24	10	10	+ 2	61	Do.

CASE 2

35	9	10	—	33	Butter-milk, 40 oz.
36	9	2	−8	77	,, ,, (with flour and sugar)
37	9	10½	+ 8½	73	Do.
38	10	1	+ 6½	—	Milk and water.
		Diarrhœa			
39	9	12	−5	—	—

Artificial Buttermilk.—Owing to the difficulty of procuring a standard natural buttermilk of good quality attempts have been made to produce it artificially by adding cultures of lactic acid bacteria, which are now obtainable commercially. My limited experience of these has not been encouraging. Some samples seemed almost inert; the product of others was decidedly inferior to the natural article. The process of churning by which the curd is finely divided cannot well be imitated.

In Germany conserves of buttermilk are much used.

CONDENSED MILK

In some circumstances condensed milk is very useful. When fresh milk disagrees, particularly when there is much vomiting, condensed milk is sometimes well borne. It is also useful during sea voyages when fresh milk cannot be procured.[1] It should be clearly understood that it must be looked upon as a temporary food.

There are three forms of condensed milk—

[1] See Appendix, p. 206.

unsweetened whole milk, sweetened whole milk, and sweetened skim milk. The last contains so little fat as to be unsuitable for infants. The process of manufacture consists in removing by evaporation about two-thirds of the water originally present in the milk; sometimes cream is added and in the sweetened form, cane sugar.

The composition of the principal brands is shown below:—

	Proteid.	Fat.	Milk Sugar.	Cane Sugar.
Unsweetened:				
Ideal	8·3	12·4	16	—
First Swiss	9·7	10·5	14·2	—
Viking	9	10	13·3	—
Hollandia	11·3	9·8	18·5	—
Sweetened:				
Nestlé	9·7	13·7	15	37·2
Rose	8·3	12·4	17·6	36·1
Milkmaid	9·7	11·	14·6	38·7
Full Weight	12·3	11·	13·5	37·2
Anglo-Swiss	8·8	10·8	16	37·1

(*Pearmain and Moore's Analysis.*) [1]

[1] Quoted by Hutchison. The chief producers of condensed milk are now controlled by a single company.

If unsweetened condensed milk be diluted with about two parts of water the mixture corresponds fairly well to ordinary milk of good quality. On account of the cane sugar it contains, sweetened condensed milk requires to be further diluted in order to make it drinkable. The brands which I have used are Ideal, Nestlé, and Milkmaid, diluted, as a general rule, in the case of the first-named, with two to three parts of water, in the other two with 3 ozs. of water to one or two teaspoonfuls. Theoretically, no doubt, unsweetened is preferable to sweetened milk, but as neither should be used except as a temporary food, there is not much to choose between them. Unsweetened milk does not keep well, but the contents of one tin (10–11 ozs.) diluted with a pint of water is just about a day's ration, hence a fresh tin should be opened daily. By punching two holes in the tin the contents can be poured out as required without removing the lid and exposing the milk to the air. In ordering ordinary dilutions of sweetened milk it must be remembered that owing to its viscosity a " teaspoonful " is a considerable quantity. Two full teaspoon-

fuls of Nestlé's milk (including what adheres to the outside of the spoon) added to 3 ozs. of water yield a total volume of a trifle under 4 ozs. Milkmaid brand is even more viscous, and a teaspoonful of it amounts to nearly $\frac{3}{4}$ oz. by volume.

Estimation of the fat [1] in the following mixtures gave :—

	Fat.	Proteid (calculated).
	Per cent.	Per cent.
1. Ideal, 1 part, water 2 parts. .	4·2	2·6
2. Nestlé, one teaspoonful, water 3 oz.	2·5	1·8 [2]
3. Nestlé, two teaspoonfuls, water 3 oz.	4·	—
4. Milkmaid, two teaspoonfuls, water 3 oz.	3·1	2·8

Making allowance for the uncertainty of measurements by teaspoonfuls, the results coincide fairly closely with Pearmain and Moore's analyses.

[1] By Gerber's butyrometer.

[2] Hutchison states that a mixture of 1 teaspoonful of Nestlé's milk in 6 tablespoonfuls of water has a composition of proteid, 2 ; fat, 1·6 ; sugar, 8·17 ; ash, ·34 (*Lectures on Diseases of Children*, London, 1904).

There is no doubt that such mixtures are more digestible than ordinary milk. From a clinical point of view I should place them on a level with

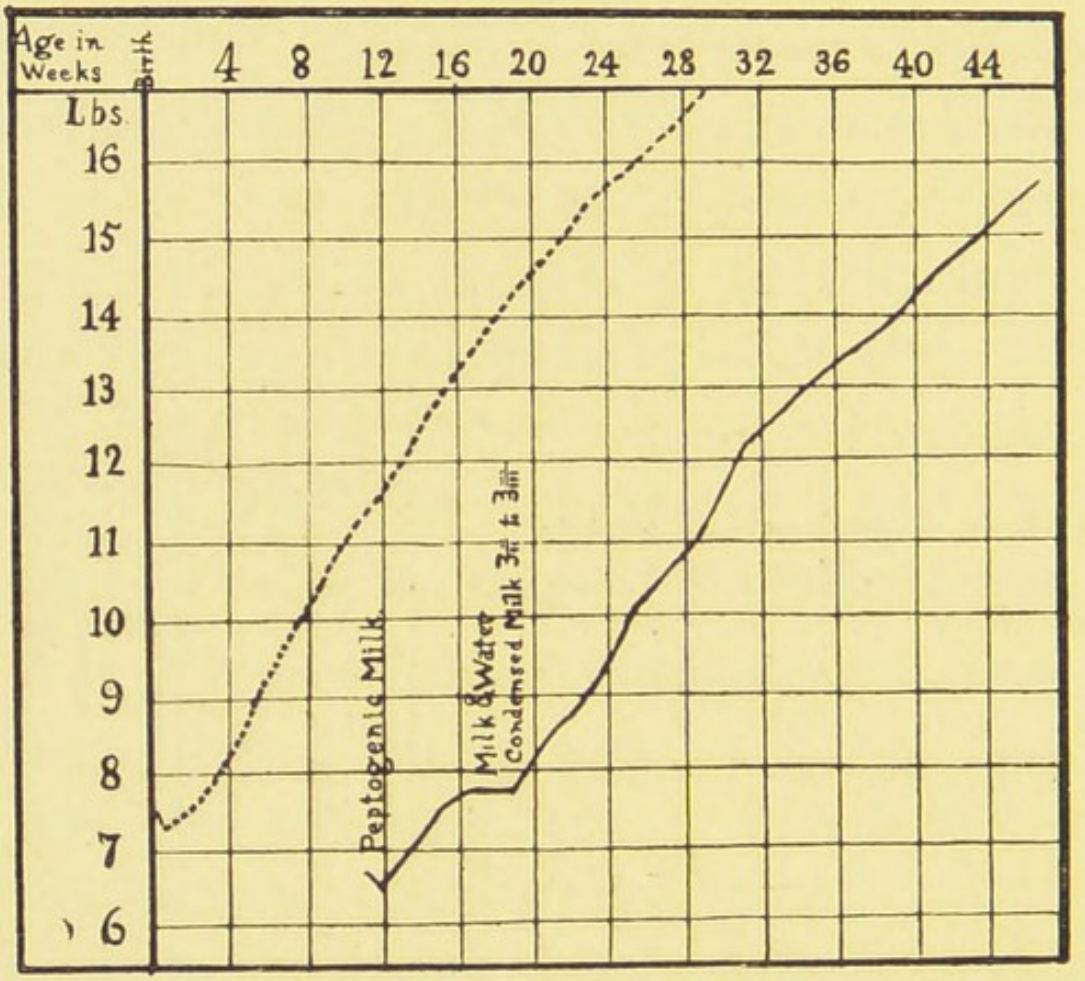


CHART X.—Breast feeding for a month, then sterilized milk mixture from a milk depot for two months; wasting, vomiting, and constipation. Nestlé's milk agreed well.

peptogenic milk in this respect. With rennet and hydrochloric acid (*in vitro*) curding is either very slight or absent, and I do not find that adding more acid affects the result. The disadvantage of con-

densed milk is that it is apt to produce scurvy, and, in the case of the sweetened form, the large amount of cane sugar it contains. In the long run, children fed on condensed milk are apt to be flabby, and to suffer from rickets. It is probably safer to boil

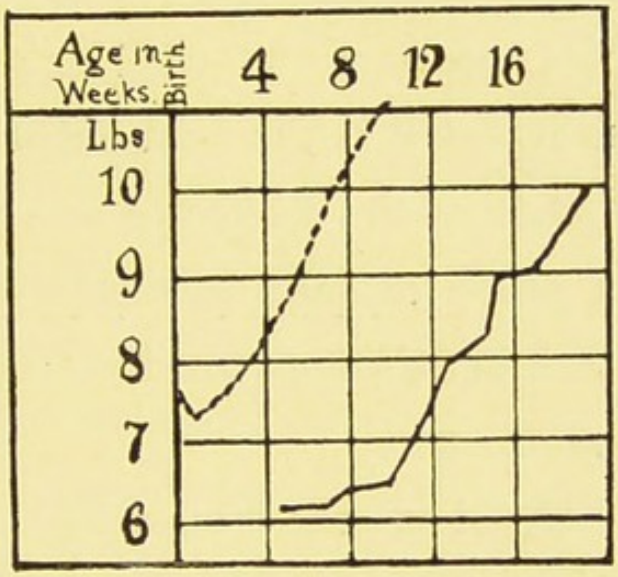


CHART XI.—Vomiting and diarrhœa on boiled milk and water. Condensed milk agreed well.

condensed milk mixtures before use, though, as a rule, no evil follows the neglect of this precaution.

In feeding an infant on condensed milk, therefore, the main thing is to select a brand which is rich in fat, and to discard condensed skim milks. Unsweetened milk should be diluted with from two to four times its bulk of water, sweetened milk with 3 ozs. of water to the full teaspoonful. Opened

tins of milk should be kept in a cool place, and it is best to use a fresh one daily. As compared with fresh milk they are not economical foods, the mixtures prepared for use costing from 3*d*. to 4*d*. a pint.

ALBUMIN WATER

When it is necessary to withdraw milk altogether, albumin water is the best substitute. It is prepared by shaking the whites of one or two eggs, along with a pinch of salt, in half a pint of cold water, and straining through muslin. It is warmed, not boiled, before use.

White of egg has the following composition (Hutchison) :—

Proteid, 12·6, fat, ·25 ; ash, ·59 ; water, 85·7.

Hence albumin water prepared as above contains from 1 to 2 per cent. of proteid. For general use the weaker solution is best ; it is given in the usual quantities at ordinary intervals. I generally add to it milk sugar in the proportion of one level tablespoonful to 10 ozs. As a rule it is inadvisable to limit the diet to albumin water for more than five days, though if the weight be fairly well maintained

it may be continued for a day or two longer. Sometimes a mixture of albumin water and Mellin's or Savory and Moore's food is serviceable as a temporary diet in summer diarrhœa after the acute stage is over, and cream may be added in small amount, so as gradually to pave the way for a return to milk.

BEEF JUICE AND MEAT BROTHS

Raw beef juice, and meat broths such as veal, chicken, and mutton tea are sometimes used as milk substitutes, or to enrich the diet in proteid. Their usefulness is very limited. Raw meat juice, prepared by extracting lean minced beef with its own bulk of water, and straining under pressure through muslin, contains $5\frac{1}{2}$ per cent. of coagulable proteid (Hutchison)—less than half what is present in egg albumin. The usual practice is to add a teaspoonful (one and a half drachms) of raw meat juice to each feed ; in the case of 3 oz. feeds this means about ·3 per cent. of proteid.

Raw meat juice is expensive, troublesome to prepare, and keeps badly ; it does not seem to have

any advantage over egg albumin, except that it is certainly anti-scorbutic.

Neither veal, chicken, nor mutton broth has much to recommend it. Albumin water is a perfectly satisfactory substitute.

PROPRIETARY INFANT FOODS

The value of proprietary infant foods[1] is extremely small, and were it not that they are widely used, and still more widely advertized, it would scarcely be necessary to mention them. They may be divided into three groups :—

1. Dried milk foods.
2. Malted starches.
3. Unaltered starch.

The dried milk foods differ little from condensed milk, and the sole advantage they present over it is that they keep better and are less liable to bacterial contamination (cf. footnote, p. 172). A typical member of this group has the following composition :—

Allenbury No. 1 : proteid, 9·7 ; fat, 20 ; carbo-

[1] A Table of the most important is given in the Appendix.

hydrate, 60·85 ; ash, 3·75 ; water, 5·7. (Hutchison.)

Some members of the second group (e.g., Mellin) are completely malted ; in others the conversion of the starch is not wholly accomplished until the food is prepared for use. All are very poor in fat, as the following instance exemplifies :—

Benger's Food : proteid, 10·3 ; fat, 1·4 ; carbohydrate, 83·2 ; ash, ·6 ; water, 4·5. Members of the third group consist of unaltered starches, e.g. :—

Ridge's Food : proteid, 9·2 ; fat, 1· ; carbohydrate, 81·2 ; ash, ·7 ; water, 7·9.

Most proprietary foods are inadequate, usually in fat ; all are liable to produce scurvy. Claims that they are identical with human milk are wholly illusory. While it cannot be denied that some infants thrive well on these foods, it is far safer to avoid them altogether.

It is never necessary to use desiccated milks ; the same results can be got with ordinary condensed milk. The following example shows how closely the two preparations resemble each other as made up for use :—

	Proteid.	Fat.	Sugar.	
Nestlé one teaspoonful to 3 ozs. water	1·8	2·5	9.5	
Allenbury No. 1 . .	1·56	2·3	7·2	(Hutchison.)

Foods of the second group are perhaps more useful; they must be looked on merely as temporary substitutes for, or additions to, milk. They can be employed to make malted cereal decoctions for use as diluents, or may be added to a diet of whey or albumin water in order to enrich it. Foods of the third group should not, as a rule, be given before the eighth or ninth month, when such preparations as oat flour are commonly added to the diet.

CHAPTER V

Diet in Abnormal Cases—Physical Examination—History of Case—Examination of the Stools—I. Young Infants who do not thrive on Ordinary Mixtures—II. Failure of Nutrition—Marasmus—III. Gastro-intestinal Disturbance—Vomiting, Diarrhœa, Constipation.

It is often far from easy to diet successfully a baby which is not thriving or has feeble digestive powers; fortunately, such cases are in a minority among infants whose diet has been properly supervised. Success in treating these cases cannot always be looked for, and it is impossible to lay down rules as to diet which will prove applicable in every case. Each patient requires individual study, and if we first conscientiously try to discover what is wrong, and where the difficulty of digestion lies, and, second,

intelligently prescribe an appropriate diet, we at least have the satisfaction of knowing that we are proceeding on rational lines.

Looking at cases of this kind as they are met with in practice, we can divide them into three groups. *First*, we have the newly-born infant whose diet, regulated according to the principles described in chapter III, proves unsuitable and requires modification. *Second*, we have infants brought to us with the complaint that they are not thriving—in these the digestive disturbance, though seldom altogether absent, is thrown into the background by the failure of nutrition. *Third*, we have cases of obvious gastro-intestinal disturbance, chronic or acute.

Before we can institute proper treatment, we must know what is wrong, and this can only be found out by inquiring carefully into the history of the previous feeding, and by a physical examination, including inspection of the motions. Physical examination must not be omitted ; true, it is often negative, but, on the other hand, an organic disease—e.g., abdominal tuberculosis or intussusception—

may be overlooked through failure to examine the abdomen.

It is essential to go thoroughly into the history, not only as regards the composition of the food, but the way it is prepared, the intervals at which it is given, the method of storing milk, the degree of cleanliness which is attained—in short, all the ordinary routine of feeding should be reviewed. It is an advantage to see the baby in its own surroundings, as errors of management which might otherwise be overlooked are then less likely to escape detection. Having heard the mother's story out, ask "Is that *all* the baby gets?" because unconsidered trifles of food may be doing the mischief yet not be thought worthy of mention. Another point to be considered in this relation is the personality of the baby's nurse. Sometimes one is absolutely baffled in treating an infant until there is a change in the attendant, and quite frequently it will be found that where a good nurse is introduced difficulties disappear as if by magic, and the peevish infant, who vomited his meals, cried incessantly to be fed in the night watches, and was alike an

anxiety to his mother and an annoyance to the doctor, settles down into a blissful state of contented babyhood.

If we are lucky enough to discover some obvious error in the diet or management of the baby, it is usually sufficient to correct this, and to lay down strict rules as to diet on the ordinary lines. The quantities should be on the small side. The infant ought to be weighed, and at the end of a week the diet is changed if need be, according to the result of a second weighing. A point I wish to emphasize here applies to all cases. *Do not make changes in the diet too frequently, or without reason.* Unless a baby is seriously ill a week or fortnight's fair trial should be given to any food. If the diet be altered every day or two nothing but disappointments will follow.

In infants suffering from wasting and indigestion a gain in weight cannot be expected until the digestion improves. We must be satisfied in the first instance if the diet agrees ; usually, when this is the case the weight will soon begin to go up. Children of this class require to be nursed a good deal ; they

do not bear lying in a cot for the greater part of the day so well as a healthy child does. This seems to me to be the reason why such cases often get on better in comparatively unhygienic homes, provided the mother is intelligent and careful, than under the apparently better sanitary conditions of a hospital ward.

It is desirable that they should have as much fresh air as possible, and it is equally important to prevent chilling, particularly of the abdomen, either in or out of doors. Soiled napkins should be changed immediately, and in cold weather there should be a hot water bottle in the cot or perambulator.

EXAMINATION OF THE STOOLS

The habit ought to be formed of periodically inspecting the motions of every baby whose feeding is being supervised. If they are healthy in appearance digestion is probably normal, while abnormal motions show that something is wrong, though, unfortunately, they seldom tell exactly what it is. Up to the present I have found microscopic examination of the stools singularly barren of practical

results, and shall not refer to it farther. The most useful, and also easily obtainable, information is derived from inspecting the motions, and testing the reaction to litmus.

Normal Stools.—1. **Meconium.** During the first few days after birth the motions (meconium) are of a dark greenish brown or black colour, and consist of mucus and epithelium from the intestine, as well as particles of vernix caseosa and epidermis swallowed *in utero* along with the liquor amnii. The colour is due to bile. 2. **Motions in breast-fed infants.** As the meconium is excreted the stools gradually—by the sixth or seventh day—assume the bright yellow colour characteristic of breast feeding. They are perfectly uniform in consistence, moderately coherent, have a faint, not unpleasant odour, and in colour closely resemble the yolk of egg. Their reaction is faintly acid, from the presence of lactic and fatty acids. 3. **In infants fed on cow's milk** the variations in colour are considerable. The stools ought to be pale yellowish white, homogeneous, rather more coherent than in breast-feeding, and feebly alkaline in reaction.

During the first month a healthy infant should have three or four motions daily; after this time, one or two. The stools do not become brown and properly formed until starchy food is taken.

It is unnecessary to enumerate all the abnormalities of the fæces, many of which are of importance in the diagnosis of disease, but have no special bearing on the question of diet. The chief drugs given in infancy which discolour the motions are bismuth (dirty greenish to black), grey powder and calomel (green), and such tannic acid preparations as tannigen, tannalbin, etc., which give a dark greyish-brown colour.

In examining the stools the following matters should be noted: 1. **Homogeneity.** Normal motions are homogeneous. Whitish masses in a yellow or greenish matrix show that the milk is not being properly digested. They are commonly called "curd," but they really consist of soaps, fat, and salts, as well as casein. Such white masses appear even in the stools of babies fed on fully peptonized milk, and under these circumstances cannot, of course, contain casein. They yield no

further information than that the child is unable to digest the mixture he is getting, either because it is excessive, or by reason of its composition.

Neither should the stools contain mucus in any perceptible amount. Visible shreds of mucus are a sign of irritation of the lining membrane of the bowel, especially of the colon. More or less visible mucus occurs in all loose stools, and sometimes the evacuations consist almost wholly of mucus. Such motions, if small and frequent, particularly if blood-stained, are indicative of ileo-colitis, which is always a serious affair. On the other hand, one sometimes sees a very large stool composed entirely of slightly bile-stained mucus, and as a rule these are not serious. Their size shows that the bowel is not in an irritable state, or it would have expelled its contents before such an accumulation took place. They are often seen in older infants suffering from diarrhœa due to careless feeding, and it is surprising how soon things mend on a régime of diluted milk.

2. **Colour.**—The motions may be paler or darker than normal; they may be green, or they may be discoloured by drugs. The last point has already

been referred to. **Pale stools** are frequently seen. Pallor is often due to excess of fat, and possibly deficiency of bile may also be to blame, although in most cases it is difficult to apportion the part each plays. Small, pale, rather dry stools are often passed by babies who are thriving fairly well, and are not of much importance. Large pale or white stools are always, I think, evidence that the fat in the diet is excessive. One sometimes sees veritable "fat diarrhœa" in which four or five large white pultaceous motions resembling cream cheese occur daily. These are markedly acid in reaction and sometimes contain needle-like crystals of fatty acids. They occur when too much of a food rich in fat—e.g., peptogenic milk—is given.

Dark Motions.—Dark yellow motions are generally fluid, not very large, and often contain mucus. In babies fed on albumin water or whey the stools are watery, brownish-yellow, or tinged with green, and do not assume the usual fæcal character. It is therefore useless to wait for the motions to become normal before returning to a milk diet ; it is enough if their number diminishes to three or four in the day,

and if noticeable mucus disappears. When starchy food is taken the stools become darker.

Green stools are not uncommon. It is necessary to distinguish between those which are green as they are passed, and those which become so only on exposure to the air. This is easily done by breaking down the motion so as to expose its interior, which, in the latter case, will be found to remain yellow, though the superficial part has become green. Provided such stools are normal otherwise, the discolouration is of no moment. Motions which are green as they are passed are usually loose, and contain mucus and "curd." The green colour is due to altered bile; possibly in some cases it is caused by bacterial fermentation. Green stools occur in all forms of gastro-intestinal disorder, especially in chronic and subacute cases.

Number and Consistence.—The more fluid the motions, the more frequent, as a rule, are they, and *vice versa*. When diarrhœa exists it is important to try and form some estimate of the total loss of fluid. Large liquid motions indicate that the small intestine, chiefly, is affected; smaller, very

frequent evacuations of mucus show implication of the colon. In either case the indication is to cut off milk altogether. Constipated motions should be carefully examined, as they often call for some change in the diet. A greasy, glistening appearance when broken down, with an acid reaction, points to excess of fat, and possibly of casein also. On the other hand, when the stools are pale and crumbly, and do not appear to contain fat, the constipation may be relieved by diminishing the casein and increasing the cream in the food. On the whole, constipation is associated with over-feeding rather than the reverse; stools of the last variety occur in infants fed on too large amounts of undiluted milk. Very small constipated motions occur in marasmus, and in congenital hypertrophy of the pylorus.

Odour.—In health the evacuations have not an unpleasant odour. Putrid stools are occasioned by proteid decomposition; sour-smelling stools owe their odour to fatty acids. In carbohydrate fermentation the stools are frothy and sour-smelling. Buttermilk stools are frequently ammoniacal;

sometimes they have the sour odour of lactic acid.

Reaction.—Slight alterations in the reaction afford little guidance. Almost any unhealthy stool may be amphoteric instead of alkaline. Excessive alkalinity is due to proteid decomposition ; acidity, to the splitting up of fat and carbohydrate. When the motions are extremely acid, causing scalding or actual blistering of the buttocks, full doses of sodium bicarbonate should be given. Buttermilk stools are usually alkaline ; sometimes acid from lactic acid. If they are frothy-looking and acid, lactose should be substituted for cane sugar, or the diet may need to be changed altogether.

SUMMARY

Practically, the chief dietetic indications to be derived from the examination of the stools are :—

1. Motions containing "curd" show that the milk is not being digested. Try further dilution, with the addition of lime water, or adding sodium citrate. If this fails peptonizing may be tried, or milk may require to be withheld altogether for a time.

2. Large constipated motions are generally associated with overfeeding; if they also contain fat, both fat and proteid are in excess.

3. Large pale pultaceous or semi-fluid motions, with an acid reaction ("fat diarrhœa") show that more fat is being given than can be absorbed.

4. Frothy, acid stools show that too much carbohydrate is being given.

5. Thin brownish yellow motions are the natural sequence of a diet of albumin water or whey; when they have ceased to contain mucus in appreciable amount, milk may be cautiously given.

6. When the stools are extremely acid, and irritate the skin, give full doses of soda.

7. Motions which are either very loose, frequent, or undigested indicate the withdrawal of milk altogether for the time being.

I. NEWLY BORN INFANTS WHO DO NOT THRIVE

In almost all instances the difficulty lies in the digestion of casein. If the ordinary dilution of 1 : 1 is not well borne, the best plan is to prescribe a weaker mixture, say 1 : 2 or even 1 : 3, to add lime

water (5 to 20 per cent.), and to use barley water or a malted cereal decoction as a diluent. If this still causes difficulty, further dilution is inadvisable ; to modify the curd in some way is better. Citrated milk (1–2 grs. to the oz.) should be tried. Should this also fail, peptogenic milk will often suit. It seems to be more useful in very young babies with whom ordinary milk mixtures disagree than in older infants suffering from gastro-intestinal disorder. Among the poor condensed milk may replace peptogenic milk ; it is almost as digestible, and is useful particularly in cases in which there is much vomiting. If persisted in for several months it is apt to cause rickets, and as it is easy to prepare afresh, mothers find it convenient, especially in hot weather, and are often disinclined to give it up. This is one of its chief drawbacks, and its unsuitability as a permanent food ought to be explained. Failing success with this, fully peptonized milk may be tried.

In most cases some of the above measures will overcome the difficulty with proteid, and as the baby's digestion improves his diet should be gradu-

ally altered until a moderately strong milk-and-water mixture is taken. One should be content with a proteid content of 2 per cent., with sugar brought up to 6 per cent., and fat to 3·5 per cent. by the addition of lactose and cream.

If the infant cannot digest any of the above foods, its powers of proteid digestion are obviously very feeble, and in all probability there will be great difficulty in rearing it. By far the best chance is to get a wet nurse. It is practically impossible to bring up some children by any other means, and the life of a baby which would otherwise die may be saved by a good foster-mother. The trouble and sacrifice involved are therefore often well repaid.[1] When, however, as is usually the case, hand feeding is the only possibility, there remain to us whey or albumin water, which should first be given with added

[1] For much useful information concerning wet nursing, see Prof. Budin's book *The Nursling* (London: 1907) chap. iii. The fact that a good wet nurse can easily nourish more than one infant is not sufficiently appreciated, and if mothers were allowed to suckle their own as well as their foster children it might lessen the dislike of our own countrywomen to act as wet nurses.

sugar only, and then be fortified by cautious additions of cream. The main point is to eliminate casein altogether for a time. There is no doubt that some babies who have great difficulty with proteid have considerable power of digesting carbohydrates. One may be driven, then, as a last resort, to try the effect of adding a malted food, or even an unmalted cereal, to the diet.

The ground principle in this class of case is to remember that casein is the main source of trouble, and to work rapidly downwards until a food within the infant's digestive capacity is reached ; then, by slow increments, gradually to raise the diet to as near the normal level as possible.

Drugs play little part in the management of these cases. When the stools are unhealthy castor oil or grey powder should be given as required. The latter, too, sometimes exerts a favourable influence on nutrition and digestion, even where there is no question of syphilis.[1] Thyroid ought also to be tried in bad cases (see p. 164).

[1] Hutchison, *Lectures on Diseases of Children*, London, 1904, p. 31.

II. CASES IN WHICH MALNUTRITION IS THE PROMINENT SYMPTOM

These range from a slight falling off in weight to the gravest forms of atrophy. In many cases of malnutrition inquiry will elicit signs of gastro-intestinal indigestion, the cure of which speedily mends matters. In a smaller number of patients the malnutrition is symptomatic of an organic disease, and this possibility should not be overlooked. It is often surmised on insufficient grounds that marasmic infants are tuberculous or tainted with syphilis, but unless further definite signs are present the diagnosis cannot be made on the ground of atrophy alone. What perhaps more frequently escapes recognition is that the wasting is secondary to congenital heart disease, to mongolian imbecility, or to latent empyema.

Organic disease and digestive disorder being excluded, malnutrition must be looked on as due to faulty diet. The food as a whole may be inadequate ; if there is any doubt on this point the calories may be estimated. Overfeeding, too, is sometimes to blame. Most commonly, however, the defect is a lack of fat, as may occur when a baby is kept on

a weak milk-and-water mixture for too long a time. This is remedied by adding sufficient cream to the food to bring the fat up to 3·5 per cent. Among the poor, cod-liver oil is a very efficient substitute; half to one drachm of a good emulsion may be given thrice daily. An instance of the good which cod-liver oil often does is shown in Chart XII.

Deficiency of proteid is not so common a cause of malnutrition. If a baby is being fed otherwise than on milk—on a patent food—a suitable milk mixture containing adequate fat should be given. In infants otherwise properly fed deficiency in carbohydrate may begin to show itself by a flagging in the nutrition towards the eighth or ninth month, and under these circumstances it is well to augment the diet with some such cereal as oat flour. On the principle that it is impossible to have too much of a good thing, cream is sometimes given in excessive quantities, especially among the better classes. Four per cent. of fat, however, is a limit which should not be overstepped. At this age, when the baby is beginning to exercise his muscles more freely, and when he has gained some power of digesting starch,

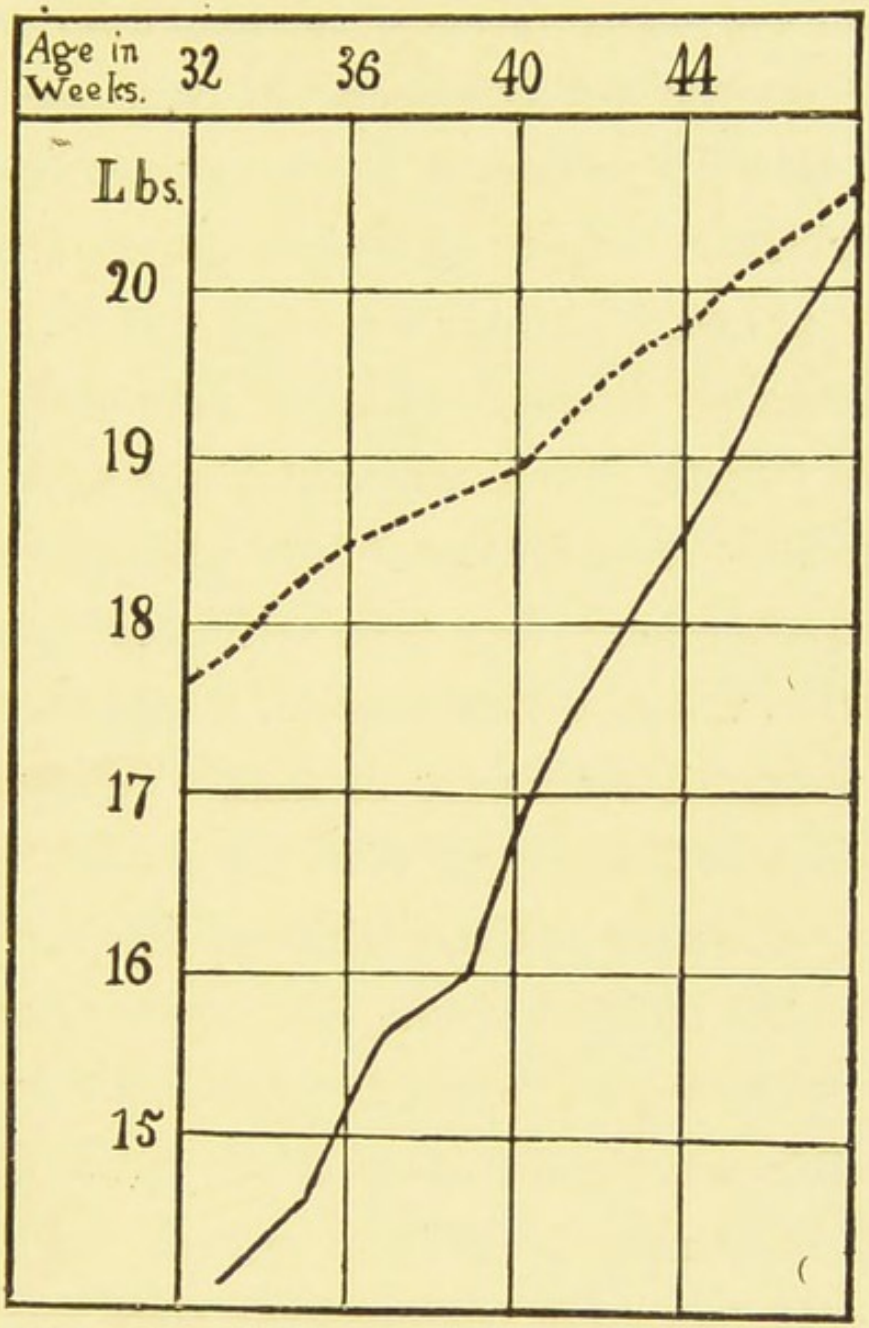


CHART XII.—Malnutrition; congenital heart disease. Previous feeding—milk and water with Horlick's malted milk. The only change made was to replace Horlick by cod-liver oil, whereupon weight rose steadily.

it is rational to increase the carbohydrate of the diet, from which the body derives most of its energy.

While the lesser forms of malnutrition respond readily enough to alterations in diet, true marasmus is often incurable. It is apparently a vice of assimilation, which may be acquired through a variety of causes, or may be congenital (cf. p. 16). The prognosis is worst when no removable cause can be found. Many marasmic infants have few symptoms of disturbance of the alimentary tract, save constipation ; they take and digest quantities of food on which a normal infant would thrive, yet their weight is stationary or falls. In selecting a diet for such infants, one with low proteid and fat should be chosen, as the slightest digestive upset only makes matters worse, and may easily prove fatal. Wet nursing offers the best outlook, but is impossible among the class of the community in which marasmus is most prevalent. In all bad cases of malnutrition, whatever the other symptoms, a trial should be given to thyroid extract (gr. $\frac{1}{3}$ thrice daily). Dr. J. W. Simpson [1] was the first to draw attention to its value in the condition. Though

[1] "The Thyroid Gland in relation to Marasmus." *Scottish Medical and Surgical Journal*, December, 1906.

it is by no means always successful, some wasted babies improve marvellously under its influence, and if it is going to do good its effect is quickly manifest.

III. CASES WITH GASTRO-INTESTINAL SYMPTOMS

Vomiting and diarrhœa generally go hand in hand but sometimes the one, sometimes the other, is more pronounced.

Vomiting.—Persistent vomiting in infancy is generally due to one of four causes: to overfilling the stomach, to congenital hypertrophy of the pylorus, to pyloric spasm, or to indigestion.

Vomiting from overfilling the stomach is easily recognizable. Soon after taking a bottle the infant regurgitates part of the meal. Vomiting of this kind is apt, unless checked, to become habitual. It is easily prevented by lessening the size of the meals; it is also advisable not to lay the baby down immediately after he has finished his bottle, but to nurse him in the upright posture, and then to lay him on his right side so as to prevent regurgitation. Vomiting of this nature is often due to carelessness

in giving the feeds, as when the infant is allowed to suck air from an empty teat, or when the perforation in the teat is too large, and permits the milk to escape too freely.

Vomiting due to congenital hypertrophy of the pylorus dates from the first few weeks (often the third) of life; it is persistent, unaccompanied by signs of dyspepsia, and is often of a spouting character, gushing from the nostrils as well as mouth. The patients are usually males, and as a rule are breast-fed. There is obstinate constipation. The diagnosis rests on mainly physical examination (visible gastric peristalsis); the treatment does not fall within the scope of this book.[1] The disease is extremely rare.

Vomiting due to pyloric spasm is much more common and is often difficult to relieve. The vomiting is urgent, and occurs many times in the day. Sometimes only a mouthful, at other times the whole feed, or even the previous feeds also, are

[1] See Thomson, *Guide to the Clinical Examination and Treatment of Sick Children*, 2nd ed., Edinburgh, 1907, pp. 131–4, for a full discussion of this difficult question.

ejected. It is often propulsive, as in hypertrophy of the pylorus. The bowels are not confined; they usually move regularly, or are loose. Pyloric spasm rarely occurs in breast-fed infants. No thickening of the pylorus can be made out, and there is no visible peristalsis. During and before the act of vomiting the stomach may stand out rather prominently in the epigastrium, but this bears little resemblance to the forcible peristaltic waves passing across the upper half of the abdomen which are pathognomonic of hypertrophy. The cause of pyloric spasm is unknown. Hyperchlorhydria has been blamed; it is, however, difficult to prove the correctness of this in babies on account of the power which milk has of fixing hydrochloric acid, and I have not felt certain that there was hyperacidity in the cases I have examined. The condition has nothing to do with hypertrophy of the pylorus. On post-mortem examination of several typical cases the stomach was found to be quite normal.

Some cases yield very rapidly to treatment; in others, the vomiting, though apparently quite

uninfluenced by diet, gradually subsides spontaneously in the course of a good many weeks; a few cases prove fatal. In pyloric spasm it is rational to select a diet which needs little or no gastric digestion, and a trial should be given to a milk mixture alkalinized with sodium bicarbonate (2 grs. to 1 oz.). As alternatives, peptonized or citrated milk may be used. In case of these failing I have employed whey or albumin water with a malted food with some measure of success—e.g., one to two teaspoonfuls of Savory and Moore's food to every feed—but I do not think it is wise to restrict the diet much for too long a period. The vomiting is often just as bad on a diet of plain albumin water as on milk, and failure of nutrition is more likely with the former than the latter. On the assumption that hyperchlorhydria is present, I have tried giving these cases whole milk in order to take full advantage of its combining power, but without success. Thoroughly alkalinized milk will attain the same end without the attendant drawbacks of whole milk. Altering the quantities of, and intervals between, feeds does not seem to do much good

in these cases, but probably it is as well to keep the former small, and the latter long. Breast feeding should be arranged for if possible. The stomach ought to be washed out daily, though the measure is less effectual than in other forms of vomiting. Recourse may also be had to feeding with a stomach tube; in some cases food given thus is retained, when that swallowed in the usual way is rejected.

Temporary improvement often follows any change in the diet. Opium and belladonna are the most useful drugs. They may be given in doses of $\frac{1}{20}$ minim and $\frac{1}{4}$–$\frac{1}{2}$ minim of the tinctures respectively. Warm compresses kept constantly applied to the abdomen seem at times to operate beneficially.

Vomiting due to indigestion.—The vomited matter consists of sour smelling curd and mucus, and occurs some little time after a meal. It is usually accompanied or followed by diarrhœa. Apart from acute cases, which call for lavage of the stomach and complete withdrawal of milk, the general indication is to lower the percentage of fat, and to alkalinize,

to citrate, or to peptonize the milk in order to relieve the stomach. The dilution of the milk should be increased, the bulk of the feeds diminished, and the intervals regulated. When peptogenic milk is used it is best to omit the cream. In cases of troublesome gastric indigestion with vomiting, condensed milk is sometimes well borne and will serve as a temporary food. It may quite safely be continued for from four to eight weeks or longer.

Diarrhœa.—When an infant has a sudden attack of diarrhœa the first thing to settle is whether or no the gravity of the illness demands complete abstinence from milk. I am now much more disposed than in the past to cut off milk at once, even in mild cases. By doing so, time is generally saved in the long run. Unless the diarrhœa is really slight—three or four motions in the day at the outside, with no pyrexia or constitutional disturbance—it is best, therefore, to exclude milk from the diet at once. This applies particularly to cases occurring in hot weather.

Put the infant on albumin water, with sugar to

make 6 per cent. This should be given in the usual quantities, and at the usual intervals, unless there is much vomiting, when smaller amounts should be given more frequently. If there is thirst, cold boiled water is grateful and beneficial, and ought to be administered freely. In acute diarrhœa brandy is always required (10 to 20 minims three or four hourly according to age); it acts primarily as a sedative, secondarily as a food.

On this diet the stools usually become less numerous, but remain watery, and dark brownish-yellow in colour. The diet may be continued for from four to seven days; if persisted in for a longer time the nutrition will fail considerably, as the food is, of course, inadequate. The next step is to make a change to whey, with sugar added as before. If this is well borne, and if the stools, though still fluid, are not numerous and contain no mucus, it is generally safe after three days of a whey régime to give a little peptonized milk, and gradually to work up to an ordinary diet. The strictest precautions must be taken to ensure the sterility of the food during con-

valescence.[1] As an alternative to the above procedure the whey may be enriched by the addition of raw meat juice, cream, and a malted food. The simpler sequence of albumin water, whey, peptonized milk, however, as a rule meets all requirements.

Cases which, after the acute onset, develop signs of ileo-colitis are very intractable, and milk should be excluded from the diet for a much longer period. Hence the importance of examining the stools frequently.

In acute diarrhœa and vomiting, other than dietetic measures are also required. Briefly, the alimentary canal is first emptied by washing out the stomach and giving a full dose (ʒii–ʒiii) of castor oil, and stimulants in the shape of saline infusions (which also replace the fluid lost to the tissues), mustard baths, hot bottles, and strychnine and digitalis are called for. Brandy is invaluable;

[1] It has been pointed out to me that when the milk supply and sanitary conditions are unsatisfactory, there is something to be said for the use of a dried milk food (e.g., Allenbury's food) in the convalescence from summer diarrhœa. The diminished risk of renewed infection may justify its use as a temporary measure.

it probably acts by soothing the child and thus enabling it to conserve its strength, and as a food. Irrigation of the bowel is sometimes beneficial, particularly in ileo-colitis.

While acute diarrhœa is due to infection, chronic diarrhœa is generally caused by the food disagreeing, and examination of the stools is of great assistance in the choice of a diet.

When undigested fat is present the quantity in the food should be restricted to 2 per cent. or less, to be again increased as the motions improve. If there is no difficulty with the proteid a mixture of milk, 12 ozs., water, 12 ozs., milk sugar, 1 oz. will prove suitable. Fat diarrhœa is easily cured when its nature is recognized.

Should the difficulty be with the proteid, that component of the food must be lowered, and lime water or sodium citrate be added to the bottles; or the milk may be peptonized. In bad cases we may be driven to whey and cream mixtures. Many infants suffering from chronic gastro-intestinal disorder—wasted, vomiting, and passing loose stools containing mucus and curd—thrive exceed-

ingly well on buttermilk, and when it can be procured regularly it seems to me the most generally useful food for this class of case at our disposal. After a week or two fresh milk should be substituted at one or two of the feeds, but the transition should be gradual to avoid a relapse.

Diarrhœa from excess of carbohydrates, indicated by frothy acid stools and a diet rich in malted or unmalted starch, should be treated by complete withdrawal of the noxious substance, and the administration of a food low in all its constituents, which can gradually be raised to normal.

Lienteric diarrhœa is a common affection, and is less influenced by diet than the preceding. During or after each feed an undigested motion is passed. Any dietetic error should be corrected, and small doses of liquor arsenicalis ($\frac{1}{4}$–$\frac{1}{2}$ minim thrice daily before food) prescribed.

Stools which are putrid from albuminous decomposition require the administration of castor oil to cleanse the bowel, and the limitation of the diet to a cereal decoction—e.g., Mellin's food made without milk—for a few days. Excessively acid,

sour-smelling stools, which irritate the buttocks indicate the free administration of sodium bicarbonate, as well as correction of the diet.

Constipation.—Constipation is less common than diarrhœa in artificially fed children; it is usually due to excess of proteid and deficiency of fat. Having ascertained that the motions do not contain excess of fat, the proportion of that constituent in the food should be raised to 3·5 or 4 per cent., and the proteid may be diminished if need be. Cod-liver oil has a mildly laxative effect, and may replace extra cream, or a little olive oil or butter may be given. The addition of one or two teaspoonfuls of fluid magnesia to the bottles, or the substitution of thin gruel for barley water, may also help matters. Malted foods, extract of malt and brown sugar, are all slightly laxative and are sometimes given for this reason.

The insertion into the rectum of a small piece of soap is a simple way of stimulating the bowel to empty itself. It is important from the earliest months to try to develop the habit of a regular daily evacuation of the bowels at a fixed time.

CHAPTER VI

Diet during the Second Year—Weaning, and Mixed Feeding—Premature Infants—Forced Feeding, and Washing out the Stomach—Rectal Injections.

DIET DURING THE SECOND YEAR

From the eighth or ninth month, particularly if one or two teeth have been cut, some starchy food may be added to the diet, and about the same time it is desirable to accustom the baby to drink from a cup or spoon.

Oat flour gruel should be given in the proportion of one or two tablespoonfuls to first one or two, then each feed. In another month one of the bottles is replaced by a saucerful of well boiled farola, or such preparation. Towards the end of a year porridge made from oat flour and a little bread and milk may be given. Milk, however, remains

the staple, and the infant ought to have about 36 or 40 ozs. in the twenty-four hours.

With the opening of the second year, eggs, a most valuable adjunct, should be given. At first only the yolk is taken, mixed with a little bread-crumb ; later the whole of a boiled egg followed by a cup of milk and some thin bread forms an excellent midday meal. Bread and butter, too, is now allowable. A baby should be encouraged to exercise his jaws and teeth by gnawing the crust of bread or roll, or a strip of toast. Chewing, in the strict sense, is impossible until the temporary molars appear, but it is a mistake to reduce all food to pulp or pap for that reason. Probably the use of food which requires mastication is beneficial to the teeth and helps to prevent caries.[1]

A sample schedule for the diet of a child from twelve to fifteen months old might read :—

7–8 a.m. Bread and milk.

10–11 a.m. Porridge and milk.

1–2 p.m. Egg, with half a slice of bread, and milk.

[1] See Dr. Harry Campbell's book *On Treatment* (2nd ed. London, 1908) for a discussion of this subject.

4–5 p.m. Saucer of farola.

7–8 p.m. Cup of milk.

From the eighteenth month the child may have fresh vegetables—a little mashed potato, cauliflower, or spinach, and fruit, such as bananas and ripe apples. At this time, gravy, free from grease, is also given. During the latter half of the second year fish, bread soaked in the fat of bacon, oatmeal porridge, thin soups, any form of milk pudding, custards, and occasionally a little roast mutton, lamb, or chicken, or a piece of chop, or a spoonful of mince, may be given.

Sample diet for a child of eighteen to twentyfour months :—

7–8 a.m. Milk, bread and butter, with a little porridge or egg.

10–11. Cup of milk if desired.

1–2. Minced or shredded chicken, mutton, or chop, or fish, or potato and gravy with bread and milk, and milk pudding, or custard, or roast apple, or a banana.

5–6. Milk, and toast, or bread and butter.

Thus during the latter half of infancy a satis-

factory diet may be chosen from the ordinary household fare. It is unnecessary to brew beef tea, or veal broth, or chicken soup, or to lay in stores of rusks for the child's use. The tendency undoubtedly is to give too much farinaceous and too little nitrogenous and fatty food to children, and in particular to give the food in too soft a form.

Milk, of course, remains a very important item during the whole of childhood, and about a quart a day should be allowed. The question is often asked, How long shall it continue to be boiled? After the first year the risk of infective diarrhœa is not great, but the possibility of other infections, notably tubercle, cannot be neglected.[1] It is certainly advisable to continue the practice of boiling milk until the child arrives at school age, if not later.

A mother is often anxious because a child does not eat as much as she thinks he should. As a rule this anxiety is quite groundless. If the child is

[1] J. S. Fowler, "Milk Problem and Tuberculosis in Infancy and Childhood." *Tuberculosis in Infancy and Childhood,* edited by T. N. Kelynack, London, 1908, p. 27.

thriving it is quite unnecessary to induce him to eat more than he is naturally inclined to, and it is a great mistake to tempt his appetite by savoury dishes.

WEANING, AND MIXED FEEDING (*Allaitement mixte*)

We distinguish between weaning at the normal period, and abnormal weaning, i.e., the withdrawal of the infant from the breast during an earlier stage of lactation.

Normal Weaning.—As a rule it is advisable to wean an infant between the eighth and tenth months. The fact that among less civilized peoples children are suckled until a much later period is no argument for prolonging lactation. Among some savage and semi-savage races children are given the breast until the second or third year, by which time, of course, their mother's milk is only an addition to other articles of diet. The suckling period is often unduly prolonged, with the object of avoiding the occurrence of conception, but while lactation may render pregnancy less likely, it by no means prevents it, especially if men-

struation be re-established. Protracted lactation favours the development in the child of rickets and anæmia, and it is probably inadvisable to nourish a baby wholly on breast milk after the age of ten months. The process of weaning should be gradual, and it is as well to avoid a season when epidemic diarrhœa is prevalent.

In weaning an infant we have to accustom it to a diet consisting of carbohydrates and cow's milk, which will form the principal elements of its food during the second year. A feeding bottle ought not to be used, but the baby should be taught to drink from a cup or spoon. If lactation has been properly regulated the infant will be having, at most, five meals a day, and if his development has been satisfactory he will have cut one or two teeth and his salivary function will be established. We begin by substituting for the second breast feed a feed of carbohydrate (thin oat flour gruel made with milk and water). If this agrees, a cup of boiled milk should in the course of a week or so replace the fourth breast feed. In the course of the following fortnight the remaining breast feeds are stopped

and the infant is given two feeds containing carbohydrate and three consisting of milk in the course of twenty-four hours. At this age the average daily quantity of milk taken will be from 30–35 ozs. A quart of milk should be regarded as the most important item of the daily ration during the early years of a child's life.

The period of transition from breast to artificial feeding need not be longer than three or four weeks. It is said that during the decline of lactation the milk tends to assume the characters of colostrum, and may thus be harmful. One of the advantages of introducing a cereal into the diet early in weaning is to check the tendency to constipation, which may otherwise ensue.

It is not always easy to persuade a baby, hitherto accustomed only to his mother's milk, to sup milk or gruel. Sometimes the new food is more readily taken if sweetened. Difficulties in changing the diet, however, usually depend as much on the character of the mother as on the baby, and are nearly always speedily overcome by intelligent perseverance.

Abnormal Weaning.—When it is necessary to take an infant off the breast before the normal time, it is desirable, if possible (except in the very rare case of the mother's milk disagreeing), to make the change gradually. Whether weaning be sudden or gradual, however, the most suitable food is a milk modification resembling human milk, e.g., proteid 1–2 per cent., fat 3·5 per cent., sugar 6 per cent. Peptogenic or "humanized" milk may also be used.

Mixed Feeding.—In the event of a mother being, or becoming, unable to suckle her child unaided, mixed feeding (*allaitement mixte*) should be resorted to. It is in all respects preferable to artificial feeding. We substitute for one, two, or more nursings bottles of a milk mixture containing about 2 per cent. proteid, 3·5 per cent. fat, and 6 per cent. sugar. It is best to give the artificial food during the waking hours, and to reserve the breast for the evening and morning. On account of the greater ease with which the baby draws milk from a bottle he is apt to turn away from the breast. To prevent this as far as possible teats with small orifices should be used, and the inter-

val preceding a breast meal should be lengthened so as to ensure the infants being hungry and sucking greedily.

The best stimulus to a functionally inactive breast is to suckle, hence in mixed feeding it is important not to err in the way of making the number of nursings too small. It often happens that the lessening of the physiological stimulus by limitation of suckling causes an already inadequate milk supply to vanish. This can only be hindered by exercising the function to its fullest capacity, and by refusing to allow more artificial feeds than are absolutely necessary.

PREMATURE AND FEEBLE INFANTS

Premature infants may be divided into two classes. In some cases they are the healthy offspring of healthy parents, and prematurity is due to some such cause as the induction of labour from pelvic narrowing. In other cases the premature birth arises from disease of the mother, fœtus, or placenta. The prospects of an infant of the first group are probably better on the whole than those

of the second class, and if the immaturity be slight they are nearly as good as those of a full term baby. No particular difficulty need be anticipated in rearing a healthy eight months' infant.

Infants who from whatever cause weigh less than $5\frac{1}{2}$ lbs. at birth must, however, be regarded as demanding special care. Scarcely less important than the diet in these cases is the maintenance of the bodily heat. Such infants are very liable to become chilled unless special measures are taken, and Budin [1] has shown that the mortality among them is almost directly proportionate to the lowering of the rectal temperature. In bad cases an incubator is required: if this be not available the baby should be rubbed with oil and swathed in cotton wool. If the wrappings are so arranged as to admit of the buttocks being cleansed without exposure of the rest of the body, the wool need only be removed when the infant is bathed every fourth or fifth day.

By far the best food is, of course, human milk, and if the baby is too feeble to suck it must be fed with milk withdrawn from the breast by a pump,

[1] *The Nursling*, chap. i.

and given either by the nose or mouth (*see* below). If artificial feeding be necessary the feeds should be smaller and the dilution greater than under normal circumstances; the intervals may need to be reduced, but this should be avoided as far as possible. Some prefer to begin with a whey and cream mixture, or predigested milk. Peptogenic milk without added cream is generally useful.

Premature babies are often unnaturally somnolent and must be aroused in order that they may be fed. If they are able to suck well the prospect of rearing them successfully is much greater than when spoon feeding or some such device has to be resorted to, either by reason of feebleness, or the presence of cleft palate, harelip, etc.

FORCED FEEDING, AND WASHING OUT THE STOMACH [1]

Forced Feeding (Gavage).—The simplest

[1] The indications for forced feeding, and washing out the stomach, and the relative advantages of the various methods, are fully discussed in Dr. John Thomson's *Guide to the Clinical Examination of Sick Children*, 2nd edition, Edinburgh, 1908.

method is to feed with a spoon, allowing the milk to trickle slowly into one side of the mouth, a few drops at a time, lest choking occur. Feeding in this way is a tedious process, but with patience it often succeeds well. Instead of using a spoon milk may be given by a tube passed along the side of the mouth (in older children between the cheek and the teeth) towards the back of the throat.

Nasal Feeding.—A baby may be fed through the nose either without, or with the aid of, a nasal tube. The former method is less likely to irritate and is therefore preferable, but can only be employed in the case of bland fluids such as milk. The infant is laid on his back and the food is dropped slowly down one nostril from a funnel (the barrel of a syringe), small measuring glass, or spoon. As it reaches the posterior wall of the pharynx time must be allowed for its being swallowed. In feeding with a nasal tube a small-sized rubber catheter (No. 7 English), sterilized and oiled, with a funnel attached, is passed along the floor of the nose into the gullet or upper part of the œsophagus. It is not necessary that it should enter the stomach.

The repeated passage of a tube soon causes rhinitis, and may have to be discontinued for this reason. When a child is being fed by the nose, the nostrils should be washed out daily or oftener with normal saline or an antiseptic and alkaline nasal solution.

Forced feeding by means of a stomach tube is employed in the treatment of intractable vomiting in older children, and is often efficacious. The apparatus used, and the method of procedure, are the same as in washing out the stomach.

Washing out the Stomach (Lavage).—A flexible double-eyed red rubber catheter (No. 10–14 English, according to age), or a stomach tube of the same size, with a terminal eye, is used. This is connected by 18 ins. of rubber tubing with a funnel (Fig. 20). Funnels of this shape, with a capacity of 2 ozs., and a nozzle diameter of a quarter of an inch, are better than the ordinary conical pattern. One specially blown is superior to the barrel of a glass syringe (which will, however, answer in an emergency) because the orifice of the latter is so narrow as to render lavage a tedious process. The stomach tube

should certainly be sterilized before use ; olive oil is the best lubricant.

The infant is seated on the lap of the nurse with his back supported by her left arm, and a mackintosh or towel is wrapped round the body. A jug of warm sterile water or saline solution is set within convenient reach of the doctor's right hand, and a pail is placed on the floor a little to his left to receive the washings. A cup should be at hand in which to collect for examination the gastric contents which escape when the tube is passed. It is often important to measure their quantity, and to compare it with that of the last meal. The left forefinger is introduced along the right side of the mouth as far as the back of the tongue, and the stomach tube, held in the right hand, is passed along it to the posterior wall of the pharynx and then steadily onwards. A gag is not necessary. It is as well previously to measure the tube against the infant's body and mark the distance from the mouth to the stomach.

FIG. 20

Before the operator lets go the tube the nurse takes hold of it close to the lips with her unoccupied right hand so as to prevent its being ejected. After waiting for a moment or two until the baby has got its breath, and also to allow gas to escape from the stomach, the funnel is lowered and the gastric contents siphoned off into the cup. If they do not escape, the epigastrium may be gently pressed upon. The stomach is washed out by repeatedly filling and lowering the funnel, about 2–3 ozs. of water being introduced at a time. The funnel should not be raised more than a foot above the level of the stomach. If the tube becomes blocked one of the advantages of the cylindrical funnel is apparent, for it is easy to blow down it and dislodge particles of curd.

After the washings are clear, it is often desirable to give a feed through the tube. The latter should be withdrawn rapidly in order to prevent vomiting.

Washing out a baby's stomach is a very simple matter compared with the same process in the adult. It causes no discomfort, and many infants seem to like it, or at least to enjoy a sense of well-being while

it is being done. That this is so will be admitted by any one who has noticed the contented way in which a baby sits sucking its stomach tube.

RECTAL INJECTIONS

Rectal feeding is of little use in infancy, as nutrient enemata are seldom retained.

Saline Injections are sometimes extremely serviceable as stimulants in debility or exhaustion from any cause—e.g., sepsis of the newly-born, diarrhœa, or prematurity, or when fluid cannot be given by the mouth (as after some surgical operations) or is not retained by the stomach. Normal salt solution (·7 per cent.) at a temperature of 100° F. is used. About an ounce may be given to a baby one or two months old ; the injections are repeated every four hours. The requisite apparatus consists of a glass funnel (the barrel of a small syringe) attached to a No. 5 or 6 rubber catheter. The catheter is gently introduced for a couple of inches into the bowel, and the saline solution is run cautiously in. The main point is to give the injection as slowly as possible—literally by drops at a time. After the

injection has been given the catheter is withdrawn and the buttocks firmly compressed for a minute or two. If, as so often happens, the first injection is returned, it is worth while giving another after 10 or 15 minutes, for at times a second attempt is successful though the first has failed.

APPENDIX

TABLE OF THE COMPOSITION

(Compiled, by kind Permission of the Author, from

Food.	Water.	Proteid.	Fat.	Carbo-hydrate	Mineral Matter.
Dried human milk . . .	—	12·2	26·4	52·4	2·1
GROUP I. (*Milk Foods*).					
Allenbury No. 1 (for children below 3 months)	5·7	9·7	20	60·85	3·75
Allenbury No. 2 (for children from 3 to 6 months)	3·9	9·2	15·	69·1	3·50
Horlick's Malted Milk . .	3·7	13·8	9·	70·8	2·70
Milo Food (Nestlé's Milk Food)	1·56	11·03	3·92	81·38	2·11
GROUP II. (*a*) *Completely Malted Foods.*					
Mellin's Food	6·3	7·9	Trace	82·2	3·8
Hovis Babies' Food No. 1 .	3·7	7·7	0·20	86·6	1·82
(*b*) *Partially Malted Foods.*					
Savory and Moore's Food.	4·5	10·3	1·4	83·2	0·6

OF PATENT FOODS

Dr. R. Hutchison's "Food and Dietetics," 1906)

	Remarks.
	The standard to which artificial substitutes should conform.
	Desiccated cow's milk from which the excess of casein has been removed, and soluble vegetable albumin, milk sugar, and cream added. No starch present. Half an ounce in 3 oz. water for a child aged three months.
	Resembles the above, with some malted flour in addition. No starch. 1 oz. in 6 oz. water for a child of six months.
	A mixture of desiccated milk (50 per cent.), wheat flour (26¼ per cent.), barley malt (23 per cent.) and sod. bicarb. (¾ per cent.). Contains no unaltered starch when mixed. Three teaspoonfuls in 4 oz. of water for a child of three months.
	A mixture of desiccated Swiss milk, baked flour, and cane sugar (30 per cent.), 62 per cent. of soluble and 18 per cent. insoluble carbohydrates (largely starch). To be made with water only.
	Completely malted food; all carbohydrates soluble. May be regarded as a desiccated malt extract. Half a tablespoonful ¼ pint milk and ¼ pint water for a child under three months.
	Fully malted. To be made with milk.
	Wheat flour with malt added. Prepared according to directions, most of the starch is rendered soluble (chiefly dextrins). 1 or 2 oz. mixed with two or three tablespoonfuls of cold milk and water, and a third of a pint of boiling milk or milk and water added.

Food.	Water.	Proteid.	Fat.	Carbo-hydrate	Mineral Matter.
GROUP II (*continued*).					
b) *Partially Malted Foods.*					
Benger's Food	8·3	10·2	1·2	79·5	0·8
Allenbury Malted Food .	6·5	9·2	1·	82·8	0·5
Moseley's Food	10·8	11·0	0·92	76·4	0·94
GROUP III					
Farinaceous Foods.					
Ridge's Food	7·9	9·2	1·0	81·2	0·7
Neaves' Food	6·5	10·5	1·0	80·4	1·6
Frame Food Diet	5·0	13·4	1·2	79·4	1·0
Robinson's Groats . . .	10·4	1·13	1·6	75·0	1·7
Robinson's Patent Barley .	10·1	5·1	0·9	82·0	1·9
Scott's Oat Flour	5·8	9·7	5·	78·2	1·3
Chapman's Entire Wheat Flour	8·4	9·4	2·	79·3	0·9
Nichol's Food of Health . .	11·9	7·7	1·7	76·9	1·75

OF PATENT FOODS (*continued*)

Remarks.
Wheat flour and pancreatic extract. Prepared according to directions most of the starch is rendered soluble. The proteid is also partially digested, as well as that of the milk used in mixing it. Take 1 tablespoonful and 4 of cold milk, then add ½ pint of boiling milk and water, set aside for fifteen minutes, then bring to the boil.
Wheat flour and malt. Prepared according to directions still contains some unaltered starch. Take 1 oz., 1 teaspoonful of sugar, and 3 tablespoonfuls of cold water ; mix, and add ½ pint boiling milk and water (equal parts). For children above six months.
Complete conversion of starch during mixing. To be given with milk.
Baked flour ; only 3 per cent. soluble carbohydrates. To be made with milk *or* water. Made with water alone not a sufficient food.
Resembles above. To be made with milk and water.
Baked flour, with cane sugar and some extract of bran. Not specially rich in mineral ingredients, but nitrogenous matters are abundant and it contains much unaltered starch. Half an ounce to be mixed with a breakfastcupful of milk and water (1 : 2).
Ground oats, from which husk has been removed. Rich in proteid and mineral matter.
Ground pearl barley, and of same nutritive value.
Fine oat flour ; starch unaltered.
Finely ground whole wheat flour. Not much superior in nutritive value to ordinary flour.
To be used with equal quantities of boiling milk and water for making infant gruel.

COMPOSITION OF MILK (RAUDNITZ—*abridged*)

	Woman.	Cow.	Goat.	Ass.
Water	86·4	88·	85·5	91·
Dry substance	13·6	12	14·5	9
Caloric value per litre	736–790	673	803	427–490
Fat—				
Percentage in milk	5	3·4	4·8	1
Melting point (centigrade.	30°–34°	31°–34·6°	30°–35°	15°–17·5°
Percentage of volatile fatty acids.	1·4	6–8	—	—
Percentage of oleic acid.	50	34–38	—	—
Percentage of cholesterin.	0·6	0·5	—	—
Proteid—				
Casein	0·6–1·0	3·	3·8	0·6–1·8
Lactalbumin and lactoglobulin	0·5	0·3	1·2	0·3–0·7
Total nitrogen	·15–·25	·55	—	—
Milk sugar	6·4	4·4	2–5	5–6
Citric acid	·005–·07	·12–·2	·1–·15	—
Ferments—				
Katalase	+ +	+	+	—
Reductase	Trace	+	Trace	—
Aldehydase	0	+	Trace	—
Peroxydase	0	+	+	0
Amylase	+	+	+	+
Lipase, reckoned in terms of acids	5–7	2–3	1	1
Proteolytic and glycolytic ferment	?	?	?	?

	Woman.	Cow.	Goat.	Ass.
Minerals—Total ash per 1,000	1·4–2·8	7	7·7–10	4–5
CaO	0·3	2·0	1·9	1·0
„ in solution	·17	·6–·8	—	—
P_2O_5	·46	2·4	2·8	1·5
„ organic	·09	·6	·7	·26
„ inorganic	·37	1·8	2·1	1·24
Cl	·43	·95	1·	·31
K_2O	·8	1·7	1·3	·84
Na_2O	·2	·5	·6	·3
MgO	·06	·2	·15	·13
Fe_2O_3	·005	·01	·03	·01
Reaction to litmus paper	Alkaline	Amphoteric	Amphoteric	Alkaline
Decinormal soda neutralized by 1 litre	20–25 cc.	175cc.	—	60–70 cc.
Decinormal acid neutralized by 1 litre against blue litmus	85 cc.	320–550 cc.	—	350 cc.

Goat's milk does not differ very greatly in composition from that of the cow. It is somewhat richer in fat, and the casein is said to form a more flocculent curd (Still). From a dietetic point of

view it has no special advantage over cow's milk, but where (as in some parts of India) the latter cannot be obtained, goat's milk is the most generally available substitute. The goat is almost immune to tuberculosis.

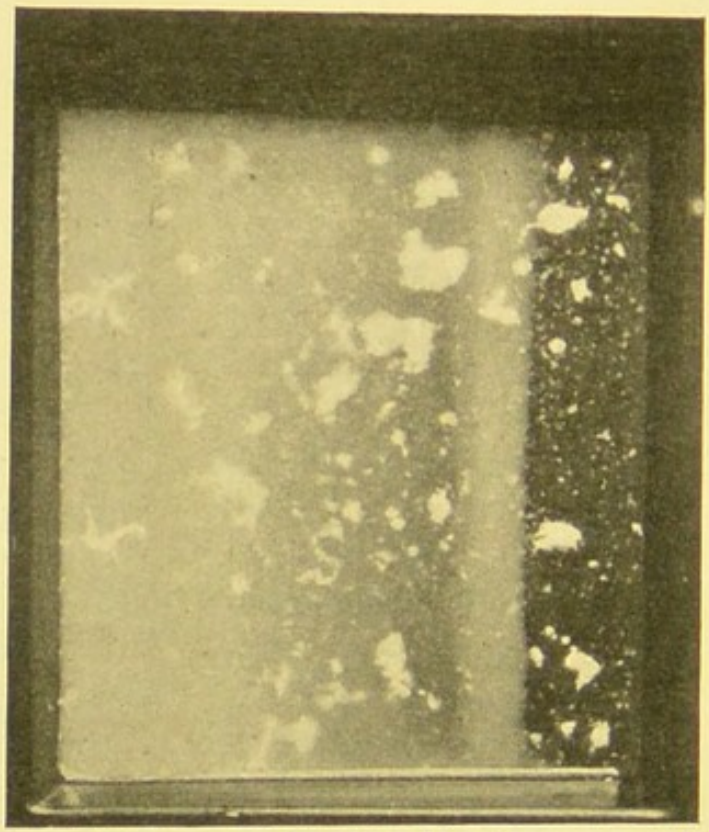


FIG. 21.—Ass's Milk, coagulated with Rennet and HCl, showing very scanty, soft curd (cf. Fig. 3).

Ass's milk bears considerable resemblance to human milk, and enjoys a favourable reputation as a food for infants who cannot digest cow's milk. It contains 1–1·6 per cent. proteid, 1 per cent. fat, and 5–6 per cent. sugar. The deficiency in fat puts

it out of court except as a temporary food; its strong point is the digestibility of its proteid, only half of which exists in the form of casein. It yields a very light curd, resembling that of human milk (Fig. 21). Ass's milk must needs be consumed raw, as the abundant soluble proteid coagulates below the temperature required for pasteurization (Fig. 22). Special care must therefore be taken, by cleanliness and preservation at a low temperature, to prevent the milk turning sour. Tubercle is not a danger, as the ass is practically immune. Ass's milk (obtainable in London from Welford & Sons, Ltd.) is not very widely used, owing partly to the difficulty in procuring it, and partly to its cost, (3*s.* per pint). It is cheaper, where possible, to

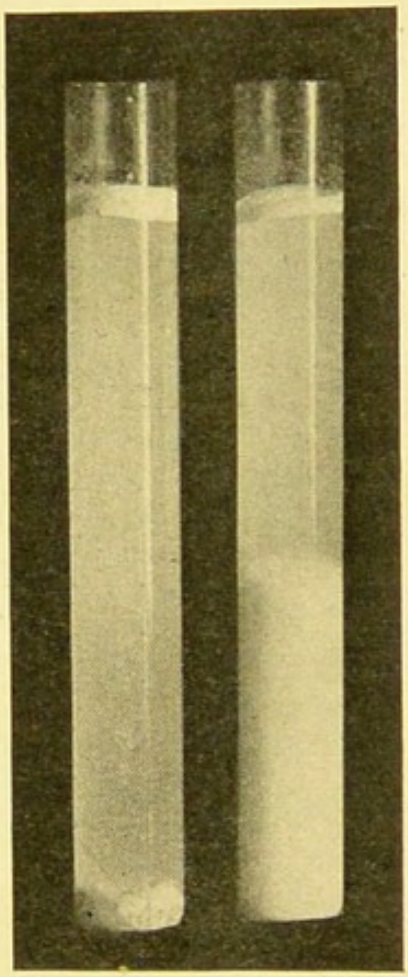


FIG. 22.—Ass's Milk —(*a*) casein curd; (*b*) proteid coagulated by boiling, in 1 oz. of milk. Note large quantity of soluble proteid precipitated by heat; compare whey, Fig. 19 (*b*).

keep a milch ass. It is, however, a valuable food in special cases.

Buffalo milk is used in some parts of India; infants are said to thrive well on it. It contains 6·1 per cent. proteid, 7·5 per cent. fat, 4·1 per cent. sugar, and ·87 per cent. salts. Mare's and ewe's milk has also been used.

Summary of Effect of Heat on Milk

45° F. . . .	"Chilled" milk.
68° F. to 140° F. .	"Dangerous" temperatures.
149° F. . . .	Tubercle bacilli may survive.
155° F. . . .	"Pasteurization."
158° F. . . .	Tubercle bacilli usually killed.
161° F. . . .	Soluble proteid coagulates.
170° F. . . .	Milk "rises" in pan.
213° F. . . .	Boiling point of milk. All germs destroyed.
248° F. . . .	All spores destroyed.

Pasteurizing and Sterilizing Apparatus

Freeman's Pasteurizer consists of a kettle and a frame of ten cylindrical metal bottle holders. A little water is poured into each bottle-holder to act as a heat conductor, and the bottles of milk, plugged with cotton wool, are placed in the holders. The kettle is filled with water to the level of a mark

impressed upon it, and is then boiled. It is then removed from the fire and set on a non-conductor, the frame charged with bottles is put into it, and the whole is covered and allowed to stand for half an hour. At the expiry of this period the frame is removed and the bottles rapidly chilled in running water. The proportion of boiling water and milk is so adjusted that at the end of the first 10 minutes the latter reaches a temperature of 167° F., which is maintained with little variation during the remaining twenty minutes of pasteurization.

Hawksley's Sterilizer consists of a milk bottle fitting a kettle, the lid of which is provided with a thermometer, by means of which it is possible to read the temperature of the water. It may be used either to pasteurize or sterilize milk.

Arnold's and Siebert's Sterilizers are modifications of the Soxhlet type.

Cathcart's Sterilizer consists of a tin jar which goes readily into an ordinary pot. It is furnished with a draw-off cock, and the lid is perforated to admit a stirring rod. The milk or milk mixture is placed in the sterilizer, the stirring rod is intro-

duced, and a plug of clean cotton wool is placed round the handle so as to close the hole in the lid. The whole is then put in a pot of boiling water, and kept on the fire for from ten to twenty minutes, the stirrer being rotated occasionally. When sterilization is complete a rubber band is adjusted round the junction of the lid with the can, so as to close it hermetically; the sterile contents are withdrawn as required by means of the stop-cock. It is an efficient and inexpensive apparatus.

Aymard's Milk Sterilizer is also an inexpensive form, costing from 3*s.* 6*d.* upwards (3 pint size, 6*s.* 6*d.*). It consists of a pan, and a tin milk chamber with a lid and lip for pouring. Water is boiled in the pan, and then the milk receptacle is placed in position. Completion of sterilization is indicated by the escape of steam from the lid of the pan, which takes place in about a quarter of an hour.

Holt's Schedule for Feeding Healthy Infants during the First Year

Age.	No. of Feeds per 24 Hours.	Intervals during Day.	Night Feeds 10 p.m. to 7 a.m.	Quantities.	
				Per Feed.	Per Day.
3–7 days . .	10	2 hours	2	1 –1½oz.	10–15oz.
2–3 weeks. .	10	2 ,,	2	1½–3 ,,	15–30 ,,
4–5 ,, . .	9	2 ,,	1	2 –3½ ,,	22–32 ,,
6–13 ,, . .	8	2½ ,,	1	3 –4½ ,,	24–36 ,,
3–5 months .	7	3 ,,	1	4 –5½ ,,	28–38 ,,
5–9 ,, .	6	3 ,,	0	5½–7 ,,	33–42 ,,
9–12 ,, .	5	3½ ,,	0	7½–9 ,,	37–45 ,,

MILK PRESCRIPTIONS

Prescriptions for milk mixtures according to the percentage system are written in this form :—

		Per cent.		
℞	Fat . . .	3·00	No. of feedings	9
	Sugar . . .	6·00	Amount at each feeding . .	℥iiſs.
Proteid—				
	Whey proteid .	0·75	Alkalinity . .	5 per cent.
	Caseinogen . .	0·25	Heat . . .	155° F.

Such prescriptions are dispensed by the Walker-Gordon Laboratories, Ltd., 79, Duke Street, Grosvenor Square, London, W., and by Messrs. Welford & Sons, Ltd., Elgin Avenue, Maida Vale, W.

FEEDING INFANTS DURING SEA VOYAGES

The most convenient plan is to use condensed milk, and the unsweetened brands (e.g., Ideal) have the advantage that one tin is just sufficient for a day's use. Sterilized milk in stoppered bottles is also available (Welford and other Dairy Companies). Unsterilized whole milk, specially iced, and intended to be kept in the refrigerator, can also be obtained (Walker-Gordon Laboratories). On board some steamers a cow is carried, so that fresh milk is available (Messageries Maritimes, and perhaps other lines).

CREAM MIXTURES

Meigs's Mixture.—Allow a quart of milk to stand for three hours; decant the upper half and add to it 1 oz. of lime water and 1½ oz. of a solution of milk sugar (8 heaped teaspoonfuls in 16 ozs. of water).

Gaertner's Fett-Milch.—A commercial preparation, made by means of a separator, and stated to contain proteid, 1·5; fat, 3·2; sugar, 6·; mineral matter, ·35.

Ashby's Humanized Milk.—Add two tea spoonfuls of rennet to 30 ozs. of fresh milk, and strain off the whey. To every 20 ozs. add 10 ozs. of fresh milk and half an ounce of milk sugar. If "top milk" (upper fourth) be used instead of fresh milk the mixture will contain 4 per cent. of fat.

Biedert's Cream Mixture.—Materials : 10 per cent. cream, 6 per cent. solution of milk sugar, milk. No. 1 is intended for use during the first month, No. 2 during the second, No. 3 from the third to the fourth, No. 4 from the 4th to the 5th, No. 5 from the sixth to the seventh.

	Parts of			Composition.			
	Cream.	Sugar Water.	Milk.	Proteid.	Fat.	Sugar.	Calories per Litre.
No. 1 .	1	3	—	·9	2 5	5·6	500
,, 2 .	1	3	½	1·2	2·6	5·5	515
,, 3 .	1	3	1	1·4	2·7	5·4	535
,, 4 .	1	3	2	1·7	2·9	5·2	550
,, 5 .	1	2	4	2·5	3·5	5·	630

Backhaus's Milk.—Skim milk is treated with rennin and trypsin for half an hour at 40° C., heated

to 80°, and the curd strained off. Water, cream, and milk sugar are added to the whey in different proportions according to the strength desired. Backhaus's milk (procurable in England under the name "Nutricia") is supplied in separate feeding bottles at a comparatively moderate price. It is prepared in four grades, stated to have the following composition :—

	1.	2.	3.	4.
Fat	2·90	3·00	3·00	3·10
Lactose (Sugar)	5·20	5·10	5·00	4·90
Proteid (Albumin and Casein)	1·40	2·00	2·60	3·20
Soluble : Insoluble . . .	1 : 1	1 : 2	1 : 3	1: 4
Salts	0·40	0·50	0·60	0·70

Weight Table for First Year

Age.	Crozer Griffith.		Emmett Holt.		Age.	Crozer Griffith.		Emmett Holt.	
	Lb.	Oz.	Lb.	Oz.		Lb.	Oz.	Lb.	Oz.
Birth .	7	10	7	3	7 months	17	4	16	8
1 month	8	12	8	2	8 ,,	18	4	17	0
2 months	10	11	10	8	9 ,,	18	14	17	6
3 ,,	12	5	12	3	10 ,,	19	11	17	14
4 ,,	13	14	13	12	11 ,,	20	8	18	13
5 ,,	15	2	14	13	12 ,,	21	8	20	0
6 ,,	16	3	15	11					

Weight Charts.—These may be purchased, or can be simply made in the following way. On squared paper such as is used by draughtsmen, plot out a curve of the weight week by week, paste the

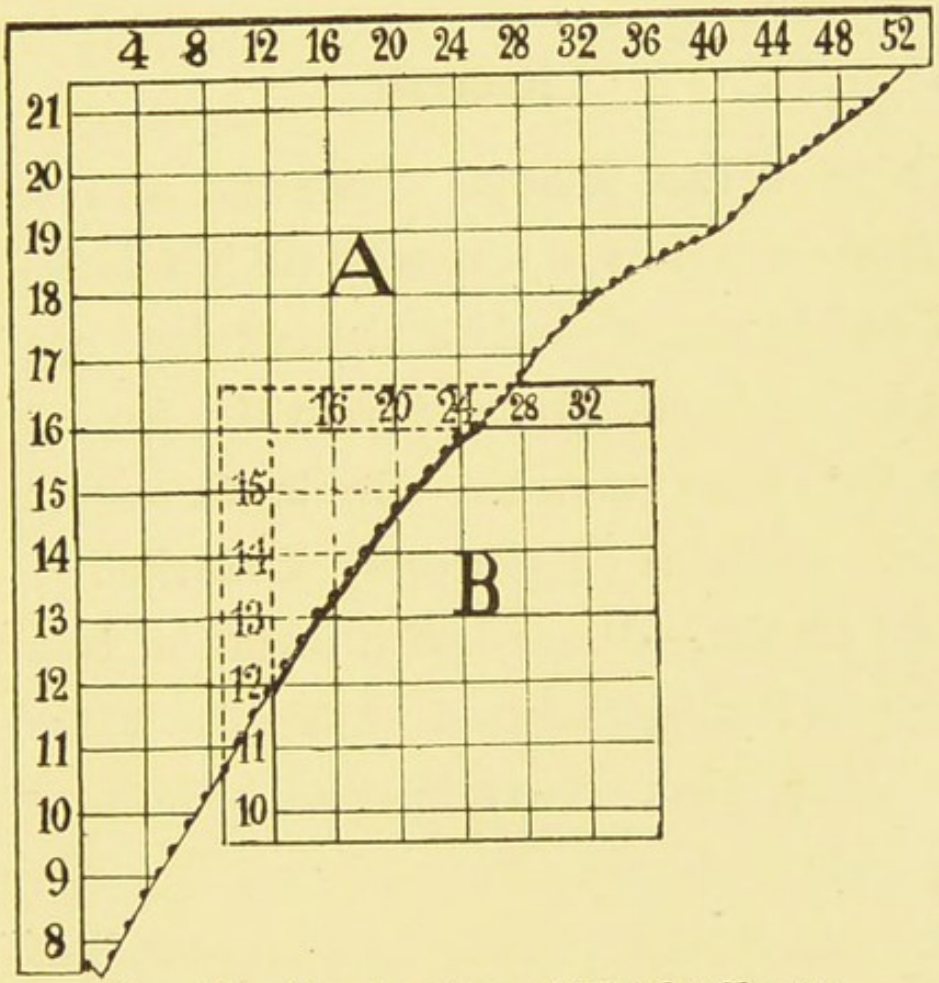


FIG. 23.—Construction of Weight Charts.

paper on cardboard and cut carefully along the curve, so as to make a shape as in A. From this shape any part of the normal curve can at once be drawn on a similar piece of squared paper. Thus we can

construct a chart for an infant of any age : for instance, B is for an infant from the twelfth to the thirty-sixth week, and has on it the normal curve for part of that time.

RECIPES

White Wine Whey. Myers and Still's Method.—Heat 10 ozs. of milk till just boiling and then add 2½ ozs. of cooking sherry ; heat again till the mixture boils. Remove from the fire and set aside for three minutes. Strain through butter muslin. Contains 2½ per cent. of alcohol.

Veal Broth.—Mince half a pound of lean veal, pour upon it a pint of cold water ; let it stand for three hours, then slowly heat to boiling. Strain, and season with salt.

Mutton Broth.—Mince half a pound of lean mutton, and place in a saucepan with a pint and a half of cold water ; add salt, and allow to simmer for three hours. Strain, when cold skim off the fat ; serve warm.

Raw Meat Juice.—Finely mince raw steak, add

enough cold water to cover it, and a pinch of salt. After standing for an hour express forcibly through muslin.

Whey.—To a pint of fresh milk add one to two teaspoonfuls of extract of rennet, and allow to stand in a warm place until curding takes place. Break up the curd with a fork, and strain. The curd should be strained into a wide bowl through a large piece of muslin, rolling it to and fro on the latter. If the attempt is made to strain through a small piece of muslin into a narrow vessel, the pores of the muslin become clogged by the curd, and the process is very tedious. An alternative plan is to remove the greater part of the whey from the broken up curd with a tablespoon, and to strain only the last part. Pressure should not be used in straining. From a quart of milk about 30 ozs. of whey is obtained.

Albumin Water.—Cut the white of a fresh egg into several portions with a clean pair of scissors, and shake with half a pint of water in a closed bottle. Strain, and add sugar if desired.

Barley Water.—Put two teaspoonfuls of washed pearl barley into a pint of water; boil slowly for

twenty minutes. Strain, and make up to one pint. Does not keep well, so must be made twice a day.

Oat Flour Gruel.—Take one tablespoonful of oat-flour, mix with enough water to form a paste, and gradually add about half a pint of water, stirring the while. Boil for ten minutes, with constant stirring. One or two tablespoonfuls to be added to each bottle, for a baby over eight months.

Oatmeal Water may be made by diluting the gruel with seven or eight times its bulk of boiling water, or in the following way : Put one tablespoonful of coarse oatmeal into a pint of water ; allow to simmer for an hour, replacing the water lost through evaporation ; strain.

Bread Jelly (Cheadle). Take a thick slice of stale bread (4 ozs.) and allow it to soak in cold water for six hours ; squeeze the water out. Place the pulp in a pint of fresh water and boil for an hour and a half. Rub through a sieve. About one tablespoonful of the cold jelly is added to 8 ozs. of water. The mixture contains ·74 per cent. proteid, ·13 fat, 4·15 carbohydrate, and is used as a basis for feeding infants with delicate digestions, its

deficiencies being supplemented by milk, cream, raw meat juice, etc. (See Dr. W. B. Cheadle, *Artificial Feeding of Infants*, 3rd Edit., Lond., 1894.)

MILK ANALYSIS

Fat is usually determined by the butyrometer (Gerber's is used in this country, Babcock's in America; obtainable from any Dairy Supplies Company), which consists of a centrifuge with specially graduated tubes. Milk, mixed with definite amounts of sulphuric acid and amyl alcohol is centrifuged in these tubes, and the fat read directly from the scale. Fat percentage and specific gravity being known, the total solids can be estimated indirectly. The specific gravity varies inversely with the fat, and directly with the proteids (sugar is fairly constant). Hence, High fat and High sp. gr. = high proteid.

Low fat and low sp. gr. = low proteid.

High fat and low sp. gr. = medium proteid.

Low fat and high sp. gr. = high proteid.

The butyrometer is rather cumbrous and expensive, but is accurate, and very simple in use. Other methods of estimating fat, such as Holt's

cream gauge (in which the percentage of fat is taken as $\frac{3}{5}$ of the determined quantity of cream), though not very accurate, are sometimes used in clinical work.

Percentage Feeding with Top Milks

Milk containing 4% fat. 1 oz. milk sugar=2 level tablespoonfuls.

Top Milk.	Proteid.	Fat.	Sugar.	Ratio of Proteid to Fat.
Upper fourth	4	12	4	1 : 3
,, third	4	10	4	2 : 5
,, half .	4	8	4	1 : 2

Diet During :—					Top Milk.	Dilu-ent.	Sugar.
1st week .	·5	1·5	5	Ratio of Proteid to Fat 1 : 3 (upper fourth milk)	1	7	1 oz. to pint
2nd ,, .	·65	2·	6		1	5	,, ,,
3rd ,, .	·8	2·5	6		1	4	,, ,,
4th–8th week	1·	3·	6		1	3	,, ,,
3rd month .	1·25	3·	6	Ratio of Proteid to Fat 2 :5 (upper third milk)	1	2	,, to 24 oz.
4th ,, .	1·4	3·5	7		6	11	,, to pint.
5th month.	1·7	3·5	7	Ratio of Proteid to Fat 1 : 2 (upper half milk)	3	4	,, ,,
6th–10th ,, .	2·	4	7		1	2	,, ,,

Percentage Feeding with Top Milks

Milk containing 4% fat. 1 oz. milk sugar=2 level tablespoonfuls.

Top Milk.	Proteid.	Fat.	Sugar.	Ratio of Proteid to Fat.
Upper fourth	4	12	4	1 : 3
„ third	4	10	4	2 : 5
„ half .	4	8	4	1 : 2

Diet During :—					Top Milk.	Diluent.	Sugar.
1st week .	·5	1·5	5	Ratio of Proteid to Fat 1 : 3 (upper fourth milk)	1	7	1 oz. to pint
2nd „ .	·65	2·	6		1	5	„ „
3rd „ .	·8	2·5	6		1	4	„ „
4th–8th week	1·	3·	6		1	3	„ „
3rd month .	1·25	3·	6	Ratio of Proteid to Fat 2 :5 (upper third milk)	1	2	„ to 24 oz.
4th „ .	1·4	3·5	7		6	11	„ to pint.
5th month.	1·7	3·5	7	Ratio of Proteid to Fat 1 : 2 (upper half milk)	3	4	„ „
6th–10th „ .	2·	4	7		1	2	„ „

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3rd „ .	·8	2·5	6		1	4	„ „
4th–8th week	1·	3·	6		1	3	„ „
3rd month .	1·25	3·	6	Ratio of Proteid to Fat 2 :5 (upper third milk)	1	2	„ to 24 oz.
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6th–10th „ .	2·	4	7		1	2	„ „

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