Principles and Practice of Infant Feeding

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TO

ISAAC A. ABT, M.D.

MY FRIEND AND TEACHER

THIS BOOK IS AFFECTIONATELY DEDICATED

PREFACE.

It has been our experience that the best results obtained in the teaching of the principles and practice of infant feeding have been accomplished when the theory of feeding and the study of actual cases have been combined.

Our object in publishing this volume is to place in the hands of teachers and students a manual on infant feeding to be used in preparation for clinical conferences. Whenever possible, the subject under discussion is illustrated in the class-room by clinical cases and case records from the teacher's personal material.

While there are many excellent works covering this subject, we have found most of them to be too voluminous to fulfill our needs, and we have therefore attempted to present the subject in concise form in this small volume.

For the teaching of nurses we have selected those chapters which have to do with the nursing care of premature, healthy, and sick infants, the feeding of breast fed and artificially fed healthy babies, and the preparation of infants' foods and diets.

Julius H. Hess.

Chicago, Illinois.

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INTRODUCTION.

The dependence of the offspring upon its mother for food to supply its primitive needs can only be realized when we remember that one-fourth of the civilized race die during the first year of life, and that 60 per cent. of these deaths are due to nutritional disturbances, while a large portion of the other 40 per cent. are primarily dependent upon impairment of the infant's constitution by improper feeding. The mortality of the first year is nearly 60 times that of the fifteenth year, and it is not until we approach the 85th year that we meet with such a high percentage death-rate. The problem is not simply to save life during the perilous first year, but to adopt those means which shall tend to healthy growth and normal development. The child must be fed not only to avoid the immediate dangers of acute indigestion, diarrhea, and marasmus, but the more remote ones—rickets, scurvy, and general malnutrition. These latter three are the most important conditions that predispose to disease in early life.

A growing child requires far more food than its weight would indicate. For, in the first place, its intake must exceed its expenditure, so that it may grow. The expenditure of an organism is pretty nearly in proportion, not to its mass, but to its surface. The skin surface of a boy from 6 to 9 years, with a body weight of 18 to 24 kilograms (40 to 50 pounds), is two-fifths to one-half that of a man of 70 kilograms (154 pounds), and he should therefore have about half as much food as the man. This disproportion in the needs of the infant as compared with the adult, is even greater than that of the child compared with the adult. By exact measurements it has been determined that an infant from its fourth to the sixth month consumes about twice as much food per kilogram body weight as the adult.

PART I.

General Considerations.

CHAPTER I.

THE ANATOMY OF THE DIGESTIVE TRACT OF THE INFANT.

Oral Cavity. The salivary glands are well developed at birth, and the active principles of the salivary secretion are present, but in small quantities. Teething begins at about the sixth month, and dentition is not completed until about the end of the second year. In most instances this is a normal physiological process, and should cause no disturbances. However, in a considerable number of cases the gastric and intestinal secretions are affected reflexly, with a diminished activity on the part of these glands; and if there is any tendency to a general disturbance during this period, a reduction in the quantity of the food administered is indicated. However, far too great an importance is usually given by the laity to the process of teething.

Stomach. In the newborn the stomach has a more vertical position than in the adult. However, röntgenologic examination has demonstrated that it is less vertical than has been formerly supposed. The cardiac end is found at the left of the tenth dorsal vertebra. The pylorus lies about midway between the ensiform cartilage and the umbilicus. The position of the stomach and its form, due to lack of development of the fundus and lack of muscular development at the cardiac end, account in great part for the frequency of vomiting in the infant.

The **pylorus** also lacks the muscular development of the adult, and is decidedly more patent.

Considerable difficulty is experienced in our attempts to gain accurate knowledge of the capacity of the stomach. Pfaundler, who measured the size of numerous infants' stomachs, using air under a given pressure, has given us figures which are, in all probability, fairly accurate.

He states that the capacity at birth is 2 ounces (60 mils), at one month 2 to 3 ounces (60 to 90 mils), at six months 6 ounces (180 mils), and at one year 9 to 10 ounces (270 to 300 mils). The importance of the stomach's capacity in determining the size of the individual feeding is only relative, dependent to a great extent upon the form of diet. With milk as the food, a considerable portion of the water content passes through the pylorus before the meal is finished, if the food is not too rapidly given. When a child is fed by gavage, the size of the meal is of greater importance because of the danger of overdistention by the rapid administration of the food by this method. Notwithstanding the fact that the size of the stomach varies in different babies, we have found it a good working rule in the feeding of normal infants to administer at each feeding a quantity 2 ounces more of the liquid food than the infant is months old.

The intestines are relatively larger than in the adult, which applies more especially to the large intestine, and particularly to the sigmoid flexure. The sigmoid is also more mobile, due to the greater length of the mesosigmoid, and it is extra-pelvic. The musculature is relatively thin, and bears an important relationship to the frequency of its overdistention and the presence of colic, which is due to the stagnation of large quantities of gas in the intestinal tract.

The pancreas shows no special anatomical differences.

The liver is relatively two-and-a-half times as large at birth as in the adult, and is easily palpable, and in the nipple-line of the right side usually extends 1 to 1½ inches (2 to 4 cm.) below the costal border.

CHAPTER II.

THE PHYSIOLOGY OF THE DIGESTIVE TRACT OF THE INFANT.

WHILE all the ferments are present in early life, they vary quantitatively and qualitatively as compared with the older children.

Mouth. Ptyalin, which is an amylolytic ferment, is present in the saliva immediately after birth, but is small in amount, and weak in its action. Albumin, water and mucus in saliva vary with the variety of food taken (Pavlow).

Stomach. Gastric juice is present in the stomach even in the premature. Its secretion is mainly stimulated by the act of sucking and by the presence of the food in the stomach.

Free hydrochloric acid is little less than in the adult. It may be stated that the small protein content of human milk, as compared with cow's milk, favors the presence of hydrochloric acid. This is a point of great importance in the food problem of the infant. Free hydrochloric acid is found in 10 per cent. of cases after 1 hour, and in 33 per cent. of cases after 1½ hours on feeding with human milk (Hamburger and Sperck). With cow's milk, free hydrochloric acid is found very rarely, which is due to combination of the hydrochloric acid with salts and proteins. Total acidity is in small part only due to free hydrochloric acid. More important are phosphoric acid, acid phosphates, acid chlorides, fatty acids and acid albumins (albumoses and peptones). Total acidity is 20 to 60 mils N:10 acid to 100 mils of gastric contents. The action of the hydrochloric acid is as follows: (1) makes protein digestion possible (acid albumins); (2) stimulates the pancreas; (3) disinfectant and antitoxic action.

The following ferments are present in the stomach: (1) *Pepsin,* which is present at birth, and is active and causes at least partial digestion of proteins. It increases to the fourth month, then remains fairly constant. More pepsin is present in bottle-fed infants. (2) *Rennin* is also present at birth, and in the presence of hydrochloric acid coagulates milk. Whether this is dependent on pepsin, or whether it is a specific ferment, is questionable. (3) *Lipase,* a fat-splitting ferment, is found in the stomach in small quantities, and is probably a definite product of the gastric mucosa.

Small Intestines. Mucous membrane of the small intestines secretes about 1 liter of juice daily, and this contains all ferments at birth, they being, however, relatively feeble at first. The following ferments are present in the intestinal secretion: (1) *erepsin* (Cohnheim), which splits casein, albumoses, and peptones to peptids and amino-acids. Other albuminous bodies are not affected by it. (2) *lactase, maltase, invertin;* they split disaccharides (milk, malt, and cane sugar) to monosaccharides, and each is stimulated by its own sugar. (3) *prosecretin,* which is changed to secretin by hydrochloric acid from the stomach, and stimulates the secretion of the pancreas. (4) *enterokinase,* which activates the proteolytic enzyme of the pancreatic juice; and probably (5) *diastase.*

Pancreas. All of the ferments (trypsin, steapsin, and amylopsin) are found in the intestines at birth.

The liver possesses the ability to form glycogen and urea in the newborn. Bile is present, its emptying from the gall-bladder being stimulated by chemical action of fats on the duodenal mucous membrane. The functions of the bile are: (1) to hold fatty acids and fatty acid salts in solution, (2) to stimulate the pancreas, and (3) an antiseptic action. Other functions of the liver are formation of urea, acetone, and formation and storing of glycogen.

Large intestines secrete no enzymes, their chief function being absorption of water and throwing off of Ca, P, Na, K, Fe, Mg.

CHAPTER III.

METABOLISM IN INFANTS.

1. General Considerations.

THE term metabolism covers all of the functions of the human body which have to do with the preparation for and assimilation of food.

To furnish the body with fuel for its normal activities, the following groups of food elements are necessary: proteins, fats, carbohydrates, salts, and water. Fats and carbohydrates, and to a lesser extent proteins, furnish fuel; while the proteins and salts more especially form the elements necessary for body growth.

It is necessary to distinguish between the activities which take place within the gastro-intestinal tract before absorption of the changed products and the deeper seated metabolism which takes place beyond the intestinal wall, which can be designated as the "intermediary metabolism."

Under normal conditions in the adults the intake and the products of excretion balance one another, while in the infant there is a positive balance—that is, less is excreted than is absorbed—and one may well say that a balance which would be normal in the adult is pathological in the child, and would thereupon soon result in a stationary weight, or a loss in weight.

Several factors offer difficulties in the study of infant metabolism.

First, it is difficult to obtain stools free from urine and with the water content intact.

Secondly, the small volume in which the urine and stools are obtained offers many difficulties in their study. Urine and stool examinations should cover a period of at least three days to be of conclusive value.

2. Composition of Milk and the Metabolism of Its Constituents.

The natural food of the infant is *human milk,* characterized by the fact that its quality changes very little, the infant's growth being dependent on the changes of its volume.

Milk of different animals varies as to its fuel value, and also in its chemical composition, especially quantitatively there being marked differences.

	Protein	Fat	Sugar	Salts
Human	1.5	3.5	6 to 7	0.20 per cent.
Cow's	3.4	3.8	4 to 5	0.75 " "

Human *colostrum* differs from the milk in that the protein is 5 to 6 times as great in the former; salts are also higher than in later milk; sugar is low—3 to 5 per cent.—and it is low in fats, averaging about 2 to 2.5 per cent., although it varies in different women, and also with the day of puerperium. Colostrum contains also numerous leucocytes and large cells containing fat, these latter probably being epithelial in origin.

1. **Proteins.** *Chemistry of Proteins.* Proteins contain carbon, hydrogen, nitrogen, oxygen, sulphur, and phosphorus. They are highly complex chemical substances, similar in their chemical composition to protoplasm and essential to life.

Of the proteins milk contains mainly casein and albumins, with small amounts of globulins, opalisin, nuclein, etc.

	Albumin	Casein	
Human milk contains	0.6	0.8	per cent.
Cow's milk contains	0.2 to 0.3	2.7 to 3.0	" "

Casein belongs to the nucleo-albumin group (proteins), which contain phosphorus, are insoluble in water, moderately in alkalies, precipitated by acids, not coagulated by boiling, and by pepsin digestion changed to para- or pseudo- nucleins (which are bodies rich in phosphorus). Chemically it is composed of a complex group of amino-acids, the basis of all protein bodies, and a prosthetic group which contains the phosphorus. Amino-acids are characterized by the group COOH, in which an H is replaced by NH_2 group, *e.g.,* acetic acid (CH_2HCOOH), amino-acetic acid, or glykokoll (CH_2NH_2COOH).

Human casein contains much less phosphorus than cow's (0.25 to 0.88). This proves that the casein of the human and the casein of the cow's milk are different bodies, although this difference is probably of a quantitative nature only. The two caseins differ also in their coagulability, the human casein being more difficult to precipitate with acids, salts and rennin. The soluble albumins are coagulated by heat and weak acids.

Metabolism of Proteins. Casein is separated from the so-called whey albumin, and is changed to an insoluble paranuclein. It is unknown whether enzyme causing it is identical with the protein digestive ferment of the gastric mucous membrane or not.

Pepsin (from the pyloric mucous membrane) changes paranucleins to albumoses and peptones, which then pass into the small intestines. (Erepsin, the ferment of the intestinal juices, works very rapidly on the end products of pepsin digestion.) In the small intestine an intricate splitting takes place.

With the human milk as a food, a very small amount of nitrogenous products of the food appears in the stools, the total being about one-sixth of the intake, and part of this arises from

1. Intestinal juices,
2. Intestinal epithelium.
3. Bacterial activity.

After passing through the intestinal wall, proteins have three functions to perform:

1. To replace used proteins (lost through urine, sweat, digestive juices, cell destruction, etc.).

2. To satisfy cell growth which would be impossible without proteins.

3. To furnish fuel for part of the dynamic loss (fats and carbohydrates are the natural fuels, the protein combustion being incidental).

In feeding with cow's milk, three times as much protein is given as needed for 1 and 2, therefore it is used for 3 (that is, dynamic purpose).

The great disproportion as seen in a comparison of the proteins in cow's over human milk is probably due to the needs for cell growth in the calf. Within certain limits, however, the excess of protein feeding in the infant does not cause increased retention and cell growth because of the ability of the organism to regulate its functions.

End Products of Protein Metabolism in Urine:

Urea 60 to 80 per cent.
Ammonia 3 to 10 per cent.

$$\left.\begin{array}{l}\text{Oxaluric bodies}\\\text{Uric acid}\\\text{Kreatinin}\\\text{Oxybutyric acid}\end{array}\right\}\text{Nitrogenous by-products.}$$

Urea forms 75 to 86 per cent. of the nitrogen constituents of the urine.

By *ammonia coefficient* is meant the relation of ammonia to the other nitrogenous bodies in the urine.

Influence of the Carbohydrates and Fats on the Nitrogen Metabolism.

1. Carbohydrates cause
   (1) Increased retention of proteins.
   (2) Increased nitrogen in feces.
2. Fats cause
   (1) No increased protein retention.
   (2) Increased nitrogen in feces.

2. **Fats.** *Chemistry of Fats.* Human milk fats are esters of palmitic, stearic, and oleic acids with glycerin, the oleic acid ester being present in larger amount in human than in the cow's milk. Human milk fats are derived partly from body fat and partly from food fat. Carbohydrates also furnish ingredients for fat making; proteins do not.

Metabolism of Fats.

1. Lipase from the gastric mucous membrane causes some splitting of fat.
2. Fats are emulsified in small intestines.
3. Live intestinal cells can change fatty acids to fats.

Resorption.

1. Lymph-vessels.
2. Blood-vessels.

Disposition.

1. Subcutaneous tissue.
2. Præperitoneal spaces.
3. Liver.

4. Burned with resulting end products.
   (1) Carbonic acid.
   (2) Water.

In stools found normally as unresorbed portion of ingested fat in the form of

1. Fat (neutral).
2. Lecithin.
3. Cholesterin.
4. Fatty acids representing 1 to 10 per cent. of fat ingested.
5. Alkali soaps.
6. Earthy alkali soaps.

In Urine. Fatty acids and glycerin are found in very small quantities, but we cannot say that these are from the fats ingested.

Nursing babies always have at least a small amount of fat in their stools. In contradistinction to proteins, the fats in the stools are in greater part only unresorbed fats, only a small amount being due to cell activity. (Proteins greater part).

Various percentages of fat ingredients normally present in human stools are, as follows:

Neutral fat	29.5 per cent.	
Fatty acids	10.7 " "	
Combined fatty acids	59.8 " "	(18.3 Ca and Mg.)

Fat in the Gastro-intestinal Tract and its Relation to Metabolism. Unlike proteins we can nourish the individual without fats, as carbohydrates can replace them. If too long continued, the organism changes, however, in its chemistry through increased absorption of salts and water, which, however, lessens the processes of immunity.

3. **Carbohydrates.** Milk sugar formed by the mammary glands from material circulating in the blood is a disaccharide (glucose and galactose).

Chemistry of Carbohydrates.

1. Monosaccharides.
   (1) Glucose (dextrose, grape sugar).
   (2) Lævulose (fruit sugar).
   They ferment and are reducible. (1) Has a right and (2) left polarization.
2. Disaccharides.
   (1) Lactose—glucose and galactose.
   (2) Maltose—glucose and glucose.
   (3) Saccharose—glucose and lævulose.
   (1) and (2) are reducible, (3) is not.
3. Polysaccharides (three or more sugar molecules).
   (1) Flour.
   (2) Dextrin.
   (3) Cellulose.

Metabolism of Carbohydrates. Monosaccharides are without further change absorbed in the small intestine or fermented.

Disaccharides are first reduced to monosaccharides by the intestinal ferments (every disaccharide having its specific ferment) before they can be absorbed. (This is not entirely true of maltose).

Polysaccharides are first acted upon by ptyaline in the saliva; this is continued in the stomach until the stomach content becomes acid, and then by enzymes of intestines and pancreas they are converted to monosaccharides.

After absorption into the blood, the carbohydrates serve the following purposes:

1. Used for energy.
2. Synthetically inverted into glycogen.
3. Fat foundation (probably).

Body cells can oxidize only monosaccharides (maltose excepted).

Interesting is the storing up of glycogen by the liver and muscles so that the sugar in the blood can be kept constantly at about 0.1 per cent.

Glycogen is most easily made from glucose and lævulose; less so from galactose, maltose and starch; least easily from cane and milk sugar.

Fat is formed from sugar by the subcutaneous cells, which are especially adapted to this function.

Sugar is oxidized to carbon dioxide and water, which can be measured by the respiratory metabolism. Normally, sugar is absorbed from the small intestines, and is not found in the feces.

In urine very minute amounts are present, when passing the capacity for assimilation, thereby producing an alimentary glycosuria. This is most easily accomplished in the following order: lactose, galactose, lævulose, glucose.

The assimilation limit for sugars is much greater in infants than in adults. An infant may develop mellituria when milk sugar exceeds 3.1 to 3.6 grams per kilogram body weight; in the adults at over 1 gram per kilogram. The cane sugar limit is about the same as milk sugar, while that of malt sugar is 7.7 grams per kilogram body weight. The height of the assimilation limit in itself shows that the infant's organism is adapted to a higher carbohydrate metabolism than that of the adult.

Carbohydrates in the Tissues. The newborn has a glycogen depot.

Carbohydrates can, in part at least, replace proteins and fats. They cause a rapid increase in weight (very rapid at first), being deposited in the tissues, as glycogen, which latter can absorb two to three times its weight of water.

The relation of fats to carbohydrates is as follows:

The more carbohydrates present, the greater is the tendency on the part of the system to build up body fats. As to oxidation of fats, "They are burned up in the fire of carbohydrates" (Naunyns).

The complete burning of fats into carbon dioxide and water takes place only when the carbohydrate metabolism is normal; otherwise we get as mid-products the acetone bodies (acetone, aceto-acetic acid, oxybutyric acid, etc.). This occurs also in starvation. (Important in infants' diseases, as seen in diabetes, continued fevers, intoxication, etc.).

Acetone bodies can also be formed from protein molecules. This occurs in starvation and in meat and fat diets (deficiency of carbohydrates in the latter).

Weight becomes stationary or a loss results when carbohydrates are excluded or insufficient in the diet. Temperature falls, and does not rise to normal until they are replaced.

4. **Salts.** *Chemistry of Salts.* Salts added to water are relatively split into their "ions"—that is, into either electrically positive or negative bodies. A solution of sodium chloride is a solution in which the NaCl molecule is intact, but the Na (kation) is electro-positive; the Cl (anion) is electrically negative.

Human milk contains 0.2 Gm. ash in 100 mils. Cow's milk 0.75 Gm. ash in 100 mils. Some exists as inorganic salts, others as important organic compounds.

I. *Kations* (or *cations*).

1. Calcium.
   (1) Human 0.42 Gm. per 1000 mils, cow's 1.72 Gm. per 1000 mils, about 1 : 4.5.
   (2) Excretion is almost entirely through intestines, some from unabsorbed food remnants, and the rest by tissue metabolism.
2. Magnesium.
   (1) Human 0.068 Gm. per 1000 mils, cow's 0.2 Gm. per 1000 mils.
   (2) Its metabolism is very closely related to the calcium.
3. Sodium. 4. Potassium.
   (1) Human milk 0.16 Gm. Na_2O, cow's 0.465 Gm. Na_2O per 1000 mils, 1 : 3.
   (2) Human milk 0.69 Gm. K_2O, cow's 1.885 Gm. K_2O per 1000 mils, 1 : 3.
   (3) Excretion mostly through kidneys and stools.
5. Iron.
   Human milk 0.001 to 0.004 Gm. cow's 0.0007 Gm. per 1000 mils. These figures show considerable variation according to different authors. Excreted mainly through the bowels.

II. *Anions*.

1. Chlorine.
   Human 0.294 Gm., cow's 0.82 Gm. per 1000 mils, 1 : 3.
   (1) Absorption: 90 to 100 per cent. through the intestine.
   (2) Excretion: mostly through kidneys.
   (3) About 0.5 per cent. retained by the system.

2. Phosphorus is contained in the milk in the following forms:
   (1) Inorganic (calcium phosphate).
   (2) Organic (casein, nuclein, lecithin, etc.).
   (3) Total in human 0.294 to 0.418 Gm., in cow's 2.437 Gm. per 1000 mils, 1:9.
   (4) Organic in human 43.3 per cent., and cow's 46 per cent., 1:1.
   (5) The retention is higher in artificially fed than those fed on human milk.

Relation of Salts to Metabolism. The salts are necessary in digestion and in every step of metabolism from absorption to excretion and secretion. The rôle of these salts in both normal and pathological conditions has been given constantly increasing importance in the last few years.

Metabolism of Salts in Infants. In the gastro-intestinal tract the foods and salts are constantly changing action.

A casein product and calcium combine in the stomach to form calcium paracasein.

Fatty acids and alkalies and earthy alkalies in the intestines form soaps.

Casein increases excretion of salt in the intestine (moderate).

Fat increases excretion of salts in the intestines (markedly, especially Ca, Na, K). At the same time the phosphorus excretion decreases as the calcium phosphates are changed to calcium soaps by combination of calcium with fatty acids, and the free phosphoric acid unites with sodium and potassium to form easily absorbed salts.

Salts are excreted in the urine and stools. The stools are the main source of excretion of calcium, magnesium,

2

and iron. Whether these are formed from the tissues or unabsorbed food is difficult to decide. The difference in percentages in human and cow's milk is equalized by the body using only what is necessary to its life and growth and not attempting to use it all.

Functions of Salts.

(1) They furnish building material for new cells. (Rachitis due to lack of absorption.)

(2) They are necessary to nerve excitability, muscle contraction, and many other vital functions.

(3) Addition of calcium and potassium to normal salt solutions counteracts their poisonous effects.

(4) Life is incompatible with withdrawal of minerals or even one ion.

(5) Life does not so much depend upon the ion as on its chemical combination. Therefore ash alone will not supply the needs.

(6) Infants need minerals for growth, as well as for life. Different tissues require different amounts and different salts.

(7) Weight drops with withdrawal of salts, even if other ingredients are constant, due to loss of water. Sodium salts are most important in water retention, calcium salts are least.

(8) Temperature falls, when salts are withdrawn (sodium).

(9) Phagocytosis is increased by calcium salts. Of value in infection.

5. **Water.** Infants need 105 Gm. of water, and adults 40 Gm. of water, per Kg.

Metabolism of Water. Intake is in the food. The outgo from the kidneys, bowels, lungs, and skin.

Water when ingested quickly passes through the stomach to be absorbed by the intestines. The water content of the organism varies with age and food. In the adult 58 per cent. of body is water, and in the newborn infant's body 66 to 69 per cent. is water. Sodium salts have the greatest facility for water retention.

Of the anions, Cl is the most marked in causing water retention.

Excretion of water takes place as follows: kidneys 59 per cent., skin and lungs 33 per cent., intestines 6 per cent. One to 2 per cent. of the water intake is retained.

Relation of Water to Metabolism. Approximately two-thirds of the body is water. All cells need it; it is necessary to different combinations and reactions. In general, it is necessary for young infants on artificial feeding to receive about 140 to 150 mils (4 to 5 ounces) per kilogram (2 pounds) body weight every twenty-four hours.

It carries nutritious material in the blood, lymph, cells, etc., and also the material for anabolism and katabolic products.

It is also necessary to the function of the lungs and of the skin.

It is deeply involved in the question of immunity.

6. **Lipoids.** *Lecithin.* Lecithin is the fatty acid ester of the glycerophosphates (glycerin phosphoric acid). Human milk, 0.499 Gm. per 1000 Gm.; cow's, 0.63 Gm. per 1000 Gm. The organism can apparently live without it in its food.

Cholesterin. Human milk, 0.25 to 0.38 Gm. per 1000 Gm. Mainly excreted by the intestines.

Lecithin and cholesterin belong to the group of the so-called lipoids, the substances which according to our present knowledge play a very important rôle in the life of the cell. Mice die if their food is made free from all lipoids. This is of interest when we consider that fat-free milk contains but little lipoids.

3. Milk Digestion.

1. **In the Mouth.** In the mouth milk is mixed with saliva, each 100 mils of milk averaging about 5 mils of saliva (Tobler). The secretion of saliva is stimulated mainly by the act of sucking, but also in part by appetite (psychic reflex). Ptyalin begins its action on the carbohydrates of the milk. Saliva may also cause coagulation.

2. **In the Stomach.** In the stomach the milk is curdled, casein being precipitated by rennin. Human milk coagulates less rapidly and less completely than cow's milk. Therefore in the latter the curds and the whey are more quickly separated.

Proteins are changed to albumoses and peptones by pepsin, and thus they are prepared for further digestion in the intestine. Albuminous digestive products stimulate gastric secretion.

Of *fats* 25 per cent. are changed to fatty acids and glycerin by lipase and action of bacteria. Fats at first retard, and later increase, the gastric secretion.

Action of ptyalin on *carbohydrates* is continued during the alkalinity of the stomach.

Absorption in the stomach is as follows: (1) salts and sugars, (2) proteins (small amounts), (3) water (none), (4) fats (none).

Shortly after beginning of the nursing some of the whey content of the food begins to leave the stomach. This is more especially true if the ferments are active.

The time also varies with the quality of the meals. Human milk leaves the stomach in about one and one-half to two hours after ingestion, and cow's milk in about three hours after ingestion. Two factors have an important bearing on this point: (1) the quantity of the fat, which delays the passage of the food through the pylorus, (2) the size of the curds, the large curds of the cow's milk delaying emptying of the stomach.

As previously stated, whey quickly passes out of the stomach, and remaining curd is digested at the surface, and this passes over. Solid masses may pass through. After each passage of food the pylorus again closes. The rapidity of emptying the stomach depends on the action of the pylorus, and this in turn on the chemical composition of the food. Fats and albumins remain long in the stomach, sugars and salts passing through more rapidly.

3. **In the Small Intestines.** The action of the gastric digestion on the proteins is supplemented by trypsin from the pancreas, and the erepsin of the succus entericus. End products of the protein digestion are amino-acids. Carbohydrates are split into monosaccharides in the small intestines and are absorbed there. Fats which have been split into fatty acids and glycerin are emulsified and absorbed. Absorption of all digested food is almost complete in small intestines. It may be stated that intestinal or pancreatic digestion is far more important than gastric digestion in the infant.

4. **In the Large Intestines.** Absorption of water and excretion of salts are the chief functions of the large intestines in the digestive process.

5. **Feces and Urine.** *Feces* is composed of food remnants, products of secretory activity of the intestines, products of desquamation of the intestines and bacteria.

Composition of feces depends to a certain extent upon the nature of the food ingested. Foods rich in proteins (skim milk, albumin milk, etc.) cause increased intestinal secretion, with resulting alkaline reaction, which favors putrefaction and furnishes conditions favorable for development of fat soap stools. Excess of carbohydrates with acid fermentation gives another picture. Putrefaction and fermentation work antagonistically on the reaction of the stool. There is a balance between the acids derived from fat and sugars by bacterial action and the alkaline intestinal secretion.

Proteins in the stool (giving biuret and Millon's tests) are in greater part not derived from food proteins, but they are due to intestinal secretions, desquamated epithelial cells of the intestines, and to the bodies of bacteria. This is especially true of breast-fed infants. The normal infant stool contains no unchanged casein.

Fat has important influence upon the formation of the stool. On feeding with human milk poor in fat the stools are small, containing small quantities of solids and some mucus. On feeding with human milk which is rich in fat, normal stools are produced. Microscopically fat is always evident in stools, and is derived partly from food, and in small quantities from the secretion of intestinal juices. Fatty acids and fat soaps are constantly found.

Salt excretion is an important function of the large intestine. In the breast fed, ash content of dry stool is 10 per cent., bottle fed 40 per cent. Insoluble calcium salts harden the feces.

The following are some tests on constituents of feces:

1. Fat soap easily seen as fatty acid crystals (needles) by heating with acetic acid on the cover glass and allowing to cool.

2. Carbofuchsin in weak solution stains as follows: Neutral fat: no stain. Soaps: faint rose color. Fatty acids: red.

3. Sudan III. stains as follows: Neutral fat: orange red. Soaps: crystals do not stain. Fatty acids: stain red or crystals, orange red.

4. Sugar is not demonstrable in any quantity as such, but the character of the fat soap stool seen in milk feeding without sugar is changed to a softer, smaller, and normal color by adding sugar.

5. Starch is demonstrable by iodine test microscopically, but care must be exercised in the interpretation of the test, as the starch may be derived from baby powders.

The color of the stool is due to bile coloring matter derivatives: bilirubin and its reduction products, urobilin and urobilinogen. The smaller the reduction of coloring matter there is present, the more colored the stools. By marked reduction to urobilinogen, the color becomes almost white. The more milk and cream, *i.e.,* fat, in the diet, the paler the feces. The so-called soap stool is due to excess of fat and overfeeding with milk or cream, and is a firm, grayish, putty-like stool. (See Disturbed Metabolic Balance.)

Thin watery stools must always be taken seriously. However, the same cannot be always said of green, curdy stools, which are not infrequently seen in thriving breast-fed infants. These curds are almost invariably due to fatty acids and soaps.

Normal stools of breast-fed infants are homogeneous, salve-like, ochre-yellow color, acid, and of sour odor. Microscopically may be seen detritus masses, bacteria, few neutral fat corpuscles, and fatty acid crystals.

Normal stools of bottle-fed infants vary with the diet. One can frequently tell the diet by the appearance of the stool. On milk diet: less frequent, usually 1 or 2 daily, firmer and drier, usually pale yellow, alkaline and of foul odor. Constipation is the rule in babies receiving large quantities of milk with a moderate amount of carbohydrates. Sugars have a laxative tendency (fermentation). Excess of brown color may be caused by excesses of malt sugar. Starches, if well taken, tend to constipate, in large amounts they tend toward an acid reaction and an aromatic odor.

Starvation of hunger stool is seen on a very limited diet, as minimum amounts of milk, tea, cereal water. The stool has a dark, greenish-brown color, is soft, and composed in great part of mucus, and appears semi-transparent. This mucus may lead to further starvation through mistaken interpretation of its meaning, and result disastrously.

In the past it was taught that a study of the stools gave one definite information for the differential diagnosis of the gastro-intestinal disease, but experience has taught us that conclusions are of value only when based upon stool examinations in conjunction with a careful study of the diet, and clinical examination of the infant.

Urine. A normal infant urinates ten to fifteen times daily, and the urine passed represents 60 to 70 per cent. of the fluids taken as food and drink. It is acid in reaction, and should be free from albumin. However, albumin frequently is present in the simple nutritional disturbances, and almost constantly in the severe acute illnesses. The temporary presence of albumin in the urine of the newborn may be considered physiological, as well as the uric acid during the very early stage. Great decreases, even to anuria, are common with the intestinal disturbances.

CHAPTER IV.

BACTERIA OF THE DIGESTIVE TRACT OF THE INFANT.*

1. The Newborn.

For about one day the meconium passed by the newborn baby is sterile. During this time, however, the bacteria begin to invade the digestive canal of the infant through the mouth and through the anus. The initial intestinal flora which thus develops is subject to marked differences, the number and nature of the bacteria depending chiefly upon the surroundings of the infant, and exhibits no characteristic constant findings.

This period is followed by gradual transition in the nature and in the number of the intestinal bacteria, until about the third day after birth characteristic intestinal flora becomes established, constituting chiefly of Bacillus bifidus (in the nursing infant) and Bacillus coli (in the artificially fed infant), and, besides these, Bacillus acidophilus, Micrococcus ovalis, Bacillus lactis aërogenes and others.

2. The Nursing Infant.

The principal portal of entry of the intestinal bacteria is the mouth. There is no doubt that a great variety of organisms may from time to time enter this atrium, in-

* In the elaboration of this chapter free use has been made of A. I. Kendall's Bacteriology, Lea & Febiger, Philadelphia and New York, 1916.

cluding not only the ordinary organisms of the nursling's environments, but pathogenic bacteria as well. A majority of these pass to the stomach, and they may pass to the intestinal tract.

The flora of the mouth and of the stomach are not well known, but they appear to be of relatively slight importance as a rule.

The duodenal flora in health is composed chiefly of coccal forms of the Micrococcus ovalis type. Bacillus coli and other members of the colon group are most numerous at the ileocecal valve and the cecum, and Bacillus bifidus or similar organisms dominate the large intestines from this level to the sigmoid flexure. The remainder of the large intestines to the rectum is somewhat sparsely populated with living bacteria, partly because the fecal mass is relatively desiccated by the absorption of water, partly because of the accumulation of waste products of bacterial activity—principally acids resulting from fermentation of lactose, formed higher up in the tract—which inhibit the development of bacteria in the lower levels.

Bacillus bifidus (Gram positive, blue stain) predominates in the intestinal flora of the breast-fed infant, being acid tolerant and finding favorable conditions for its growth and development, since in digestion of mother's milk lactic acid production from lactose is so great as to inhibit the growth of the Bacillus coli and Bacillus lactis aërogenes in the lower end of the ileum, while the highly acid medium favors the growth of the Bacillus bifidus communis and the acidophile bacteria. Coccal forms and lactose fermenting organisms are present, but scanty; spore bearers are rare.

3. Artificially Fed Infants.

Escherich directed attention to the striking dissimilarity between the intestinal flora of the breast fed and the artificially fed infant. Culturally, morphologically, and chemically the former is more uniform than the latter. The most distinctive features of the dejecta of the artificially fed infants are: the relative increase of Gram-negative bacteria of the coli-aërogenes type, and of coccal forms of the Micrococcus ovalis type, together with a diminution of Bacillus bifidus. Bacillus acidophilus is relatively more numerous, as a rule, in the artificially fed infant than in the nursling. Proteolytic bacteria of several types are also of frequent occurrence, but they are not commonly found in the dejecta of the normal nursling. These organisms are frequently spore-forming bacilli, of which two principal groups are recognized —members of the aërobic group, of which Bacillus mesentericus is a prominent type, and anaërobic bacteria. Of the latter, Bacillus aërogenes capsulatus is most widely known; it frequently occurs in small numbers in the feces of artificially fed infants. The reaction of normal feces of artificially fed babies is usually alkaline; culturally and chemically, the evidence of intestinal proteolysis of bacterial causation is more marked in these infants than in normal nurslings.

The general distribution of types of bacteria at the different levels of the intestinal tract is similar to that observed in normal nurslings. The principal differences are found in the cecum and large intestine, where the obligately fermentative bacteria of the bifidus type are replaced to a considerable degree by an extension of habitat of the Bacillus coli, of Bacillus acidophilus, and the appearance of moderate numbers of proteolytic bacteria, both aërobic and anaërobic; many of the latter are sporogenic.

The characteristic feature of the normal adult fecal flora as compared with the infantile nursling flora is the very heterogeneous variety of types of bacteria in the former, in sharp contrast to the homogeneity of types of bacteria in the latter.

4. Significance of the Intestinal Bacteria.

The striking differences in morphology, chemistry, and in cultural characters between the intestinal floras characteristic respectively of nurslings, artificially fed infants and adults suggest at once that nutritional stimuli may be an important factor in determining the dominance of type of bacteria. It is probable that the significance of the intestinal flora lies rather in its potential antagonism to alien bacteria, which certainly gain entrance to the alimentary canal from time to time, than in any specific participation in the normal digestive process of the host.

The normal intestinal flora may be regarded as intestinal parasites, just as the various bacteria which occur commonly on the skin are regarded as cutaneous parasites. It is important to realize that the normal intestinal organisms, like the cutaneous organisms, are "opportunists," potentially capable of becoming invasive whenever the barriers which ordinarily suffice to limit their development to the lumen of the alimentary canal become impaired, giving rise to endogenous infections.

5. Influence of the Diet on the Intestinal Flora.

Intestinal flora varies greatly, the most important factor in determining its nature being the chemical composition of the food. Human milk gives essentially different flora from cow's milk. There are two groups of bacteria possessing an antagonistic action, those causing fermentation (saccharolytic), and those causing putrefaction (proteolytic). The representatives of the former are Bacillus lactis aërogenes and Bacillus bifidus, the latter being the most important organism in the stool of the breast-fed infants. The group exercising proteolytic activity is less clear. We know only that in the processes of putrefaction the bifidus flora is replaced by the coli group. Depending on the predominating group of bacteria, putrefaction or fermentation takes place, causing either firm or soft stools, this rather than the activity of the ferments determining the nature of the stools. The nature of the food and its chemical composition, therefore, determines the nature of the development and activity of the particular bacteria in the intestinal tract.

The human milk, rich in sugar and low in protein, leads to the flora of fermentation, while cow's milk, rich in protein and poor in sugar, to the flora of putrefaction. This phenomenon is nothing specific, but is due to individual components of the milk and their mixture.

Carbohydrates lead to the development of the fermentative organisms; the split products of carbohydrates are acetic, butyric, lactic and carbonic acids.

The nature of the dominant organisms which develop in diets rich in carbohydrates varies with the carbohydrate itself. Bacillus bifidus is more commonly predominant when lactose is the sugar fed, without an excess of protein. If maltose or dextrose is substituted for lactose under the same conditions, Bacillus acidophilus is very frequently the more prominent.

The fermentative action is increased by sodium and potassium salts as found in whey. (This latter probably in part explains the results obtained in feeding malt sugars together with potassium carbonate.)

Proteins favor the development of the organisms of putrefaction and lead to formation of indol, skatol, and amino-acids, these being the products of aromatic and fatty series. Gases are also formed by the latter action.

The nature of the protein influences the types of proteolytic bacteria to a very marked degree. In general, animal proteins other than casein appear to encourage somewhat more active proteolytic flora than vegetable proteins.

The processes of putrefaction are favored by calcium salts.

The influence of *fat* in its relation to bacterial processes is not clear. It seems to be able to favor fermentation, if this be already present, and also to increase the intensity of the processes of putrefaction.

In breast feeding fermentation outweighs putrefaction. The question whether fermentation or putrefaction in the intestinal canal is desirable, must be answered *a priori* that the fermentative processes are physiological, since breast feeding always leads to this. By this it must not be understood that the putrefaction in artificial feeding causes injury. Excessive intestinal fermentation in artificial feeding may be the forerunner of disaster, and is to be avoided (dyspepsia, intoxication).

Within certain limits, we are able to influence the bacterial processes in the intestinal tract in the normal infant, and thereby change the character of the feces. In a sick infant this is more difficult, and larger quantities of putrefacient food are necessary to overcome pathological fermentation.

6. Intestinal Bacteria in Their Relation to Gastro-intestinal Disturbances.

There are many intestinal disturbances of unknown causation, presumably unrelated to bacterial activity. There is a second group of conditions in which bacteria may conceivably play a secondary part; in some of the latter abnormal physiological conditions in the alimentary canal may be justly regarded as the antecedent factors. The boundaries of these two groups are poorly circumscribed, and they merge through imperceptible or poorly defined limits into a third group of cases in which the activities of endogenous or exogenous bacteria in the alimentary canal may be the causative factor in morbid processes of the gastro-intestinal tract.

The symptomatology induced from the products arising from the *decomposition of proteins or protein derivatives* by the action of bacteria in the intestinal tract depends largely upon the organism or organisms concerned. It varies from the somewhat insidious, slowly progressing, so-called autointoxication, in which a marked increase of urinary ethereal sulphates may be a suggestive index, to the acute toxemias characteristic of bacillary dysentery, typhoid, paratyphoid or cholera. Of course, a variety of other bacteria than the few mentioned specifically may be concerned, either alone or in symbiosis. Thus streptococci alone, and streptococci in association with dysentery bacilli, may be justly regarded as the etiological agents in their respective syndromes. The important factor, from the viewpoint of this discussion, is to realize that the formation of nitrogenous products from proteins or protein derivatives, which are being utilized by various types of intestinal bacteria for energy, may be injurious to the host.

The other prominent type of abnormal bacterial activity in the alimentary canal—the fermentative type—is of entirely different origin. The essential factor is either a *fermentation of carbohydrates,* with the formation of products abnormal for the intestine, or of excess of normal fermentative products. The factors leading to an overgrowth of these organisms in the intestinal tract appear to be an excess of carbohydrate and a lack of normal lactic-acid-forming bacteria.

It is unfortunate that practically none of the bacteria which incite intestinal disturbances or illnesses produce soluble toxins against which antitoxins can be prepared. Sera likewise have been unsatisfactory. There is little, therefore, that can be accomplished serologically with the present methods in the treatment of intestinal disturbances of bacterial causation. Attempts to permanently eliminate or destroy undesirable bacteria with cathartics and intestinal antiseptics have not been productive of results in the past, and prolonged starvation *per se* does not lead to intestinal sterility or to a significant reduction in the offending bacteria.

There are two ways, however, in which direct influence may be applied to bacteria in the intestinal tract: by substituting harmless types of organisms for abnormal types, and by varying the diet of the host in such a manner that the intestinal contents at the desired level shall contain nutritive substances that may be reasonably expected to shift the metabolism of the offending organism, and therefore radically change the character of the products of its metabolism.

Diseases Due to Proteolytic Activity of Bacteria. There are a number of conditions of bacterial causation in which available evidence points strongly to the formation of products arising from the metabolism of protein or protein derivatives by specific organism as important etiological factors in the morbid process. Thus, cholera, bacillary dysentery, typhoid, paratyphoid, and many less acute infections are associated definitely with the development of these organisms within the body, and to some degree at least, at the expense of the body tissues.

Available evidence points strongly to the view that cholera vibrios, typhoid, dysentery and paratyphoid bacilli and similar organisms produce their characteristic and harmful effects when they are developing in media free from utilizable carbohydrates; when utilizable carbohydrates are added to these media, non-characteristic, harmless products are formed.

In the absence of any definite indication to the contrary, it would be logical to attempt to maintain a sufficient concentration of carbohydrates within the intestinal canal in these infections as a therapeutic measure.

The important effects to be accomplished by a liberal carbohydrate diet in those infections where the decomposition of proteins or protein derivatives by bacterial activity leads to chronic or acute illness of intestinal origin are: a change in the metabolism of the offending organism resulting in the formation of lactic and other acids in them in place of putrefactive products, and a gradual replacement of the proteolytic and pathogenic types by bacteria of the fermentative varieties.

Diseases Due to Excessive Fermentation of Carbohydrates. Another type of intestinal disturbances depends upon an unusual or an excessive fermentation of carbohydrates. This is frequently seen in young infants, in many of whom we have a limited carbohydrate tolerance. (See Nutritional Disturbances.)

PART II.

The Nursing.

CHAPTER I.

GENERAL CONSIDERATIONS.

WRITERS on this subject are very prone to state that the ability of the mother, particularly among the well-to-do, to fulfil this most important function is decreasing. This may have been a true statement fifteen or twenty years ago. At the present time, however, we are sure it is erroneous. The young mother of to-day is better able to nurse her offspring than was her sister fifteen or twenty years ago. We attribute this to the fact that the youth of the present day are more vigorous, more nearly normal individuals, than were those of an earlier date. Breast-milk during the first two or three weeks of the infant's life is produced under unfavorable conditions, which do not indicate the possiblities of the breast as a secreting organ. Early nursing, following as it does upon the stress of confinement, is not indicative of what may be possible later, when the customary life and daily habits are resumed. . Repeatedly we have found a very high fat or a high protein, or both, entirely corrected after the first week or two without interference. This condition at the time was considered sufficiently serious to warrant the discontinuance of nursing on the part of a weakly infant, while in a vigorous infant it would be entirely ignored. A neurotic mother makes the poorest possible milk-producer. Proportionate to the population, there are fewer neurasthenics among the young women to-day than there were twenty years ago, and there will be still fewer twenty years hence. At the present time the timid, retiring young woman of the neurasthenic type is not popular in her set.

Few functions with which we have to deal are so variable and uncertain as the production of breast milk. Breast milk is one of the most precious substances. It is invaluable, unless we can put value on human life. The most successful nursing age is between the twentieth and thirty-fifth year.

Some mothers will be able to carry on the nursing for only two months, others three, five, seven, or nine months. In our experience in both out-patient and in private practice it is extremely rare for the breast milk to be sufficient for the infant after the ninth month.

It should be remembered that besides the protein, fat, carbohydrate, salts and water content there are other bodies contained in human milk, which, even though not essential to the infant's life, are of inestimable value to it. These may be divided into two groups:

1. Immunizing bodies—antitoxins, alexins, etc.—which are contained in the mother's blood, and transmitted to the baby through her milk. They are of value in protecting the infant against infections.

2. Ferments: lipase, galactase, lactokinase, and diastase.

Examination of Human Milk. This is rarely of any practical value. The protein rarely causes trouble, and the sugar is usually constant (6 to 7 per cent.). The examination of milk is therefore usually restricted to a determination of the fat content by means of the lactometer. The richest milk, however, will usually agree with the baby, and it is apt to thrive equally well on a milk that shows a small amount of fat. In other words, the baby and not the lactometer is the only practical test. If the milk disagrees, it will be evident clinically. *No baby should ever be deprived of its mother's milk only because of the results of a clinical examination of the milk.*

In making an examination of the mother's milk one must bear in mind that the first milk is very poor, the last very rich in fat, and that an average specimen can be obtained only by mixing the whole amount, or by combining the first and the last, or, better still, by taking only the middle portion after a few drams have been drawn off. This can be accomplished by allowing the infant to nurse for two minutes before expressing the sample.

Contraindications to Nursing. *Tuberculosis* when progressive or open is always a contraindication to nursing, because of the danger to the infant and the strain on the mother. With proper precautions, and where the breast is not diseased, and human milk is not obtainable from other sources, it may be well to tide a weak infant over its first weeks by expressing the milk from the mother's breast.

Syphilis of the mother, except in freedom from infection on the part of the infant, is not a contraindication. Lack of symptoms on the part of the mother in congenital syphilis is a very common occurrence; a Wassermann reaction on the mother's blood will quickly clear up any doubt.

Any *grave constitutional disease* in which there is an extraordinary drain on the resources of the body (diabetes, heart disease with disturbed compensation, nephritis, Basedow's disease, malignant neoplasms, epilepsy and psychoses) are contraindications to nursing.

Acute diseases should only in exceptional cases be considered as contraindications to nursing, and should include conditions in which there is danger of overburdening the mother and infections endangering the infant.

CHAPTER II.

MATERNAL NURSING.

1. Nursing Axioms.

The following may be laid down as nursing axioms:

A diet similar to what the mother was accustomed to before the advent of motherhood should be taken.

There should be one bowel evacuation daily.

From three to four hours daily should be spent in the open air in exercise which does not fatigue.

At least eight hours out of every twenty-four should be given to sleep.

There should be absolute regularity in nursing.

There should be no worry and no excitement.

The mother should be temperate in all things.

2. Hygiene of the Mother.

The Diet of the Mother. Many times, when consulted by nursing mothers because the nursing was unsuccessful or a partial failure, we have found that their diet had been restricted to an extreme degree. To put on a greatly restricted diet a robust young mother who has always eaten bountifully of a generous variety of foods is one of the best means of curtailing the quantity and lowering the quality of her milk supply. When asked to prescribe a diet, we tell such mothers to eat as they were accustomed to before the advent of pregnancy and motherhood. That this particular vegetable or that particular fruit should be forbidden on general principles is a fallacy. Food that the patient can digest without inconvenience is a safe food so far as the nursing is concerned, as may readily be determined in any given case. For certain individuals, however, a plain, more or less restricted diet is desirable. This must be remembered in the management of the wet-nurse (to be detailed later).

Nursing is a perfectly normal function, and a woman should be permitted to carry it out along the natural lines. Inasmuch as there are two lives to be provided for instead of one, more food, particularly of a liquid character, may be taken than the mother may be accustomed to. It is our custom to advise that milk be given freely. A glass of milk may be taken in the middle of the afternoon, and 8 ounces of milk with 8 ounces of oatmeal or cornmeal gruel at bedtime, if it does not disagree with the mother. Our only evidence that a food is disagreeing is the condition of the digestion. When any article of food disagrees with the mother, or if she is convinced that it disagrees, whether or not such be really the case, the food should be discontinued. In a general way, milk (one quart daily), eggs, meat, fish, poultry, cereals, fresh vegetables and fruits constitute a basis for selection. Although occasionally mother cannot take acid fruits, salads and aromatic vegetables, they may be tried and discarded, if they disturb the infant. Eggnogs, thin cereal gruels mixed with milk, cocoa and malted milk and similar drinks can often be taken to advantage between meals.

The Bowel Function. A very important and often neglected matter in relation to nursing is the condition of the bowels. There must be one free evacuation daily. For the treatment of constipation in nursing women we have used different methods in many cases. The dietetic treatment and plenty of recreation and exercise promise most. Manipulation of the diet should not be such as to interfere with the milk production. Three other methods are open to use: massage, local measures and drugs. Massage is available in comparatively few cases. Local measures consist in the use of enemas and suppositories. Every nursing woman under our care is instructed to use an enema at bedtime, if no evacuation of the bowels has taken place during the previous twenty-four hours. For a laxative in such cases and in many others, a capsule of the following composition has served well:

℞ Extracti nucis vomicæ .... 0.015 Gm. (¼ gr.).
Extracti cascaræ sagradæ .... 0.325 Gm. (v gr.).
Sig.: To be taken at bedtime.

The amount of the cascara sagrada may be varied as the case may require. In not a few instances we have found it necessary to give 2 capsules a day in order to produce the desired result. Neither the nux vomica nor the cascara appears to have any appreciable effect on the child.

Air and Exercise. Outdoor life and exercise are not only as desirable here as they are under all other conditions, but to the nursing woman, with her added responsibility, they are doubly valuable. In order to get the best results, exercise or work should be so adjusted as not to reach the point of fatigue. The mother whose nights are disturbed should be given the benefit of a midday rest of an hour or two. It should be our duty, however, to explain to the mother and to other members of the family that an important element in satisfactory nursing is a tranquil mind.

Care of the Breasts. A well established routine should be instituted for the care of the breasts. To facilitate this a readily accessible tray with the necessary utensils should be provided. This should contain a glass-stoppered bottle with a saturated solution of boric acid, a jar of cotton pledgets on toothpicks, to be used as applicators for the boric acid, a graduated glass or beaker. The nipples should be thoroughly washed before and after nursing with a saturated solution of boric acid poured fresh from the bottle for each cleansing, and the surplus thrown away. The boric acid should be applied with the cotton pledgets. The fingers should not come in contact with the nipples, if the child is to nurse directly at the breast. If the nipples are tender, they should be annointed with a sterile mixture of 5 per cent. tincture of benzoin in liquid vaseline.

All utensils, including the breast-pump, if one is in use, should be sterilized by boiling. In case of the breast-pump, the rubber bulb may be removed for this purpose. Where the milk is to be expressed by hand, the hands must be thoroughly disinfected by washing with soap and water, and rinsing with alcohol before manipulation of the breasts. Under all conditions soap and water should be freely accessible, and their use required before handling the breast or the infant.

3. Conditions Influencing the Breast Milk.

The advent of the first *menstruation* period particularly, and in some cases the beginning of every menstruation period, is attended with an attack of colic or indigestion in the child. Such attacks, however, rarely necessitate the discontinuance of the nursing even for a single day. Not infrequently the quantity of milk is somewhat lessened during menstruation, and this will result in the infant becoming fretful, due to insufficient quantity of the feeding. Under no circumstances should menstruation be considered an indication for weaning.

Factors influencing the *mental condition of the mother,* such as anger, fright, worry, shock, distress, sorrow, or the witnessing of an accident may affect the milk secretion sufficiently to cause no little discomfort to the child, and oftentimes the lessening of the flow for a day or two. At times, especially when the mother is under influence of shock or grief, it may be necessary to substitute artificial feeding for a few nursings during these periods, until the mother has again resumed her mental equilibrium, her breast being emptied by mechanical means in the meantime.

Drugs, alkaloids of opium, hyoscyamus, belladonna, and similar drugs, when given in large quantities, not infrequently pass into the milk, and should therefore never be administered in large quantities to the nursing mother. Belladonna may cause a decrease in milk secretion, and should be administered with caution during the period of lactation. Mercury, iodides and the newer salts of arsenic are also secreted in the milk, and may be used to advantage when a luetic mother is nursing a luetic infant.

4. The Nursing Proper.

Regularity in Nursing. The breast which is emptied at definite intervals invariably functionates better than does one which is not, not only as regards the quantity, but also the quality, of the milk, thus regular habits in breast-feeding are as essential to milk production as to its digestion and assimilation. *The baby should be wakened to be fed.*

The average mother will supply the needs of the individual meal with *one breast,* and the breasts should be alternated in successive feedings. Thorough emptying of the breast should be encouraged under all circumstances, as this is our best method for increasing the milk supply, and the baby is the only means at hand by which this can be accomplished. This should be encouraged in every instance. It is most readily thwarted by allowing a lazy baby to partially empty both breasts, and will soon lead to a diminished milk secretion. By this means the mother and the baby soon become adapted to one another, and it will be found that the desired effect is accomplished both where the milk supply is insufficient or, again, excessive. In the former instance complete emptying of the breasts increases the secretion, and, where excessive, incomplete emptying will soon result in a lessened supply.

Sometimes, however, it is advisable to give *both breasts* at each feeding, *i.e.,* under the following conditions: (1) During the first few days, to stimulate secretion, and a little later to relieve the congested breasts; (2) to weak babies when there is an abundance of milk, and they are not strong enough to get the last milk that comes harder; (3) to overfed babies, where it is desirable to give them only the first and weakest milk, and to lessen the yield of the milk from the breast; (4) as the milk supplied by one breast fails to meet the needs of the infant, both breasts should be given at each nursing; the first breast should be thoroughly emptied before allowing the baby to take the second breast, and the next nursing started on the second breast given in the last feeding.

Number of Feedings in Twenty-four Hours. Four-hour intervals at start with six feedings in twenty-four hours, five feedings by the second to the fifth month, according to the individual needs of the child. Night nursing can often be discontinued by this time, and babies properly fed will go from 10 P.M. to 6 A.M. without anything but perhaps a drink of water.

Premature and delicate infants and infants with a tendency to vomit are exceptions, and must be fed smaller amounts at more frequent intervals.

Length of Nursing. As a rule, a robust baby takes three-fourths of the milk obtained from a good breast in the first five minutes of a twenty-minute nursing. Fifteen to twenty minutes should be the limit for the nursing period. If a baby is doing well on shorter periods, and seems satisfied, let it be its own judge of the nursing time. Weak and lazy babies may require awakening during the nursing period to keep them at work. Very weak babies may require a longer period, with short intervals, in which they rest.

Giving of Water. From ½ to 1 ounce of a 1 per cent. solution of cane or milk sugar should be given the infant every three or four hours until the milk appears in the breast. Otherwise there will be unnecessary loss of weight and perhaps a high degree of fever due to inanition. A high temperature during the first days of life is more commonly due to *"inanition"* than infection in present-day obstetrics. The best differential test is administration of water or sugar-water at regular intervals. In a case of inanition plenty of fluid intake results in a critical drop in the temperature.

If the child is restless and uncomfortable, it is safe to conclude that it is thirsty. One ounce of the sugar-water will usually satisfy it. With the commencement of nursing, the baby should be accustomed to getting the food at regular intervals. Even when milk is plentiful, the administration of water, two or three times daily, from a nursing bottle accustoms the baby to taking the food in this way. This makes weaning more easy in case of emergency.

CHAPTER III.

WET-NURSING.

1. The Wet-nurse: Her Selection and Her Baby.

The Problem. When there is a positive inability on the part of the mother to nurse her offspring, either through improper development on the part of the breast or systemic disease, we are confronted with the problem of securing human milk from another source, as notwithstanding the numerous reports on successful raising of infants on artificial foods, the statistics of infants fed by artificial foods when compared with those of infants fed on human milk are so strikingly in favor of the latter that the obtaining of human milk must always be considered as an important issue.

How Obtained. In our experience, even in a large city, great difficulty has been met in obtaining a regular supply of wet-nurses. On several occasions various charitable and hospital societies have attempted to establish a wet-nurses' registry as a clearing-house for the several maternity and general hospitals of Chicago. These attempts have not been successful for two reasons: (1) because of the irregularity in the demand, and (2) because of the lack of co-operation on the part of the various institutions caring for this class of cases.

The Nationality of the Wet-nurse is of considerable significance where the supply allows of a selection. The phlegmatic temperaments as seen in women of Northern and Central Europe of Teutonic and Slavic descent, offer the ideal material, while other nationalities, such as Italians, and the Southern negroes when removed from their home environment to a Northern climate, secrete a milk poor in quality. However, even the latter in an emergency should not be neglected.

Requirements of a Good Wet-nurse. 1. She should be in good health, and, especially, free from all contagious and infectious diseases, and also from local diseases of any kind, such as those involving the nose, throat, skin, etc.

2. Her mammary glands should be of such quality that she can secrete sufficient milk of good quality, and the nipples sufficiently developed to allow of nursing, or proper expression of the milk.

3. Whenever possible, her age should be not less than 18 and not more than 35 years.

4. The age of her baby, as compared with that of the baby she is to nurse, is a matter of indifference in most instances. However, the first weeks, or if possible the first two months, of lactation should be avoided, because of the presence of colostrum and the rapidly changing quality of the breast milk, which not infrequently causes serious gastric and intestinal disturbances in very susceptible infants, as evidenced by vomiting, colic and diarrhea. Multiparity may be considered an asset, if the nurse has demonstrated her ability to care for and feed previous cases. A multipara is also less likely to be affected by her new surroundings, especially if this be a private home. When the wet-nurse has more or less direct charge of the infant, one who has been nursing her own or other infants will be more likely to meet the technical difficulties in the care of her charge.

Examination of the Wet-nurse. The examination of the wet-nurse should always be made in a systematic manner to insure against overlooking important things.

First, a careful history should be taken as to the number of her children, miscarriages, and the presence of constitutional diseases in her family.

Second, she should be thoroughly examined, all parts of the body being exposed, and the examination should include the skin and hairy parts of the body for the presence of skin lesions and parasites, as well as for old luetic scars. The organs of the chest and abdomen should be subjected to careful examination.

Third, the breasts should be examined.

Fourth, the genitalia, including the cervix and the urethra, and in all cases a cervical (and where suspicious, a urethral) smear should be taken and examined for gonococci. As a single smear is often misleading, in cases of the slightest suspicion, where a girl baby is to be nursed, the examination of the cervical and urethral smears should be repeated.

Fifth, an examination and search should be made for chronic infections, especially for syphilis. A Wassermann test should be made in every case, and reported upon before she is allowed to supply milk, as it is well known that a syphilitic mother in a very great number of cases shows no clinical evidence of syphilis. The mouth and pharynx, neck, anus and genitalia, entire skin and lymphatic glands should also be examined for evidence of syphilitic lesions.

Tuberculosis. The lungs, glands, and osseous system should be examined, and a careful history as to susceptibility to colds and to recurring bronchitis elicited.

Sixth. Acute infections. She should be questioned as to exposure to contagious disease, and she should be examined for evidence of acute infections of the nose, throat, and ears.

Seventh. Her teeth should be examined and defects and pyorrhea corrected, if necessary, at the expense of the family.

Eighth. The urine should be examined (1) for evidence of nephritis, (2) for evidence of diabetes. It should, however, be remembered that a positive reaction for sugar should not be overestimated, unless the sugar is proven to be dextrose, as very commonly in our experience during the early weeks of lactation a lactosuria is present. The kind of sugar can easily be determined by the phenylhydrazine test, followed by a microscopical examination of the crystals.

Ninth. Nervous and psychic disturbances, such as epilepsy, insanity, hysteria, should, if found, by all means exclude the subject.

Tenth. Her child should be examined for evidence of syphilis. Possibly one of the best arguments for the non-employment of a wet-nurse during the first two months of her lactation is the possibility of a latent syphilis. Where there is the slightest doubt, a Wassermann reaction should be made on the infant. The general condition of the child gives us the best evidence both as to the quantity and to the quality of the maternal milk. Unless the source of the nurse be known, it is well to be certain that she is nursing her own baby. In case of its death or its absence, every effort should be made to obtain its condition at birth and its later development.

So far as possible she should not be subjected to annoying questioning on the part of the family, which is entirely unnecessary, if she has been properly examined by the physician. It has been our experience that such unnecessary questioning has led to nervousness, and not infrequently has caused her to decline the position, at a time when she was most needed.

Her Place in the Household. She should be treated neither as a guest nor as a menial, but so far as possible should be graded according to her previous station in life. There is a grave danger of mental depression on the part of a woman, well-born and sensitive, who, through misfortune or necessity, is forced to seek this means of employment, and also of an exaggerated estimate of self-importance on the part of a woman but little accustomed to the luxuries of life upon her entrance into the home of employment, particularly if attentions are paid to her. As has been previously stated, all instructions and demands should be made by the person best qualified in the individual case. A divided responsibility will always lead to future complications.

Her quarters should be well located; their ventilation should be supervised, and she should be held responsible for their general cleanliness. The wet-nurse's baby should always be kept in the room with her, so that she may feel the full responsibility for its health and care.

The Quantity of Milk to be Expected from a Good Wet-nurse. The quantity and quality of milk supplied must vary greatly with the glandular development of the individual wet-nurse, the state of her health, and the factors quoted elsewhere which would affect it temporarily. The amount and variety of stimulation applied to the breasts, of which the direct nursing by a full-term infant is the most valuable (at least for the purpose of stripping the breasts), must be given due consideration. In view of the many emergencies and influencing factors, no absolute standard for quantity and quality can be set for general rule.

A wet-nurse who does not secrete sufficient milk during the first few days in her new employment should not be discharged until every effort has been made to improve her milk production. Frequently the change in environment is sufficient to reduce it temporarily.

Cost of Milk. The wet-nurses in Sarah Morris Hospital receive their board and room and $8.00 per week. Figuring the former at $5.00 per week, this would total a cost to the institution of $13.00 per week for each nurse. With an average of 30 to 40 ounces of milk per nurse daily, or 210 to 300 ounces per week, the average cost will be about 4.25 to 6.5 cents per ounce, or approximately $1.35 to $2.00 per quart.

When milk is dispensed to patients outside of the hospital, a charge of 10 cents an ounce is made for it, which is a reasonable price when all of the contending factors are taken into consideration.

Number of Nurses Needed. Each good wet-nurse can care for the needs of about two infants, depending upon their weight and development.

Length of Lactation. No time-limit is placed upon the employment of a wet-nurse as long as the quality and quantity of her milk is sustained, and she continues in good health. One of our nurses has an infant now thirteen months old. Such long periods of lactation, however, as a whole are not to be advised.

The Wet-nurse's Baby. The presence of the wet-nurse's baby predisposes to her peace of mind, and wherever possible, she should take it with her. Her baby's state of health is by all means the best indication as to her ability as a nurse, and, with this, the presence of constitutional disease in herself. It may be of immense value, if the baby is strong and healthy, to keep up the flow of milk, in case the baby to be nursed is a weakling. It may also be used to estimate the functional capacity of a wet-nurse by nursing at regular intervals, and weighing before and after the nursing for twenty-four-hour periods. If in perfect health, it may be put to the breast, after the weakling has taken such milk as it has strength to draw. If this is not practicable, then the weakling should be nursed alternately with the well baby on each breast. It is also of immense value in emptying the breast after the wet-nurse has removed as much milk as it is possible by expression or by the breast-pump, if this is the means of drawing the milk for the weakling. It is a well-known fact in all institutions where wet-nurses are used, that the greater the degree to which the breasts are stimulated by suckling infants, the greater will be the reward in production. If the milk is insufficient for both babies, partial or entire meals of artificial food may be substituted for the wet-nurse's infant.

At the first sign of an acute illness on the part of the wet-nurse's baby, it should be separated entirely from the other baby, and removed from the breast; its illness should be given the same serious consideration as that of the other infant, so that the mother's anxiety may be relieved. It should receive as much of its mother's milk as can be spared. This can be expressed from the breasts and fed from a bottle.

Feeding of the Wet-nurse's Baby. When a single infant is to be nursed, the second baby is often a necessity in the promotion of the development and stimulation of her breasts. No breast can be developed to its fullest capacity with the breast-pump or hand expressions. It is a well-known fact that the breasts will respond in proportion to the demand placed upon them, and in most instances during the first few weeks of the premature's life, when its demands are met by from 4 to 16 ounces of milk, the wet-nurse can supply sufficient milk for both babies. When her supply becomes insufficient to meet the demands, her baby can be put upon partial bottle feedings of the strength as indicated by its age and development. The progress of the wet-nurse's baby has great influence on her peace of mind, which may spell success or failure in her ability to carry out her work. When the premature infant gives evidence of sufficient strength to be placed upon the breast, we have found the application of the wet-nurse's baby to the other breast a very valuable expedient in aiding the flow of milk into the breast which is to be nursed by the weakling. In many instances we have seen the milk flow from the second breast by this method so freely that but very little effort was required on the part of the weakling to obtain its food.

2. The Hygiene of the Wet-nurse.

In general, everything that has been said in the chapter on hygiene of the nursing mother applies also to the wet-nurse—of course, with the proper modifications, made necessary by peculiarities of her position.

Her clothes should be simple, and in every part washable. As the care of her undergarments is of even greater importance than her outer clothing, it is well that her laundry should be done with the family work, so that the family laundress who is trusted by the family may be charged with its inspection.

To simplify nursing or the drawing of milk, the author has devised two garments for wet-nurses. The material used for the outer garment is of yellow gingham, such as is used in the making of hospital uniforms, the yellow color being selected to distinguish the wet-nurse from the blue, as used by the nursing corps. The corset-waist is to be made of heavy muslin. The corset, if worn at all, should be of a very low type, so as to avoid all pressure on the breasts. It is best of a cheap quality, so that it can be replaced frequently for sanitary reasons. Each wet-nurse should be supplied with four uniforms and six nursing corset-waists.

The Diet of the Wet-nurse. There is danger of the creation of indolent habits through neglect of regular exercise and the lack of regular household duties, but even greater danger lies in the direction of overfeeding with unusual foods. The average wet-nurse is either obtained from an institution or a home in which the luxuries of life are limited, and she has been accustomed to a simple nutritious diet. Every attempt should be made to supply the nursing woman with a well-rounded diet of simple foods, with milk and cereals as the basis, and these supplemented with meats, soups, the common vegetables, limited amounts of fruits and plain desserts. In so far as possible, the aromatic vegetables, unripe and highly acid fruits, fried meats, and rich pastries are to be avoided. We believe that, on the whole, too great stress has been laid upon the danger of the diet in the mother of a full-term infant, and in most cases the average mother can partake of a very full diet. However, in the case of the woman nursing premature infants, it should become a custom to allow only such foods during the first few days after her installation as can be given with perfect impunity. When a full, free flow of milk is established, other vegetables and fruits can be added, one at a time, and after each addition to the diet a try-out should be given the milk. We have on numerous occasions seen marked intestinal distention and diarrheal attacks following even seemingly slight indiscretions of the diet on the part of the wet-nurse. It is our hospital practice to furnish each wet-nurse with two quarts of good wholesome milk daily, and at least one pint of cereal gruel, preferably farina or corn-meal. A mixture of milk and cereal gruels makes a very good combination for drinking midway between meals. The remainder of the milk may be taken with the meals, either pure or in the form of cocoa, tea, or weak coffee, in whichever form it is best taken by the individual woman. The latter is of considerable importance, as in the forced diets which are required, where an abundance of milk is demanded, distasteful foods soon become obnoxious in large quantities.

Beers, malt-extracts, and other rich drinks are not forced upon the nurse, unless she is accustomed to them, and feels their need. It must always be remembered that an excess of fluids would naturally tend to dilute the milk unless the secreting gland be of exceptional development.

Exercise of the Wet-nurse and Her Work. She should be impressed before her engagement with the fact that she will be required to do a moderate amount of work and exercise regularly out of doors. The former will be of service in promoting her general health, and both the work and the exercise will serve as a nerve tonic and prevent her becoming indolent. This does not mean that she should become a drudge, but that she should at least be required to care for her own room and her own infant's clothes, and should be made to feel that in return for her laundry work she would be requested to do some light general work about the house. Her exercise in the open air should so far as possible be at regular times. The question as to the care of the napkins of both babies is open to considerable discussion; and it may be stated that whenever it becomes necessary for the nurse to express her milk by hand, she should not be subjected to the handling of soiled napkins, whenever this can be averted.

Other Conditions Influencing the Quality of the Breast Milk.

The nervous and mental state of the nurse is of the utmost importance, and wherever possible an emotional, nervous, erratic woman should be excluded, because of the tendency of these influences to suppress the flow of milk. Therefore, whenever possible, a woman of more or less phlegmatic temperament is to be selected. This is especially true in the case of a woman who is to be in close contact with and is to nurse an infant with neurotic tendencies. There is also the possibility of the same influence being manifest in time of slight indisposition on the part of her own infant, and such an individual is also more likely to resent the necessity of partial or entire artificial feeding of her own child to the advantage of the premature infant, when it has reached such an age when it may make greater demands on her supply.

Menstruation rarely produces any serious disturbances. It is always a safe procedure to dilute the milk during the first and the second day of menstruation when the nurse suffers considerable pain at these times.

Period of lactation may or may not be a considerable factor, depending upon the individual woman. At the present writing we have in our employ a nurse who has been with the institution for sixteen and a half months, and whose infant is eighteen months old, and who is supplying us with the largest quantity and the best quality of milk of the four nurses in the institution.* When possible a nurse should be selected after the first few weeks of lactation, at which time the colostrum has disappeared from the milk, and the quantity and quality of her milk has become established. After the first few weeks of lactation, but little or no attention is to be paid to the age of the wet-nurse's baby as compared with that of the infant to be fed, and we have never noted any ill effects following this rule.

3. The Nursing.

The Infant's Bedroom. Under ideal circumstances, this should be separated from that of the wet-nurse. This is especially true where a trained attendant has care of the infant. It should under all circumstances also be separated from the wet-nurse when she is of a low degree of intelligence and of a type not to be trusted with the care of the infant.

* The milk of this nurse was examined in the laboratories of the University of Chicago after seventeen months of lactation with the following result:

Protein	1.98	per cent.
Casein	0.69	" "
Fat	3.54	" "
Lactose	7.025	" "
Salts	0.1885	" "

It must be remembered that this is an exceptional case, and but few women under the stress of ordinary life can properly nurse their infants after the ninth to twelfth month.

Methods of Drawing Milk. Numerous methods of obtaining milk from the breasts have been described, but only those most practicable of application will be detailed. These should be divided, first, into those in which the baby is placed directly at the breast, and those meth-

Fig. 1.—Proper method of holding baby during nursing.

ods by which the milk is drawn from the breasts and fed to the infant. Two methods are especially applicable where the baby is fed directly on the breast, and needs assistance because of its weakness.

1. Premature infant is placed at the breast, and is supported there by the nurse's right arm while nursing at the right breast, and the left hand is used to grasp the breast just above the nipple between two fingers (see

p. 59), and the milk is expressed directly into the baby's mouth. In this way the baby is taught to take the breast, and at the same time receives its food with little effort. This method can be continued until the baby has gained sufficient strength to nurse without assistance.

2. Much of the same result can be accomplished by placing the wet-nurse's baby on the opposite breast during the nursing period, whereupon the simultaneous nurs-

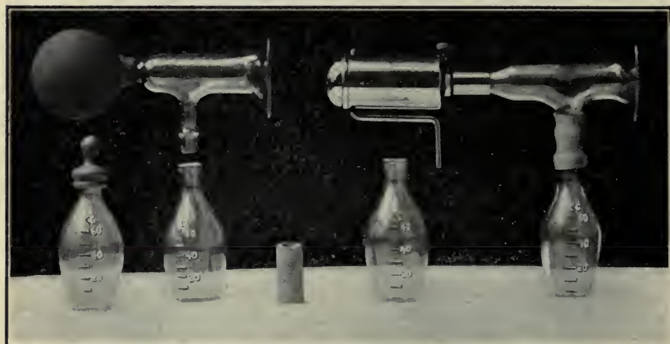

Fig. 2.—Author's improved breast milk collector. The pump is made in two types, the first filled with a large rubber bulb of a size considerably larger than is ordinarily sold with a breast-pump, and the second with an attachment to which the Holz vacuum pump can be fitted. In place of the ordinary collecting bulb at the lower surface, an arm is so constructed as to allow the milk to drain into specially designed graduated 2-ounce milk flasks.

ing on both breasts will cause a free flow of milk into both sides.

In those methods by which the milk is drawn from the breasts and fed to the infant by hand or by other means.

1. By the breast-pump. The modification of Holz vacuum apparatus, as devised by the author, by which

means the milk is drawn directly into two graduated 2-ounce flasks, which can be filled to the quantity desired, and stoppered for future use, so that the milk is free from handling, and thereby avoid contamination.

Fig. 3.—Direct expression of milk (act 1). Glass graduate is held against breast one inch to one inch and a-half back of the nipple, and held in position by the bent forefinger of the left hand. The left thumb gently grasps the upper part of the breast about one inch behind the nipple. The thumb of the left hand gently compresses the breast against the side of the glass with a gentle sweeping movement. This is repeated 40 to 60 times per minute.

2. By direct expression, which is performed as follows: A graduated glass is held against the underside of

the lower inch of the breast and nipple by the index and middle finger and a downward sweeping stroke is used to compress the corresponding part of the breast and the nipple against the side of the glass receptacle. The vessel can be supported with the other hand. By this means,

Fig. 4.—Direct expression of milk (act 2).

following a little practice, the nurse can express from 6 to 8 ounces of milk from two good breasts in fifteen to twenty minutes. While drawing, each 2 ounces of milk is poured directly into sterile, stoppered bottles, to prevent the fingers of the nurse coming in contact with the milk by overfilling the glass. It goes without saying that before each expression the breasts must be thoroughly cleansed with a boric acid solution, and the hands thoroughly washed with soap and water.

Daily Number of Expressions. Expression is performed six times daily at regular intervals of four hours during the day and night.

CHAPTER IV.

THE NURSING INFANT.

Signs of Successful Nursing. The normal full-term infant shows a gain of not less than 4 ounces weekly. This is the minimum weekly gain which may safely be allowed. When a nursing baby remains stationary in weight or makes a gain of but 2 or 3 ounces a week, it means that something is wrong, and the defect will usually, but not invariably, be found in the milk supply. When the baby is nursed at proper intervals, and the supply of milk is ample and of good quality, it is satisfied at the completion of the nursing. Under three months of age it falls asleep after ten or twenty minutes at the breast. When nursing period again approaches, it becomes restless and unhappy, crying lustily if the nursing be delayed. When the breast is offered, it takes it greedily. The weekly gain in weight under such conditions is usually from 4 to 8 ounces. At the fifth month the baby will have doubled, and at the twelfth month trebled its birth weight. The average gain per week during the first year is about 4 ounces.

The baby increases in length from about 20.5 inches (50 cm.) to 28.5 inches (70 cm.) in the first year. The first tooth appears at about the sixth or seventh month, and at one year there should be six teeth or more. (Age in months minus 6 = number of teeth normally present at that age.) It begins to smile at about the fifth week, grasps objects and holds its head erect in the fourth month, sits alone for a few minutes at seven or eight months, bears its weight on its feet at the ninth or tenth month, stands with slight assistance at the eleventh or twelfth month, and creeps or walks soon after this (tenth to eighteenth month, average fourteenth month), and says a few words towards the end of the first year.

Stools. *The feces* of breast-fed babies are *strikingly uniform,* and are *like no other bowel movement in infancy.* Normally, there are two or three a day, some times only one, or even more than three. They are soft, or mushy, homogeneous, of an egg-yellow or gold color, and have a slightly sour, not at all unpleasant odor. They are never formed, and always cling to the diaper. The nature of the bowel movement, and its uniformity, is due to the "physiological fecal flora" which is brought about by the ingestion of breast milk into the germ-laden intestinal tract, and which in turn have a fermentative rather than a putrefactive action on the food. The gases normally formed are carbon dioxide and hydrogen, and these are practically odorless. The acidity of the movement, its softness, and the mechanical action of the gases present, all insure active peristalsis and ready emptying of the bowels, so that constipation is an exceptional condition in a breast-fed baby, and, if present, it nearly always suggests too little food, or abdominal and intestinal muscles too little developed and too weak to force the stool past the anal sphincter. This latter condition is commonly interpreted as constipation by the laity.

The dried residue of the feces contains from 10 to 30 per cent. of fat, about 8 per cent. salts, a very large percentage of bacteria, bile pigments, intestinal secretion (mucus, etc.), epithelial cells, etc. No food proteins or carbohydrates are found.

The feces of the breast-fed baby are very frequently not wholly normal; they quite commonly, especially during the first few months, contain small, soft, white or yellowish fat curds, an excess of mucus, and are often greenish in color, and may be more frequent than normal. *Such a condition is perfectly consistent with a normal growth and well-being of the baby, and should never in itself be a cause of worry, or an indication for a change of food.* This is a very important point that is very commonly neglected. The condition of the bowel movements is only one factor, and in the breast fed a minor one, in determining a baby's nutrition.

CHAPTER V.

MIXED FEEDING AND WEANING.

Mixed Feeding (allaitement mixte). With a diminution in the amount of milk secreted, the breast milk must, of course, be complemented or supplemented by modified cow's milk. These methods of feeding are usually successful. By *complemental* feeding we mean the administration of milk from a bottle following a period at the breast at each nursing. By *supplemental* feeding substitution of a bottle for a breast feeding is meant. Thus, in the former the baby receives as many part bottle as breast feedings, while in the latter it will be supplied with one or more bottle feedings to replace breast feedings. As we know that the breast secretes in proportion to its stimulation, the complementary feeding is far more satisfactory, and not infrequently it is wise to nurse both breasts for a short time, let us say, each one three to five minutes, before the bottle is given. The modified milk strength should be that which is suitable for the average child of the same age (see Artificial Feeding). In beginning the use of cow's milk, however, it must be remembered that at first a weaker strength must be used than the child will require for growth, this weaker food being necessary in order gradually to accustom the infant to the change. If too strong a cow's milk mixture is given at first, it will be very apt to disagree, causing colic and vomiting. Later, when the child has become accustomed to the new food, a stronger mixture may be given. When a mother cannot give her infant at least two satisfactory breast feedings daily, it is advisable to wean the child. The newborn baby is not very discriminating, and will nurse anything equally well. The older baby, however, quickly prefers the easy-flowing bottle to the increasingly unsatisfactory breast, and will quite regularly stop nursing at the breast as the milk comes harder and is less abundant. If the bottle is given right after the breast, it is always well to use a nipple from which the milk comes with some difficulty, for the reasons given above. If it is desirable to wean the baby rather quickly, this method of following the breast by the bottle is often to be preferred to the other.

Indications for Weaning. *Pregnancy* is usually an indication for weaning. The mother's milk becomes more scanty, and often poor in quality. This is especially the case if the mother knows she is pregnant, and has been taught that a pregnant woman should never nurse a baby. If the baby continues to thrive at the breast, there is no reason why nursing should not be prolonged. Fortunately a new pregnancy does not often supervene before a time that makes it quite safe to wean the nursing baby, *i.e.,* before the sixth month.

In acute infections in the mother, such as *pneumonia,* and the acute contagious diseases, such as *scarlet fever,* one must weigh the danger from exposure to infection as against the quality of the artificial food and environment in the individual case.

In the milder contagious diseases, such as *measles, mumps,* it is true that young breast-fed infants are rarely infected. *Pertussis* is an exception, and has a high mortality in the newborn and young infants; and the infant should under all circumstances be protected from exposure. In the presence of *diphtheria* the infant can be immunized with safety.

Weaning should always be done gradually, when possible, for the sake of both mother and the child. In cases of sudden weaning, the food must be very much weaker in the beginning than for an artificially fed child of the same age. If weaned at six months, the infant should be put on a mixture suitable for a child of two or three months, and the same rule applies for older infants. When the infant becomes accustomed to cow's milk, the strength can gradually be increased. Rarely should breast feeding be continued beyond the first year.

The fear of the laity of the "second summer" is well founded when dirty milk and other improper foods are fed promiscuously, but with clean, certified, and sterilized milk, and properly prepared soft foods, the dangers of the summer heat are minimized. It should be our rule to underfeed rather than overfeed in hot weather, and during the hot spells the infant's diet may well be reduced one-half.

Care of the Breasts During Weaning. When the breast feeding is carried on the usual length of time (from nine to twelve months), the process of weaning ordinarily causes little or no discomfort. All that is usually required is to press out enough of the milk to relieve the patient as often as the breast becomes painful, which may not be more than two or three times a day. When the weaning is necessarily abrupt, no little discomfort may result. When the weaning can be accomplished more gradually, the infant should have one less nursing every second or third day, until only two are given daily. After this has been practised for one week, nursing should be discontinued. In cases of sudden weaning, a saline laxative, such as citrate of magnesia or Rochelle salts, should be given every day for five days—

sufficient to produce two or three watery evacuations daily. In the meantime the mother should abstain from fluids of all kinds up to the point of positive discomfort. The breasts should be elevated by a firm binder.

CHAPTER VI.

NUTRITIONAL DISTURBANCES IN THE BREAST-FED INFANT.

Breast milk alone furnishes all of the needs for growth and development of the human offspring. The infant will thrive in most instances on breast milk from different sources and different quality, demonstrating the ability of the average infant to assimilate the food which Nature intended for its use, even though the percentage quantity of the various components may vary greatly. Disturbances in the breast-fed baby are dependent upon one or more of several factors. In the order of their frequency they may be divided, as follows.

1. Underfeeding.
2. Overfeeding.
3. Congenital debility, with resulting impairment of the vital functions.
4. Intercurrent parenteral (pharyngitis, tonsillitis, bronchitis, pneumonia, pyelitis, etc.) and enteral infections.
5. Idiosyncrasy towards mother's milk.

While all nutritional disturbances in young infants are of serious import, they are far less dangerous than those of the artificially fed infant, and much more easily corrected. They are also much less frequent than nutritional disturbances in artificially fed infants.

1. Underfeeding.

Etiology. Two factors of prime importance must be investigated to complete the diagnosis:

(1) The daily quantity of the milk furnished to the infant.

(2) The quality of the milk supplied by the mother.

The milk may contain the normal percentage of fat, sugar, and protein, but be scanty in amount. Instead of the 4 or 5 ounces to which the child is entitled, it may get but 1 or 2 ounces. Whether or not the quantity is sufficient, may be determined by weighing the baby before and after each nursing for twenty-four hours. (The ordinary spring balance infant scale will not answer, and a simple beam scale with weights and scoop should be supplied.) One ounce of breast milk weighs practically 1 ounce avoirdupois. By nursing for fifteen minutes, a child under one week old should gain 1 to 1.5 ounces; at three weeks of age, 1.5 to 2 ounces; four to eight weeks of age, 2 to 3 ounces; eight to sixteen weeks of age, 3 to 4 ounces; sixteen to twenty-four weeks of age, 5 to 7 ounces; six to nine months of age, 6 to 8 ounces; nine to twelve months of age, 8 to 9 ounces. Of course, arbitrary limits cannot be fixed as to the quantity. It is not necessary to worry about the quantity taken at individual feedings so long as the infant is making satisfactory gains in weight, and the general progress is good.

Quantity of Human Milk Required by the Nursing Baby. Babies of the same age and weight, under the same conditions, will take nearly the same amount of food. The older and larger the baby, the larger the total quantity of food required, but its *energy quotient*—that is, the number of calories per kilogram or a pound of weight—lessens steadily with increasing age. The daily amount that normal, thriving babies take from the breast can be stated at about one-sixth to one-fifth of their body weight during the first month, about one-sixth to one-seventh up to the sixth month, and about one-eighth after the sixth month. Heubner expressed this in terms of energy quotient, as follows: "During the first few months an infant requires 100 calories per kilogram daily of breast milk; after the sixth month this energy quotient gradually comes down to 80 or 85 at the end of the first year. An energy quotient of 70 is about the minimum amount that an infant can take without losing weight." Human milk can be estimated at 21 calories per ounce, and about 70 calories per 100 Gm. of milk. With these figures in mind, it is easy to determine whether a breast-fed infant gets about the right amount of food, and we have also a valuable standard by which to measure the food of an artificially fed infant.

Symptoms. Failure to gain weight properly, or even a loss in weight, may be the first positive evidence of an insufficient food supply. Usually this is associated with more or less evidence of dissatisfaction on the part of the infant. The infant's sleep becomes disturbed, and it becomes restless, and cries long before the next feeding time. Again, it may manifest its dissatisfaction by nursing greedily for a short time, releasing the breast and crying. It returns to the breast again, but with the same result; or in other instances the infant will remain at the breast for much longer periods than should be necessary to obtain the food that it needs, which would be accomplished in from ten to twenty minutes.

Usually the stools are normal in appearance, but small in amount, and give little evidence of the cause of the trouble. However, if the food supply be decidedly insufficient, we may have a positive evidence of the underfeeding by the appearance of the so-called "hunger stools," which are of more or less brownish or greenish-brown color, containing little fecal matter and much mucus.

If the condition is not corrected, the baby becomes weak and apathetic. The skin loses its turgor, its temperature becomes subnormal, it is pale and anemic, the fontanelles become depressed, and the abdomen sunken. Whenever there is room for doubt as to the cause of this group of symptoms, the scale will be the most positive evidence.

Treatment. Undue haste in removing the baby from the breast offers the greatest danger in the treatment of underfeeding, and should be resorted to only when other means fail. The ability to increase the quantity of milk secreted by the average woman must necessarily vary directly with the quantity and quality of the glandular tissue composing the breast. However, to a certain extent at least, certain factors will more or less directly influence the quantity and quality of the secretion, and they are worthy of our attention.

Means of Stimulating the Breasts. The *surroundings* of the mother must predispose to a happy frame of mind; she must not be overburdened with household cares; her exercise must be regular, and she must be relieved of worry and lack of sleep. It is well, if possible, to free her from all care of the baby, especially at night. She should be put in as good physical condition as possible; she should get out of doors.

Her *appetite* should be stimulated, so that she will take an abundance of milk and other nutritious food. The very common forced feeding beyond the natural appetite, is of questionable value. The general rules as to the diet previously spoken of should be maintained. It should, however, be remembered that an excessive diet may be assimilated by the mother's body without increasing the flow of milk. The fluids given should be palatable to the nursing mother, and, as previously recommended, milk, weak tea, cocoa, farina, oatmeal, and cornmeal gruels as well as milk soups are probably the best. The fat and the protein of the milk can more especially be influenced by the diet. The fats are increased by overfeeding with fats and carbohydrates, with little or no exercise. They are reduced by limiting these articles and substituting vegetables, and by increasing the amount of exercise. The protein is also increased by overfeeding and limited exercise. The carbohydrates are less influenced by the diet, but are also affected by an excess of carbohydrate feeding. Alcohol in the form of malted drinks has a temporary influence in increasing the quantity of milk and the amount of fat. The effect on the protein is less constant. We never force a woman to partake of alcoholic liquors unless she desires them, because of the moral as well as of the physical effect.

Stimulating *massage* may be applied to the breast in such a manner as to stimulate the whole gland. This can best be accomplished by two movements: (1) by gently raising the whole breast from the chest wall and kneading it gently between the fingers, and (2) by holding the breast against one hand and making circular movements around the periphery with the outspread finger tips of the other hand, and gradually working from its base towards the nipple.

Baths at a temperature comfortably cool (80° to 90° F.) should be taken daily to promote her general health as well as cleanliness. These should be followed by a brisk rubbing with a coarse towel.

Steaming the breasts by the application of hot towels covered with oiled silk two or three times daily is of decided benefit.

The *Bier pump* and other means of stimulating an artificial hyperemia can be used to advantage in obstinate cases. The application should be made at regular intervals, and not too long continued. A very simple vacuum pump may be made by boring a round hole into a finger-bowl and inserting a piece of rubber tubing and attaching a clamp, which can be opened and closed at will.

Galactagogues of any material value for permanent use are unknown. Pituitrin has been recommended for temporary stimulation. We have not had much experience in its use. General tonic will often improve the digestion and tend to overcome the anemia, and in this way improve the general health, and thereby lactation.

2. Overfeeding.

This condition is a rare one in the breast-fed baby, and, when present, in all but the very young and premature, nature often provides its own remedy, either by regurgitation on the part of the baby, or by its refusal to nurse longer than to meet its needs, which latter soon leads to a lessened milk secretion. In the first weeks and months it may be of considerable importance, and may cause grave symptoms on the part of the infant—that is, before the mother's breast and the infant have become adapted to one another.

Etiology. Although overfeeding in the breast-fed infant is rare when compared with overfeeding on artificial food, yet next to underfeeding it is the most common form of nutritional disturbance in the breast-fed infant. It is also more commonly present in infants fed by a wet-nurse than in infants nursing the maternal breast.

Usually the error lies in too frequent nursing.

Rarely it may be due to excessive quantities of milk taken at proper intervals.

Occasionally it is due to milk which is excessively rich in fat.

Pathogenesis. The normal infant's stomach on breast feeding empties itself in about two hours. When all the food has left the stomach, and is undergoing intestinal digestion, free hydrochloric acid is forming in the stomach. Free hydrochloric acid is antiseptic, and it also stimulates secretion of pancreatic juice and secretion of bile, both of the latter products being essential to proper intestinal digestion.

For normal digestion it is therefore necessary that the stomach remain empty for some time after all the food has left it. When by too frequent nursings no time is allowed for the above described physiological process, or when by excessive quantities of food at proper intervals too great demands are made upon the hydrochloric acid, and the time of gastric digestion lengthened, with corresponding shortening of the period of comparative rest, or the gastric secretion diminished by excessive fat, then we may expect disturbance of the normal digestion due to overfeeding.

Symptoms. The earliest symptoms are regurgitation, diarrhea, and lessened appetite. These three symptoms are reactions of the organism to excessive intake of food attempting to get rid of the excess.

Regurgitation occurs at first occasionally only, immediately after nursing, and without any discomfort on the part of the infant ("spitting"). The regurgitated fluid is often unchanged milk. This is usually the first premonitory symptom.

Diarrhea follows when overfeeding continues and regurgitation becomes insufficient to rid the body of excess of food. The stools are more frequent than normal, and contain undigested particles of food.

Lessened appetite, although present in many cases, may be replaced by symptoms suggestive of hunger, the infant taking the breast and nursing greedily. This apparent symptom of underfeeding and of hunger may wrongly be interpreted, and lead to additional overfeeding by giving the breast at even more frequent intervals to allay the apparent hunger and to quiet the restless infant.

In many cases no other symptoms develop, the condition undergoing a spontaneous cure. The breasts lessen their yield, and thus the cause of the condition disappears, or, on the other hand, the digestive power of the infant increases to such an extent as to be able to take care of the excess, if not too large. This accounts for the fact that frequently the above-named symptoms are neglected, since they usually produce improvement in the child's condition, and are regarded as passing disturbances without much importance. When, however, they are entirely neglected, and excess of the food continued, or even increased, due to wrong interpretation of symptoms, then more serious symptoms develop, and the condition reaches a stage where spontaneous cure rarely occurs.

Vomiting becomes habitual, occurring from a few minutes to half an hour after nursing. It is accompanied by visible discomfort and straining on the part of the infant. The vomitus consists of curdled milk, mucus, and gastric juice. Between vomiting there is often painful belching. Stomach shows distention, and empties itself only after three to four hours. Free hydrochloric acid is almost or entirely absent, the acid products of fermentation being present. The micro-organisms are increased in number and variety, due to stagnation and absence of antiseptic free hydrochloric acid.

Initial diarrhea is sometimes followed by temporary constipation, diarrhea setting in again. The evacuation is painful, and, with much gurgling and discharge of gases, fluid masses are squirted from the anus. The stools are watery, with white and dark green fragments, and of disagreeable, sour, pungent odor. The irritating feces often causes eczema and intertrigo in the ano-genital region.

Abdomen is distended, tense, and often there is visible peristalsis. Intestinal colic causes restlessness and crying; the infant's face gives expression to its pain, and, as the fermentation increases, its agony is increased, due to intestinal paresis.

The infant becomes restless; its sleep is much disturbed, and even during sleep its features give evidence of its distress.

The weight early becomes stationary, and in severer cases associated with dyspepsia loss of weight becomes marked.

Complications. *Dyspepsia.* Accompanied by the milder evidence of intestinal irritation, evidenced by increased peristalsis, with its resultant colic, more or less numerous bowel movements of eight or ten or even more daily, sour and irritating, greenish-yellow in color, and containing numerous curds and much mucus. The buttocks soon become reddened and intertrigo results.

Intoxication, while rare in the breast-fed infant, may result when the dyspepsia is neglected. The baby becomes drowsy and stuporous, paying little attention to its surroundings, and not infrequently develops a severe anorexia, all associated with more profound intestinal symptoms.

In dyspepsia the intestinal findings dominate the picture, while in intoxication they share their prominence with the added nervous symptoms.

Pyelitis is not an infrequent complication in neglected dyspepsia and intoxication, and while it undoubtedly is frequently due to an ascending infection, it may result from extension through the blood stream or the lymphatics.

Eczema not infrequently results from overfeeding in the breast-fed infant, and is usually seen in the fat type of infant who is otherwise healthy.

Pylorospasm, gastric dilatation are not uncommon in the neglected cases.

Acidosis may develop in the extreme cases, associated with great loss of weight, but this is rare.

Diagnosis. In the presence of symptoms suggestive of overfeeding, positive diagnosis is made by determining exactly the amount of milk taken by the infant, and comparing this amount with what an infant of the same weight and of the same age should get. The method of this determination has been described in detail under the treatment of underfeeding.

If, however, the food is found to be quantitatively correct, occasionally information of value may be obtained by examining the quality of the milk chemically, especially as to its fat content. The specimen for examination should be taken under precautions pointed out under Examination of Human Milk. By making proper etiological diagnosis, valuable indications for rational treatment are obtained.

If a careful search is made for the etiological factors in the common illnesses of infants, which are so frequently charged to overfeeding, one will be surprised to find that the error lies in the diagnosis, and that in most cases the condition is not due to overfeeding. This leads us to warn against the only too frequent habit of weaning infants without a careful study of the exact cause of the infant's trouble.

Treatment. *Prophylaxis* of this disturbance is of importance, and consists of giving the nursing mother proper instructions as to the nursing, especially as to its frequency, and seeing to it that the rules for nursing, as laid down elsewhere, are observed by the nursing mother In wet-nursing, more caution is necessary, especially in those wet-nurses who have an abundance of milk, which is frequently the case in a wet-nurse whose own child is much older than the infant to be nursed.

A very important point to impress both on the mother and also on the wet-nurse is the fact that crying of the infant is not always due to hunger, and that offering the breast should not be used as a means for quieting the child.

When the initial or mild symptoms only are present, then correction of the nursing habits is usually sufficient, the infant improving without any special treatment.

When the error lies in too frequent nursings, it is best and often completely relieved by lengthening the feeding intervals to three or, even better, four hours.

It is of equal importance that the infant should not be left too long at the breast. The best average nursing time being about fifteen minutes, with twenty minutes as the maximum. However, when the flow of milk is very free, it may be necessary to reduce the nursing period to even three to five minutes, it being a fact that most infants take about 75 per cent. of their entire meals in the first five minutes at the breast. It is always well at the beginning of such an experiment to weigh the baby after a two, three, five, ten, and twenty minutes period to ascertain the exact amount which the baby obtains from the particular breast which it is nursing, so that conclusions may be drawn definitely as to the time it is to be left on each breast.

If placing the infant at the breast for short periods with long intervals does not give results, it is advisable to express the milk, and feed in small quantities from the bottle. And if another baby be at hand, it may be placed upon the breast to keep up the supply. Or when a wet-nurse is available for temporary use, the babies may be exchanged.

Weaning should under all circumstances be considered only as the last resort, after all other methods of adapting the infant to the breast have failed.

An excessive amount of fat in the milk is more often due to an excessive intake of food in general on the mother's part than an excess in any one element, and can be diminished best by cutting down the food as a whole, lessening the amount of all food.

When the condition has progressed farther, and the symptoms have become more serious, then it is necessary to treat the infant also. The treatment consists in emptying the stomach and the bowels of the overload of fermenting food, and of rest for the digestive apparatus, both these objects being achieved by giving a bland diet, consisting of boiled water or weak tea sweetened with saccharin, for twelve hours, the digestive tract getting rid of its contents spontaneously.

If the symptoms improve upon this treatment, the nursing should be gradually resumed by giving two breast feedings in the twenty-four hours following the period of starvation, substituting for the other nursings bland liquids, and increasing cautiously the number of nursings.

If on withholding the food, vomiting does not cease, then it is necessary to wash out the stomach.

Irrigation of the bowel is often necessary, and aids in removal of fermenting intestinal contents, and allows also the gases to pass, thus relieving the distention and colic. Only when change of diet and irrigation are not sufficient, then the use of purgatives is advisable, castor oil being just as efficient and less harmful than the frequently preferred calomel.

Colic usually disappears on correction of the diet, and after the intestinal tract has been cleansed of its irritating contents, and of gas. Massage to the abdomen will aid the passage of gases which cause distention, when the bowels tend to become paretic. In severe pain, warm applications to the abdomen give relief. If these measures fail to bring relief, and the pain is such that the infant is deprived of sleep, a mild sedative in small doses may be given.

Feeding of powdered casein in amounts varying from 6 to 8 Gm., dissolved in 30 to 60 mils of water, two or three times daily will relieve colic in many infants, in all probability due to lessening of intestinal peristalsis.

There is a class of infants who, although they are gaining progressively in weight, cry a great deal, expel a great deal of gas, and perhaps have a green stool now and then. It is almost criminal to take such infants off the breast, although the temptation to do so is very great, because of the worry they cause the mother, and consequent harassing of the physician. Such an infant will frequently cry for six, eight, ten, or twelve hours out of the twenty-four, and still make a good gain in weight each week, in which case it is very probable that the infant is being overfed, and the food supply should be reduced. The mother's diet and general habits should receive attention.

3. Congenital Debility, with Resulting Impairment of Vital Functions.

Etiology. Premature birth is the most important condition causing debility associated with deficient functionating power of the digestive organs. Method of feeding premature infants will be detailed later in a special chapter.

Hereditary weakness of the offspring caused by disease in the parents is frequently the cause of deficient morphological and functional development of the digestive organs, and thus it is often the underlying cause of nutritional disturbances, which are more commonly chronic in character. Tuberculosis, syphilis, and alcoholism in parents stand at the head of the conditions causing hereditary weakness, even when the offspring does not inherit the disease itself.

Malformations of the digestive tract (cleft palate, sublingual tumors, pyloric stenosis, atresias of the intestinal tract, Hirschprung's disease, etc.) from any cause compromise its functional capacity usually, but in most cases they cause serious conditions necessitating surgical interventions, and only rarely do they produce simple nutritional disturbances amenable to dietetic means, and therefore they belong to the domain of surgery.

Symptoms. As may be expected, symptoms of these so diverse conditions vary. Hereditary weakness may often be suspected when symptoms of nutritional disturbances develop even when the infant is given the best care possible, and the milk is quantitatively and qualitatively correct. Symptoms of underfeeding or of overfeeding, as described previously, may be present, depending upon the etiological factor.

Diagnosis. Careful examination for malformations, and thorough family history, in cases of suspected hereditary weakness are of chief importance in making the etiological diagnosis.

Treatment is usually determined by the pathology, and by the nature of the particular nutritional disturbance which developed.

4. Intercurrent Parenteral and Enteral Infections.

Etiology. Diseases both in the mother and in the infant are to be considered in etiology of this condition. In the mother the most important are the general infectious diseases, *e.g.*, puerperal fever and sepsis, typhoid, pneumonia, etc., and local infections of the breast, and also of the upper respiratory passages. In the infant there are parenteral infections, that is, infections outside the digestive tract, *e.g.*, pharyngitis, tonsillitis, pneumonia, pyelitis, bronchitis, and enteral infections, or infections of the intestinal tract, which will be discussed under a special heading.

Symptoms. In the conditions dependent on the mother's health the symptoms will vary first with the quality and quantity of her milk supply, which will have an effect on the child's general nutrition, and, secondly, may result in direct parenteral or enteral infections of the infant.

In those dependent on infections of the infant itself we invariably find evidences of nutritional disturbances, whether the infection be local, systemic, or confined to the intestinal tract. The clinical picture varies directly with the degree of disturbance of the metabolic function. While, as a rule, the enteral infections are more commonly associated with grave disturbances of the infant's nutrition, it is not uncommon to find the infant severely affected in its ability to meet its nutritional needs by the parenteral infections. While any one of the above enumerated etiological factors may give rise to a marked clinical picture, it is to be remembered that this class of disturbances in the breast-fed infants are of minor importance as compared with those of the artificially fed (see Nutritional Disturbances in Artificially Fed Infants).

Diagnosis. The diagnosis of the primary seat of infection in the infant is of considerable importance in deciding the method of treatment.

Treatment. Parenteral infections rarely call for restraint in administration of food because of the associated anorexia, and the infant should be nursed (if possible without danger to the mother) directly at her breast.

In the case of enteral infections it may be necessary to withdraw the maternal milk and replace it by a short period of starvation, to be followed by small quantities of breast milk, either taken directly from the breast during short nursings, or it may be best to feed small quantities of expressed milk to the infant at regular intervals.

Not infrequently it becomes necessary to feed these infants by catheter in order to sustain them. And this method of introducing their food should be begun sufficiently early to avoid a catastrophe.

Under no circumstances should they be placed upon food other than the mother's milk when her state of health and the quality of her milk permit.

Inert fluids, such as water, weak tea, broths made from young meats and young fowls, and cereal decoctions should be given between feedings to insure a sufficient intake of water. A careful record should be kept of the twenty-four-hour quantity of all fluids administered, in order to insure the child a sufficient water and food administration.

For conditions in the mother which would justify weaning, see chapter on Weaning and Contraindications to Nursing.

5. Idiosyncrasy Towards Mother's Milk.

Etiology. This condition is very rare, although it may not be denied that it exists. The etiology and pathogenesis are as yet little understood.

Diagnosis. The diagnosis of this disturbance should be made by exclusion of all other causes that may give rise to a similar symptom-complex. It may be confirmed by the change of the milk either by substituting a wet-nurse or cow's milk for maternal nursing, whereupon the symptoms improve.

Treatment. The treatment depends upon the particular symptom-complex which develops. Change of milk is imperative in cases in which idiosyncrasy is clearly established. The mother's milk should not be allowed to dry up during the period of experimentation, because of the possibility of an error in diagnosis.

CHAPTER VII.

METHODS OF FEEDING PREMATURE INFANTS.

1. Infants Nursing at the Breast.

In most cases we do not feed the more developed premature infant on the first day. It may be wise, however, to place the infant on the breast two or three times during the last half of the first day, after the circulatory and respiratory functions are well established, so that the infant may become accustomed to nursing. We are now confronted with two important factors, first, the ability of the infant to nurse the breast; and secondly, sufficient and proper development of the nipples to allow of the infant's properly grasping the same. If the infant is sufficiently developed to take hold of a well-formed nipple, it should be placed at the mother's breast regularly at three-hour intervals on the second day, for two- or three- minute periods, even though there is little hope of the breasts secreting at this time. By this means the infant is trained to expect its food at regular periods, and at the same time the maternal breast is stimulated. When a wet-nurse can be supplied in the home who has her own infant with her, the latter can be used to stimulate the breasts of the mother, and the new infant can have one of the wet-nurse's breasts set aside for its use. Where the infant is very weak, the breast set aside for it can be made to secrete more freely by simultaneously placing the wet-nurse's baby on the opposite breast during the period of nursing.

We have found this to be a very valuable expedient. However, with this latter method of procedure the quantity taken by the premature infant must be accurately measured to prevent overfeeding by weighing the infant before and after the nursing period. Nursing directly from the breast has the added advantage of developing the baby's sucking muscles, preventing contamination of the milk, and stimulating the breasts by the natural method. It should, however, be remembered that a weak infant may nurse the maternal breast for a considerable time, and yet the amount of food taken may be insufficient. This is especially true of that class of infants who are inclined to go to sleep at the breasts. Here, again, weighing is of the utmost importance. When the infant is too weak to nurse sufficiently to satisfy its needs, as ascertained by weighing, the nursing should be followed by substitute feeding with expressed milk, either by the bottle or one of the other methods to be described. These rules do not apply for the first and second day, when only rarely more than four or five meals should be given. In very weak infants, and those subject to regurgitation after taking small quantities of milk, it may be necessary to feed more frequently in periods varying from two to two and a-half hours, as may be indicated by the quantity retained, or better results may be obtained by catheter feeding (to be described later) with four-hour intervals.

2. Infants Too Weak to Nurse the Breasts.

In this class of infants, wherever possible, they should be fed without being removed from their bed or the incubator, if used, so as to avoid all careless exposure of the infant. The cause of inability to nurse may be due to several factors: (1) Infants unable to swallow; this is usually because of improper development of the center in the medulla, or lack of co-ordination on the part of the pharyngeal muscles and tongue. This is usually made evident by the milk flowing from the dependent part of the mouth. In such cases it is generally necessary to resort to catheter feeding. (2) Those too weak to nurse, and who may appear to be almost dead; in this class there is great danger in handling the infant, and it is best fed in the bed. (3) Those who will not suck. (4) Those vomiting after every feeding. (5) Those becoming cyanotic after feeding. In the latter cases it may even be necessary to resort to such methods as gentle friction, artificial respiration, best performed by gently compressing the thorax, warm baths, oxygen, etc.

Methods. One of the following methods can be selected for feeding these infants:

1. *The nasal spoon,* which can be used either by pouring the milk slowly into the nose or into the mouth. The latter is to be preferred, because of the dangers due to decomposition of the milk in the nose and naso-pharynx, with secondary development of rhinitis and pharyngitis.

2. *A medicine dropper* for mouth feeding. This is possibly one of the best methods for feeding this class of infants, as it is simple of application, and a small dropper is easily obtainable. As in all other methods, the food should be administered very slowly.

3. *Nursing From a Bottle.* For this purpose the small nipples commonly sold on doll nursing-bottles are of the proper size, and can usually be obtained of proper quality. We have not infrequently perforated the rubber end of a medicine dropper and used it for this purpose. The

bottle to be used can either be an ordinary 1-ounce or 2-ounce medicine bottle, or, better, the special bottle which was designed by the author for this purpose. This bottle

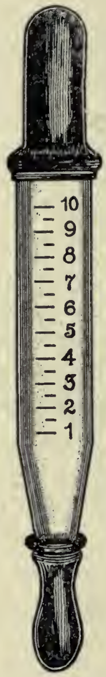

Fig. 5.—Breck feeder for premature infants.

holds 2 ounces of milk, is graduated in cubic centimeters, has a ground glass neck which coapts perfectly with the bulb on the special breast-pump, and which after being filled is corked with a ground glass stopper, and which has the added advantage in that the milk is in no way handled after it leaves the breast.

4. *The Breck Feeder.* This has the added advantage that the milk can be passed into the pharynx without effort on the part of the child when it is too weak to nurse. This has the one disadvantage of too rapid feeding if not properly controlled.

5. A rather slow but satisfactory method of feeding the infants is by *expressing the milk directly from the nipple into the infant's mouth* during the feeding period.

6. *Catheter Feeding by Mouth* (gavage). For this purpose a small funnel is attached either directly or by means of a short piece of rubber tubing with a glass connection to rubber catheter. A Nelaton catheter is used (best a No. 14 French), about 25 to 40 cm. long (10 to 16 inches), marked in centimeters or inches, so that at all times its position can be estimated. The infant should be fed in the incubator, its crib, or on the dressing table. Its head should be slightly lower than the body. The passage of the catheter is usually effected without difficulty by grasping it as one would a pen, and passing it in the midline to the pharynx, gradually pushing it into the esophagus. This is usually accomplished without difficulty, because of the poorly developed pharyngeal reflexes, and rarely results in retching or vomiting. In infants who retch during the passage of the catheter, vomiting may be expected because of the fact that these latter infants not infrequently belong to the spasmophilic group. The danger of passing the catheter into the larynx is minimal. It is rarely necessary to pass the catheter more than 10 centimeters (4 inches) beyond the infant's lips, and we have found it equally as practical to limit the passage of the catheter to 7.5 centimeters (3 inches). In most instances this does not reach the stomach, but has the added advantage of preventing

trauma to the cardiac end of the stomach and the gastric mucosa. When a graduated catheter is not at hand, it may be marked at 10 centimeters with indelible ink, and this used as the maximum point for passage. A

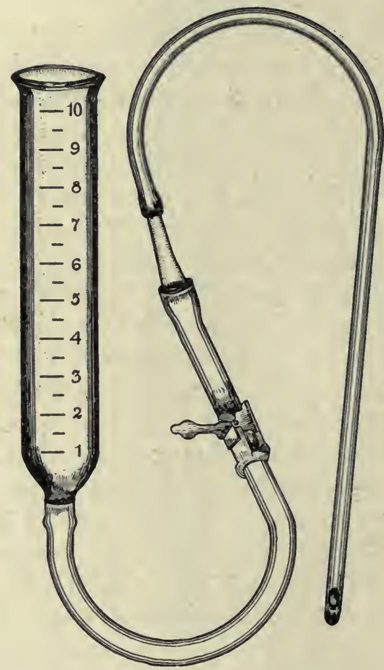

Fig. 6.—Apparatus for gavage and lavage. (Glass taken from Breck feeder.) When using for small infants the catheter should be attached directly to the funnel without the intervening rubber tube.

fairly safe maximum for the passage of the catheter can be ascertained by measuring the distance from the glabella to the epigastrium in the individual infant. The desired quantity of milk is allowed to flow into the stomach, slowly, by raising the funnel only very slightly above the level of the body. After feeding, the catheter is firmly compressed to avoid all leakage into the pharynx, and the catheter then removed, but not too rapidly. The

Fig. 7.—Introduction of catheter for gavage.

milk to be fed should be measured in a graduated glass, and the latter kept close at hand in order that the amount given can at all times be estimated.

A complete record of every feeding, both as to the time and the amount, should be kept. This is especially important in institutions where the nurses have a number of infants to observe, and is greatly facilitated by a time-clock registering the day, hour, and minute of each feeding. The nurse records the quantity of milk taken, which in breast-fed infants is obtained by weighing the infant both before and after feeding on an accurate scale, or in infants too weak to nurse by measuring the quantity in a graduated glass before feeding.

3. Proper Time for Beginning Regular Feeding.

Due to the tendency toward the rapid development of acute inanition in this class of infants, the greatest danger is that of too long delay in establishing regular feeding. Therefore it is often impossible to wait for the mother's milk to appear. We believe that it is, however, unwise in most instances to attempt to feed with milk during the first twelve to twenty-four hours, rather preferring to allow the circulatory and respiratory organs opportunity for proper accommodation to their new environment. During this time the loss of body fluids through evaporation from the skin and respiratory tract due to the warmth of the incubator, and the excretions through the kidneys and bowels, should be recompensed by the regular administration of water or some other inert fluid.

We have endeavored to administer about one-sixth of the body weight of water (inclusive of that contained in the milk if given) in twenty-four hours.

In smaller infants the first milk is given diluted one to four times during the first four days. After the first twenty-four hours water can be administered partly with the food, and otherwise between feedings. If for any reason the water is not well retained when given by mouth, it can, at least in part, be administered by rectum.

Example: An infant weighing about 1200 grams should receive 200 mils of water; should this infant receive 50 mils of milk, this can be diluted with 50 mils or more of water or sugar solution, and the remaining 100 mils administered between feedings. If a stimulant is indicated, a few drops of brandy (6 to 15 in twenty-four hours) may be added to the water or sugar solution during the first twenty-four hours. Half strength of Ringer's solution prepared as follows can be used to good advantage for rectal administration:

NaCl	7.5 Gm.
KCl	0.1 "
CaCl	0.2 "
Water	1000.0 mils.

We have made it a rule never to start milk feeding until after the first bowel movement. Not infrequently the removal of meconium may be accomplished by the administration of a small quantity of physiological salt solution through a catheter passed one or two inches into the rectum. This is done to remove the meconium before infection of the intestinal tract through the administration of food. Occasionally it is necessary to administer 5 drops of castor oil to obtain slight purgation.

4. Feeding From the Second to the Tenth Day.

It must be remembered that the general rules as applied to the feeding of premature infants do not hold for the first ten days of life. The early feedings must necessarily be small, and the increases gradual. Two grave dangers present themselves during the first period of the infant's existence: (1) overfeeding and (2) starvation, the latter usually resulting from an inability to supply sufficient quantity of human milk, following an attempt to await the natural secretion of the mother's breast. Overfeeding results either in vomiting or, more seriously, in stomach distention, which leads to asphyxia and cyanosis. Underfeeding in these weak infants soon leads to inanition. From the second day these infants should be fed regularly day and night, every two or, better, three hours, depending upon the infant's condition and the method of food administration. Not infrequently where the quantities taken are very small, ten to twelve feedings are required in twenty-four hours. It may even be necessary in very weak infants to feed minimal quantities every hour. The question of the number of feedings will be discussed in detail later.

It is practically impossible to formulate definite rules for feeding premature infants during the first ten days, because of their great variation in weight and development. Therefore it becomes necessary to *feed each infant individually.*

During the first days it is often difficult in infants weighing 1000 to 1200 grams or less to feed more than 20 to 50 mils of milk per day, and it may be necessary to limit the food to this quantity during the first ten days. It is our rule to start feedings in this class of cases with a maximum of 4 mils per feeding, not infrequently using one-fourth or one-half human milk at the start, and the balance water.

The feedings should be increased by 1 mil at a time, and with the first evidence of regurgitation the quantity should remain stationary. Even in favorable cases during this time 30 to 50 calories per kilogram is likely to be the maximum that can be fed with impunity.

The small feedings which can be assimilated, and the low energy quotient during the first two or three weeks, must be considered physiological, and as we rarely see an increase in weight with feedings of less than 90 calories per kilogram, we are confronted by a rapid loss in body weight during the first days of life. In favorable cases this is usually followed by a stationary weight, or moderate fluctuations after the first four to seven days. Occasionally an infant is seen in whom there is sufficient water retention to avoid most of the initial loss in weight. One should, therefore, remember that even with frequent feedings with human milk, either at the breast, by hand, or gavage, it is rarely possible to feed more than the minimum requirements without causing vomiting.

5. Feeding After the First Ten Days.

There has been considerable discussion as to the food requirements of premature and underweight infants during the past few years. Budin gives us the rule that premature infants of less than 2500 grams after their tenth day require one-fifth of their body weight (200 Gm. per kilogram of body weight), or 140 calories, while the full-term infant of normal development requires one-seventh of its body weight (140 Gm. per kilogram body weight), or 100 calories per day. On the other hand, Birk believes that the more fully developed premature infant, and those nearing the normal, will thrive on one-sixth to one-seventh of their body weight.

Our opinion, based on a series of experiments made on a number of premature infants, is that they require higher food values, or at least the maximum required by normal infants, for the following reasons: (1) the greater body surface as compared with the body weight; (2) in the normal infant the requirements decrease with the age, and therefore in the premature the quantity required varies inversely with the fetal age after the first weeks of life; (3) the need for body development is relatively greater in the premature than in the full-term infant; (4) a kilogram of body weight in the fat-poor premature infant cannot be taken as parallel in feeding to the well developed full-term infant, with its preponderance of fatty tissue. This latter point must also be considered in the feeding of the marasmic infant, to obtain a proper gain in weight as compared with the lower requirements in the fat, full-term infant.

6. Number of Feedings Daily.

Our own experience has led us to adopt a conservative position in that we have grouped the infants nursed at the breast or fed from the bottle or by feeders into two general classes: (1) those weighing under 1500 Gm., and (2) those above this figuré, based on the tendency of the smaller infants to become exhausted when the feedings are long continued. The former are fed at 2-hour intervals during the day, and 3-hour intervals at night, as follows: 6 A.M., 8 A.M., 10 A.M., 12 M., 2 P.M., 4 P.M., 6 P.M., 9 P.M., 12 P.M., and 3 A.M.—10 feedings during the twenty-four hours. The larger infants are fed on a 3-hour basis, 8 feedings being given during the twenty-four hours. These figures should in no way be construed as arbitrary. All feedings are more or less dependent upon the general development of the infant in relation to its digestion and metabolism, its retention, and upon the larger quantities of food necessarily given to meet its nutritional requirements, and a careful attention to gastric distention, regurgitation, asphyxia, cyanosis, and other respiratory complications.

It has been our personal experience to meet with considerable difficulty in attempting to meet the large food requirements in smaller infants without resorting to catheter feeding. In these we have adopted the longer interval between feedings, of four hours with six feedings in twenty-four hours, the individual meal in catheter feeding being greater in quantity. Notwithstanding the fact that catheter feeding offers little difficulty and few dangers in experienced hands, this may not be true with those not skilled in its use. A considerable number of our cases have, however, thrived satisfactorily on quantities of milk less than one-fifth of their body weight per day, and one should always remember that it is a safe axiom not to force the feeding in these cases as long as their general development is progressing satisfactorily and their weight curve is good.

7. The Amount of each Feeding.

The statistics as to the stomach capacity for food in premature infants indicate that this varies within considerable limits, even in infants of the same fetal age, as does also their ability to digest and assimilate food. The weight and length, naturally excluding congenital diseases and deformities, will be far more dependable as a guide to stomach capacity than the fetal age. As no definite rules can be established governing the amounts of individual feedings, we begin with what could be considered minimum quantities and gradually increase the amount of feedings as the infant develops an ability to digest it. It is our rule, as previously stated, during the first few days to feed small total quantities varying from 20 to 50 mils of milk per day, dividing these totals by the number of feedings to be administered (eight to ten), thereby feeding from 2 to 6 mils of milk per feeding. The feedings can then be increased by 1 or more mils at a time, and in the absence of vomiting the individual feedings can be increased more or less rapidly until the weight loss ceases or an increase in weight occurs. Even in favorable cases, weighing over 1500 Gm., 45 to 75 mils per kilogram weight (30 to 50 calories per kilogram) is likely to be the maximum that can be fed with impunity or safety during the first ten days.

8. Daily Gains.

These are not necessarily in proportion to the changing quantity of milk administered, as many factors, such as condition of the bowels, quantity of the urine passed, temperature of the infant's surroundings, will necessarily influence the weight. This is more especially noticeable in observations continued during a short period of time. An average greater daily gain than 20 Gm. is unusual when the infant's food is limited to one-fifth of its body weight. An average of from 10 to 20 Gm. daily can in most cases be considered satisfactory.

9. Artificial Feeding.

There can be no comparison between the results to be expected in feeding premature infants on human milk, and those to be obtained with artificial food. With human milk taken from a well regulated department for wet-nurses the milk can be obtained fresh, practically sterile; it is more digestible; its constituents are of the quality and in the proportions required for the growth and development of the human body; and it is live, and contains many of the immunity-conferring properties, as evidenced by the resistance of a breast-fed infant to infections and contagious diseases. Most of these properties and advantages are lacking in the dead foods used in artificial feeding. Therefore, if it becomes necessary to resort to artificial feeding, the selection of the food, its preparation, and its adaptation to the infant must all be given the most painstaking consideration. Many varieties of artificial diet have been suggested by various authors, such as simple milk dilutions, cream and top-milk mixtures, skim and buttermilk mixtures, malt soup preparations, condensed and evaporated milk, etc. The results with the various diets are to a great degree dependent upon the physician's intimate understanding of and directions for the use of the individual food.

Quantity of Food. It must be remembered that the figures quoted for feeding on breast milk are the maximum that can be assimilated, and in most instances these amounts more than fulfil the immediate needs of the infant's existence, and can be considered (and in most instances would be) excessive quantities for artificial feeding in the first few weeks of life, because of the greater difficulty in the digestion of cow's milk. One hundred calories per kilogram is the maximum quantity that can be digested by most premature infants, and in many instances one must be satisfied with a sustaining diet bordering on 70 to 80 calories, and they must at all times be closely watched for evidence of overfeeding, as it is dangerous to exceed the actual food requirements, and the first evidence of digestive disturbances or of intercurrent infections should lead to the feeding of human milk. During the first days the same rules for minimal feedings must be observed as in feeding with breast milk.

Quality of Food. Opinions vary greatly as to the best food for an artificial diet. Ordinary milk, water and sugar mixtures are rarely well taken. Pfaundler suggests rich fat and low protein milk mixtures; but in this feeding we have seen fat diarrhea resulting. Budin obtained the best results with peptonized boiled milk, using fresh pancreatic extracts for this purpose. Finkelstein, Oberwarth, Birk, Neumann, Von Reuss have obtained their best results through the use of boiled buttermilk mixtures, prepared according to the following formulæ:

Buttermilk	1000
Flour	10
Sugar	40

The above being used for the first feedings.

Buttermilk	1000
Flour	15
Sugar	60

For later feedings.

Dextrin-maltose compounds can be substituted for the cane-sugar if desirable.

Chymogen or pegnin milk has given us most satisfactory results in the artificial feeding of the premature infants. This latter preparation is little more than a boiled milk in which the curds are precipitated in a fine, flocculent form, about the size of that of human milk, before it is fed to the infant. It is best diluted before use. This preparation should be started with 1 part chymogen milk and 3 parts water, following the directions for increases in quantity and quality as given for human milk. Because of the low carbohydrate content of such mixtures, 0.5 per cent. of lactose should be added after the first few days, and the amount gradually increased to 3 per cent.

When even only insufficient amounts of human milk can be obtained, artificial feeding should be used as a supplement and not as a substitute.

10. Conclusions.

1. The weight, temperature, stools, absence of abdominal distention, cyanosis and well-being of the infant should be the guide for increase in the infant's diet.

2. The utmost care is necessary in increasing the diet of the infant during the first days of life. The gastro-intestinal tract offers the best evidence for increases. Vomiting and abdominal distention and associated cyanosis are the prime indications for stationary or decreased amounts of feeding.

3. An initial weight loss during the first ten days must be considered physiological.

4. These infants, therefore, should be fed small quantities, frequently repeated, every two to three hours during the day and night.

5. On the first day following the first bowel evacuation the human milk may be fed diluted with one or two parts of water and sugar, with a caloric value approximating 15 to 30 calories (20 to 40 mils, $\frac{2}{3}$ to $1\frac{1}{3}$ ounce of human milk to the kilogram of body weight).

6. From the second day on, in the absence of indigestion, the food may be increased by 10 calories daily per kilogram (15 mils daily per kilogram). In the presence of digestive disorders greater care is necessary to maintain the metabolic equilibrium (120 mils, 4 ounces of milk to the kilogram of body weight).

7. It is of the greatest importance to administer a sufficient supply of water to counterbalance the rapid evaporation due to artificially heated and dried air, and

the excessive excreta, more especially during the first few days. About one-sixth of the body weight of water, inclusive of that contained in the milk, should be fed in twenty-four hours.

8. It is to be remembered that a standstill in the weight-curve, and indigestion with bad bowel movements, frequently result when 140 calories per kilogram are exceeded.

9. All intestinal disturbances in premature infants should be given the utmost consideration.

10. The method of administration of food in each case varies with the vitality of the infant.

11. In all cases of prematurity, syphilis should be thought of; and in cases in which there is the slightest suspicion, the infant must not be placed directly on the breast of a wet-nurse.

PART III.

Artificial Feeding.

CHAPTER I.

RECENT PROGRESS IN ARTIFICIAL FEEDING.

THE presentation of the subject of artificial feeding without a review of the progress and evolution which our ideas on this subject have undergone during the past years might easily mislead the student to the belief that the last word in artificial feeding of infants has been said. The men who have given this subject the most consideration, we believe, would agree that much is to be hoped for in the future in artificial feeding.

It is most difficult to present in a concise manner the best that we have learned in artificial feeding so that it may be practically applied, because of two very important factors which make for success: (1) a careful interpretation of the needs of the individual infant, and (2) experience on the part of the feeder to meet those needs.

It remained for the American school of pediatrics to do the pioneer work in placing artificial feeding on a scientific basis.

Pepper and Meigs, of Philadelphia, gave us the first rational method in milk modification. They more especially attempted to vary the percentages of casein in cow's milk, believing that the excessive quantity contained in cow's milk was in great part the cause of feeding difficulties. This was accomplished by diluting the milk and adding milk-sugar and cream to make up the deficiency in energy value.

Rotch, of Boston, made further advances in infant feeding in that he taught us that fat and sugar, as well as protein, were important factors in the disturbances of the artificially fed infants. His work on percentage feeding, whereby he increased or decreased the various constituents of human milk to meet definite clinical pictures, was probably the first epoch-making advance in infant feeding, and his system of feeding has since been known as "the percentage method" of infant feeding.

The German school, of which Rubner and Heubner were the chief advocates, gave us the so-called "caloric method" of feeding, by which they sought to provide the number of heat units required by the infant, basing their estimations on the infant's weight. Of this method we will have occasion to speak later. It is sufficient to state that we do not now use this as a method of feeding, but find a check on the caloric contents of the food of inestimable value in determining the value of our mixtures in avoiding over- and under- feeding. The German school have never attempted the refinements in the percentage composition of their mixtures as advocated by the American school.

More recently Czerny and Finkelstein have taught us the dangers of overfeeding with whole milk, and also its individual ingredients, fat, sugar, and salts, individually and in combination. Their studies have, on the whole, ignored the proteins, in all probability due to the fact that protein disturbances other than those seen in infants suffering from an idiosyncrasy to cow's milk are for the most part limited to infants fed on raw cow's milk, while most of the Continental clinics have for several years fed boiled milk. Their studies and conclusions will be more fully discussed under the disturbances of artificially fed infants.

During the past few years there has been an increased tendency to boil cow's milk before feeding to the infants in American clinics, based on the desire to render the curd more fragile, and at the same time to destroy the pathogenic bacterial content of the milk. While this has many advantages, it must not be forgotten that it must necessarily cause changes, more especially in the ferments, vitamines, and salts, which are of vital importance to human economy. The ferments are believed to be important to the infant, and this importance has been emphasized especially since the introduction of pasteurization and boiling of milk, for the reason that a high degree of heat destroys them. Some of the ferments are normal constituents of milk, such as lipase, galactase, lactokinase, and diastase. The absence of ferments in the milk indicates that it has been heated. Hamburger's studies on the biologic differences in human and cow's milk are unquestionably of vast importance, and though there has been a tendency in recent years to neglect this factor in infant feeding, we believe that it will again receive more important recognition in the near future. The changes caused in milk by boiling make it necessary to administer fruit and vegetable juices, non-dextrinized cereals, and other foods, such as codliver oil, to prevent the retarded development on the part of the infant.

CHAPTER II.

COW'S MILK.

No method of artificial feeding can perfectly replace nursing or human milk feeding. This must be admitted, notwithstanding the many advances that have been made in infant feeding during recent years.

The best substitute for nursing is feeding with properly modified milk of other animals, and cow's milk, for practical reasons, was found to be the one best suited for this purpose.

There are marked chemical, physical, and biologic differences between the human milk and cow's milk, which account for the superiority of human milk over the cow's milk in infant feeding.

How Cow's Milk Differs from Maternal Milk. The differences between these two milks summarized in a table which follows are greater than the table indicates. While cow's milk may be modified to approximate woman's milk in composition, it can never be just the same or just as good for infants.

Cow's milk is more opaque than human milk, although the latter may contain a greater percentage of fat. This is due to the opacity of the calcium-casein, which is present in greater proportion in cow's milk. Cow's milk is faintly acid or amphoteric when freshly drawn, but ordinarily is distinctly acid in reaction when consumed. Human milk is amphoteric or alkaline.

There is three times as much protein in cow's milk as in human milk. The reason for this is obvious, when we recall that the ratio of the growth of the calf to that of the infant is about as 2: 1. Furthermore, the protein in cow's milk consists chiefly of casein (3.02 per cent.) and little lactalbumin (0.53 per cent.), while human milk contains 0.59 per cent. of casein and 1.23 per cent. lactalbumin. The sugar in the two milks varies greatly in amount, but not in kind. Cow's milk contains almost four times the amount of inorganic salts compared to woman's milk. Of more importance, the salts in cow's milk consist mainly of potassium and sodium bases. These differences have an important bearing upon infant's metabolism. There is no great difference in the average amount of fat in the two milks; however, both in human milk and in cow's milk the fat is the most variable constituent.

The curd from cow's milk is usually tougher and in larger masses than in human milk. There are also differences in antibodies, ferments, etc.

Cow's Milk		Human Milk
Amphoteric or acid	Reaction	Amphoteric or alkaline
1.029 to 1.034	Sp. gr.	1.010 to 1.040
3.5 per cent.	Proteins	1.5 to 2.0 per cent.
2.66 per cent.	Caseinogen	0.5 to 0.75 per cent.
0.53 per cent.	Lactalbumin	1.23 per cent.
Clots in large lumpy curds	Effect of rennin	Clots in fine curds
4.0 per cent.	Fat	3.5 to 4.0 per cent.
4.5 per cent.	Lactose	6.0 to 7.0 per cent.
0.75 per cent.	Salts	0.2 per cent.
13 to 14 per cent.	Total solids	12 to 13 per cent.
86 to 87 per cent.	Water	86 to 88 per cent.
Never sterile	Bacterial contents	Practically sterile

Biedert, whose theory found many followers at one time, believed that casein of the cow's milk was the disturbing factor in artificial feeding.

The large, tough curds forming from the casein of raw cow's milk differ considerably from the fine flocculent curds of the human milk casein. Steps have been taken to make the cow's milk curd resemble the human milk curd in its physical properties, such as boiling the milk, citration and addition of cereal waters, and it was found that this modification considerably improved the results of artificial feeding.

The differences in the fat contents of the two milks have less frequently been drawn upon for explanation of frequent nutritional disturbances on artificial feeding, although it has positively been established that fat plays an important part in the nutritional disturbances of the artificially fed infant. The butter prepared from cow's milk contains 10 per cent. of volatile acids, while that prepared from the human milk only 1.5 per cent. And especially the irritant butyric acid glycerid, which is contained in 6 per cent. in butter prepared from cow's milk, is contained only in traces in human milk. The fat drops of cow's milk are also on the whole much larger than those of human milk.

Lactose is the principal sugar in both cow's and human milk, average human milk containing 6 to 7 per cent., and cow's milk 4 to 5 per cent. This increased sugar contents of the human milk, with its fermentation, accounts for the laxative effect of breast milk feeding when the milk is abundant.

L. F. Meyer has experimentally shown that salts of the cow's milk, which vary both quantitatively and qualitatively from those of human milk, have unfavorable influence on children with nutritional disturbances. While we cannot from these experiments conclude that the same holds true for normal, healthy children, yet we have to admit that the salt contents of the two milks are of great importance in artificial feeding.

Escherich and Hamburger were of the opinion that human milk contained ferments which favorably influenced the processes of metabolism. Salge found that tetanus and diphtheria antitoxins could be utilized by the infant only when fed in human milk, while when contained in the milk of other species they did not get into the body fluids of the infant. But whether these biologic differences are of great importance to the infant remains to be proven.

Although it seems probable, yet it has not been demonstrated that cow's milk feeding taxes the digestive functions of the infant's organism more than human milk feeding.

Of great importance is the bacterial contents of the milk, the human milk being either sterile or of low bacterial contents, while cow's milk is never sterile, and not infrequently its bacterial contents is very high. Sterilized, pasteurized, and certified milk were the practical results of the efforts to obtain germ-free milk for infant feeding.

The milk for infant feeding must come from healthy cows, must be obtained in clean manner into clean receptacles, must be cooled very soon after milking in order to keep down the bacterial content, and kept cool afterwards. It must be delivered to the consumer as soon as possible in such a way as to prevent any contamination, and must be handled in the home, cleanly, in sterile receptacles, and at all times be kept cool.

The cow from which the milk is obtained must be entirely healthy, and be especially free from tuberculosis and glanders, tuberculin and mallein test being advisable as a routine, besides general examination of the cow. The cows must be kept clean, in a clean stable, which is well ventilated and drained. No dust, manure, or fodder, except that used for immediate feeding, should be kept in the stable. The cows should be kept clean, but even then they should be cleaned again immediately before milking.

The milking must be done in a clean way and milk kept clean afterwards, in order that the bacterial count may be as low as possible. Dry feeding of the cows is preferable, since on this feeding the feces is less liquid, and cows can be kept clean with less difficulty. The milkers should be free from any communicable disease, and be of clean habits. The udders of the cows and the hands of the milker should be scrubbed with warm water and soap immediately before milking, and antiseptic solution may be applied afterwards. Milking should be done into covered cans, and milk made to pass through a filter first. The cans should be always cleaned immediately after the milk is poured out, first with cold and then with hot water, and also rinsed out with hot water before milking. The first few ounces of milk should be discarded, since this milk contains large amounts of bacteria that are washed out from the excretory ducts.

Cooling the milk after it is obtained is a very important step in the production of clean milk. The milk having been obtained with the above-described precautions, with as few bacteria as possible, should be cooled at once in order to prevent growth and multiplication of the bacteria that have entered the milk in spite of all the precautions. This is accomplished by special cooling apparatuses, or simply by pouring the milk into sterilized bottles, closing with sterilized cap, and putting on ice. The milk in bottles should be kept iced until it reaches the consumer, which should not take longer than twenty-four hours.

In the home precautions should be taken to prevent additional contamination, and to keep the milk iced to prevent further growth of bacteria, until everything necessary is ready for making the proper mixture for infant feeding. Many good milks are spoiled on the door-step of the home between the hour of delivery and placing the milk in the ice-box. All the utensils and vessels used for preparing the mixture must be perfectly clean and sterilized by boiling. As soon as the mixture is made it should be put into the ice-box again and kept there, portions being taken during the day for individual feedings, and warmed separately just before feeding.

Certified Milk. The term "certified milk" was coined by Dr. Henry L. Coit, of Newark, N. J., who in 1892, needing good milk for his own baby, formulated a plan for the production of clean, fresh, pure milk under the auspices of a medical milk commission. The term "certified milk," then, is the milk of the highest quality, of uniform composition, obtained by cleanly methods from healthy cows, under the special supervision of a medical milk commission.

The use of the term "certified milk" should be limited to milk produced in accordance with the requirements of the American Association of Medical Milk Commissioners. The first requisite in the production of certified milk is to enlist the co-operation of a trustworthy dairyman who is willing to enter into a contract with the medical milk commission. In accordance with the terms of this contract, the dairyman binds himself to comply with the specifications set forth, and in return his milk is certified.

The dairies are subjected to periodic inspections, and the milk to frequent analyses. The cows producing certified milk must be free from tuberculosis, as shown by the tuberculin test and physical examination by a qualified veterinarian, and from all other communicable disease, and from all diseases and conditions whatsoever likely to deteriorate the milk. They must be housed in clean, properly ventilated stables of sanitary construction, and must be kept clean and properly fed and cared for. All persons who come in contact with the milk must exercise scrupulous cleanliness, and must not harbor the germs of typhoid, tuberculosis, diphtheria, or other infections liable to be conveyed by the milk. Milk must be drawn under all precautions necessary to avoid contamination, and must be immediately cooled, placed in sterilized bottles, and kept at a temperature not exceeding 50° F., until delivered to the consumer. Pure water, as determined by chemical and bacteriological examination, is to be provided for use throughout the dairy farm and the dairy. Certified milk should not contain more than 10,000 bacteria per cubic centimeter, and should not be more than thirty-six hours old when delivered.

Inspected Milk. This term should be limited to clean, fresh milk from healthy cows, as determined by the tuberculin test and physical examination by a qualified veterinarian. The cows are to be fed, watered, housed, and milked under good conditions, but not necessarily equal to those prescribed in the production of certified milk. Scrupulous cleanliness must be exercised and particular care be taken that persons having communicable diseases do not come into contact with the milk.

This milk must be delivered in sterilized containers, and kept at a temperature not exceeding 50° F. until it reaches the consumer. There should be not more than 100,000 bacteria per cubic centimeter of inspected milk. This milk should be pasteurized.

Market Milk. All milk that is not certified or inspected in accordance with the above definitions, and all milk that is of unknown origin, is classed as "market milk," and should be pasteurized.

Frozen Milk. In our own experience we have found that many infants were made ill by feeding of raw frozen milk which has been rapidly thawed, and allowed to stand in a warm room, with resulting vomiting, and not infrequently diarrhea. These symptoms are obviated when the milk is boiled. Pennington and her collaborators found very definite changes in milk after freezing. They found that when the milk is held at a temperature of 0° C. there is proteolysis of the casein, which is primarily of bacterial origin, and proteolysis of the lactalbumin, due primarily to the native enzymes of the milk. The action of these two agents together is more rapid than that of either alone. The bacteria and enzymes may break down the true protein and carry the breaking down through to peptones, even to amino-acids. There is a fermentation of lactose with the formation of lactic acid, which is largely, if not exclusively, due to bacterial action. The fat, so far as can be determined, is not affected except by the action of bacteria.

Mixed Milk Versus Milk of One Cow. It is far better, other things being equal, to use the mixed milk of a herd in preparing a baby's food than the milk of one cow, because if the milk comes from one cow, and the cow is ill in any way, the baby is almost certain to be disturbed, whereas if one or two cows in a herd are ill, the milk from these cows will be so diluted that the baby will probably not notice it. On the other hand, it is, or should be, self-evident that the milk of a healthy cow properly fed and properly cared for, taken in the proper way, and kept under proper conditions, is better than the mixed milk of a herd which is improperly fed, and whose milk is not carefully obtained or carefully taken care of.

Boiling, Sterilization, and Pasteurization. Before entering into a discussion of this subject, it is only fair to state that the general teaching in America of feeding with raw milk has led to the production of safe, clean certified milk in the large communities where so many fatalities were experienced through the feeding of unclean milk. Any methods of handling milk which will in the least interfere with the proper production of clean milk, and lead to the feeling that unclean milk can be made safe for infant feeding by the application of heat or other methods, would be a backward step in infant feeding, and would necessarily cause dire results. While the European countries, like Germany and France, have advocated feeding boiled milk for many years without fear of bad nutritional disturbances due to the changes in the milk, in America feeding with raw milk has until recently been favored. Increased experience with boiled milk, especially by those who have long used raw milk, leads to the growing conviction that boiled milk is more easily digested than raw milk by dyspeptic infants, and hence by the well infants.

While we do not believe that feeding with boiled milk should be advised as a general measure, when it is possible to obtain a good certified milk, and when the latter is to be placed in the hands of mothers and nurses who can be depended upon to keep the milk clean and wholesome through proper icing and handling, we do believe that when these requirements cannot be met, that it is safer even in well babies to feed a thoroughly sterilized milk, and that this can be done without danger of development of scurvy and rickets, when these feedings are accompanied by the administration of fruit juices, vegetable soups, and pureés and codliver oil.

Brennemann suggests that we must answer the following questions before deciding as to whether we should feed raw, pasteurized, or boiled milk:

(1) Does raw milk offer advantages over boiled milk?

(2) Does boiled milk offer advantages over raw milk?

(3) Does pasteurization solve the problem?

(4) Does certified milk solve the problem?

In answer to the first question we must decide whether the changes caused in milk by boiling, such as partial coagulation of lacto-albumin, caramelization of some of the milk-sugar, its action on casein, inhibiting coagulation with rennin, etc., lessen the nutritive value of cow's milk as an infant food. We believe that the sentiment of American, German, and French clinics, in which boiled milk has been used for a long period of time, is to the effect that the nutritive value of boiled milk, with its lesser dangers, are on the whole in favor of boiled milk.

Constipation has been suggested as an argument against boiling milk. We believe that constipation in the bottle-fed baby is one of the safest earmarks of the well-being of the infant, and that only that constipation which is due to excessive feeding of fat, and which will be described under Disturbed Metabolic Balance, is an exception to this statement. While with raw milk digestive disturbances are frequently seen before sufficient milk is given to properly nourish the infant, this is far less common with boiled milk; in fact, it has not infrequently been our experience that we have overfed with boiled milk, because the infant handles it with so much better advantage. In digestive disturbances, with loose stools, it is digested to much better advantage than raw milk, which frequently results in formation of hard casein curds as well as fat curds. The assertion that feeding with boiled milk results in anemia, underdevelopment and rickets, we believe, is not well founded, and these conditions, when present, are due to other causes. Scurvy developing during the course of feeding with boiled milk has never been seen in our experience, except when some of the proprietary infant foods have been fed in conjunction with boiled milk. That under certain conditions scurvy should develop in presence of long-continued feeding with boiled milk alone, is not to be denied. The dangers, however, are very remote, as testified to by the German and French clinicians. When such dangers are feared, they can easily be overcome, as previously suggested, by the feeding of fresh fruit juices and vegetable preparations together with the milk diet.

Does boiled milk offer advantages over raw milk? Boiled milk when properly handled is relatively free from pathogenic micro-organisms, and if the milk, which has been boiled, was clean milk, also from their toxic products. In raw milk we have a tendency even in clean milk to bacterial growth which causes souring, and which is not pathological, while when the lactic acid organisms are destroyed by boiling, in proper handling of boiled milk it will result in decomposition with its attendant dangers. Boiling in the home has the great advantage over commercial pasteurization and boiling in that, if the milk is raw and spoiled before it reaches the home, this can readily be detected by the housewife. While we know that certain pathogenic organisms may develop in the milk without giving evidence of their presence, and cause formation of toxic bodies which are not removed by boiling in the home, the latter process still offers every advantage over commercial pasteurization. Boiling milk in the home will most certainly remove the dangers from infection with tuberculosis, scarlet fever, streptococcus sore throat, typhoid fever, dysentery, and many other milk-borne diseases. The advantages of boiled milk in the presence of indigestion and diarrhea have already been mentioned. The small, flocculent curd of the boiled milk is also rapidly and more easily digested than the large, tough casein curds of the raw milk. The hard bean-like protein curds are never seen in stools of the infant fed on milk which has been thoroughly boiled, although we have occasionally seen them in overfeeding with cow's milk which has been heated by the double boiler process. These latter cases, however, are exceptions.

Larger amounts and more concentrated mixtures of boiled milk can be fed than in feeding with raw milk. This is a distinct advantage in the beginning of the feeding of atrophic infants. This latter advantage is not to be overlooked. While the large percentage of healthy babies will apparently digest equally well raw and boiled milk within therapeutic limits, it will be found that most authors who do not resort to heating milk will, at least in some other way, modify the curd of raw cow's milk, either by simple dilution, by the use of cereal waters or an alkaline, such as lime water or sodium citrate. We agree with Brennemann in his statements that boiling commends itself as an excellent casein modifier, and that it effectually disposes of the majority of bacteriological problems when the milk is properly handled after boiling.

Pasteurization *versus* **Boiling.** Pasteurization was first recommended because of the belief that boiled milk has scorbutic properties, which could not be laid at the door of pasteurized milk. The question of the relationship between boiled milk and scurvy has already been touched upon. Pasteurization in the home is not a very satisfactory process. Commercial pasteurization, even though properly carried out, is too distant from the probable time of consumption of the food to be a safe measure, unless the milk is properly handled after pasteurization. The best argument presented by the advocates of pasteurization is that the milk is essentially a raw milk in so far as its physiological properties are concerned.

Certified Milk *versus* **Boiling.** Clean certified milk, properly handled, both before and after it reaches the home, and where the cost is not prohibitive, when well digested by the individual infant, still remains the ideal food for artificial feeding. When these requirements cannot be met, boiling in the home is the best method for preparation of milk for the infant.

Various Methods of Boiling Milk. In our own work we have resorted in most cases to the heating of the milk in a double boiler. This has several advantages in that the milk is heated in a closed vessel, and has then a less pronounced flavor than when heated in open vessels, and causes but little pellicle formation, unless we have a very thin column of milk. To overcome this latter, we therefore recommend the smallest double boiler which can be obtained, and which will at the same time hold all of the milk which is to be prepared. The milk mixture is put in the inner receptacle, cold, and the water in the outer vessel also cold. The double boiler is then placed on the stove, and allowed to remain until the water in the outer vessel boils for six to eight minutes. While the milk heated in this manner forms a very much finer and softer curd than that of raw milk, it is not as fine as that of milk boiled directly over the flame. However, in most cases, it answers all purposes, and has the advantages above enumerated. In the presence of gastric and intestinal indigestion and allied conditions, the finer curd of the milk boiled directly over the flame may be more suitable; and in exceptional cases, when boiling over the direct flame for three to five minutes does not give the desired result, milk boiled for 30 to 45 minutes over the direct flame will offer further advantages, and this method is worthy of trial for temporary use.

CHAPTER III.

ADAPTATION OF MILK FOR INFANT FEEDING.

FROM the foregoing it may be seen that there is no perfect substitute for human milk in the feeding of the infant, and therefore every effort should be made to assist the mother in the nursing of her infant.

Since all the attempts made to feed an infant on the food not primarily intended for this purpose are attempts at milk adaptation, we necessarily know that no single method can possibly meet the needs of all infants.

And therefore it must be our object, first, to formulate our rules so as to make them safe and adaptable to the feeding of the majority of well babies, leaving the discussion of exceptional and sick babies for further study. It must necessarily go without saying that the food recommended will be excessive for some and inadequate for others. Every organism has its individuality and its fixation coefficient, and every infant makes a different use of the food administered to it. All infants cannot, therefore, be treated according to the same rule.

While many excellent results have been reported with the various methods described for artificial feeding of infants, and some attempt has been made to place feeding on a scientific basis, we believe that we must concede that the methods are all more or less empirical, and the result will be in considerable degree dependent upon the wide range of food tolerance of the healthy infant. The successful physician must depend on the clinical observation of the individual infant for the success of the method of feeding which he is using. Every formula with which we start feeding should be looked upon in the light of an experiment, and the reaction of the infant to this feeding should be carefully studied.

If these principles are borne in mind, many an obstacle to successful infant feeding will be avoided.

We believe that the attempts toward ultra refinement of the infant's diet has led to considerable confusion, because of the different conclusions of the various schools undertaking the work. Eventually, however, infant feeding will be placed on a thoroughly scientific basis. This, however, does not answer the pressing needs of to-day, which call for a safe and practical solution of the feeding problem for the feeding of the everyday baby in everyday life. The baby is so commonly receiving its feeding advice from food manufacturers; and if feeding on one preparation is not successful, there is a rapid transition from one proprietary baby food to another, with untold detriment to the infant. In advancing the rules for feeding the normal healthy infant, with further suggestions for the underfed, *on simple milk mixtures with carbohydrates added,* we desire to state that in our clinical experience we have found them safe for the baby and practical for the physician, which latter is neither to be overlooked nor taken lightly.

We claim nothing original for these feeding suggestions, as they represent the more common practice of the Continent, and America as well. We have, however, formulated the rules which govern the application of simple milk mixtures, with carbohydrates added, in such a way that their application becomes more practical. Knowing that the feeding advice which we are to receive and advise is founded on clinical experience, and that similarly good clinical results in feeding have been obtained by others by various methods of feeding, we believe it advisable to briefly review the more popular methods of infant feeding as practised today.

1. **Undiluted Whole Milk.** While undiluted milk has been used with varying degrees of success by some German and French pediatricians (of the latter Budin being the foremost advocate), it may be generally stated that, on the whole, it is not well borne before the fourth month of life. If whole boiled milk is used in the feeding of the very young infant, the size of the individual meal must be greatly restricted over that as recommended for diluted mixtures, so that it will not exceed the caloric requirements of the individual. Budin recommended that all whole milk fed to an infant should first be boiled, which causes the protein to be precipitated in the infant's stomach in the form of a fine curd. This can be further facilitated by the addition of pegnin or chymogen, which causes the formation of the fine curds before it is fed to the infant, with no recoagulation in the stomach.* Alkalinizing milk by the addition of sodium bicarbonate also results in the formation of fine curds. In some forms of vomiting, small quantities of a concentrated food will frequently be found of considerable value. As a routine measure of feeding, whole milk cannot be recommended.

2. **The Percentage Method or System of Feeding.** This is frequently spoken of as the American method, or Rotch's method, because of the fact that Rotch, of Boston, did much to popularize and systematize this method of feeding. Not only did he work out a system of

* Brennemann, Archives of Pediatrics, 1917, 34, 81.

formulæ adapted to infants of varying ages and development, but he also was the means of establishing the first so-called public milk laboratory. The chief objections to this method, as originally described by Rotch, were its lack of flexibility and the difficulty of remembering the various formulæ and their preparation. The followers of the Rotch school state that the percentage feeding, so-called, is not a method of feeding, but merely a method of calculation, and a means of obtaining relative accuracy in the preparation of infants' foods. They have simplified the method as originally applied, lengthened the feeding intervals, and, while still retaining some of the original ideas, have made the method far more practical.

3. **Top Milk Feeding.** In this method a definite number of ounces of the upper part of the milk, which has stood for a number of hours, is used as the basis for preparing the mixture to be fed.

To successfully carry out top milk feeding, the percentages of fat at various levels in 32 ounces (quart) of milk containing 4 per cent. of fat, and which has stood for six hours or longer, must be known:

Upper	16	oz. has	7	per	cent.	fat.
"	20	" "	6	"	"	"
"	24	" "	5	"	"	"

(1) This method endeavors to provide ample caloric values. In this respect the method may be regarded as successful. (2) There is the idea that casein is not very digestible, and that it is advantageous to feed casein in small quantities, making up the shortage in energy value of the mixture with fat. In the light of our present knowledge, however, we know that the casein of boiled or alkalinized milk, or when mechanically divided

by the addition of cereals, is easily digested. (3) The attempt to produce a formula with the percentage of fat in the same proportion as is found in human milk, as well as larger amounts, which, however, frequently leads to fat indigestion, because of the greater difficulty experienced by many infants in handling large quantities of cow's milk fat. (4) The importance of the sugar and salt content of the mixture is underestimated.

This method of feeding, nevertheless, has many advocates, and we would advise that the above shortcomings of the method as originally described be given full consideration by those adopting this method of feeding.

CHAPTER IV.

MILK DILUTIONS WITH THE ADDITION OF CARBOHYDRATES.

It has been our experience that about 90 per cent. of the infants that come under our observation for artificial feeding will tolerate a wide range of quantitative values in the components of the milk, *i.e.,* fats, proteins, carbohydrates, and salts. And the simpler the first formula on which the baby is started, the easier we find it to meet its later needs for growth and development, by increasing or decreasing the individual elements in the diet. The first step of this method consists in the dilution of whole milk with water, thereby reducing all the ingredients of the milk. When we compare such a dilution with human milk we find that when protein approximates that contained in breast milk, the fat is considerably reduced below that contained in the latter. This in practical feeding we find to be an advantage rather than a disadvantage, and if there be an indication for increasing the fat content of the formula this is easily accomplished by the addition of cream, or top milk, which is, however, usually not necessary, as the deficiency in fat can usually be successfully compensated by adding sugar and starch to the formula. As a result of dilution, the salts, which are about three times as great in quantity in cow's milk, are reduced to more nearly the amounts contained in breast milk. We must, however, remember that there are still great qualitative differences in the *salt content* of the cow's milk dilution and human milk.

In	K_2O	NaO	CaO	MgO	F_2O_3	P_2O_5	Cl	
Human milk .	30.1	13.7	13.5	1.7	0.17	12.7	21.8	% in 100 parts ash
Cow's milk ..	22.14	15.9	20.05	2.63	0.04	24.7	21.27	% in 100 parts ash

Feeding should primarily be formulated to promote normal growth and development, to supply energy for the body functions, to prevent disease; and, although of no lesser importance, feeding in disease should be given a secondary consideration in the study of this subject.

The food must be given in such form that the infant may be able to digest it easily, to assimilate it, and to utilize its constituents for the purposes enumerated above.

The following factors must be considered before estimating the composition and quantity of food for infant feeding.

1. The clinical aspects—that is, the general well-being of the infant—must be given equal importance with the percentage and energy value of the food administered.

2. Is there a normal gain in weight which an infant must show as a sign of full health?

3. The qualitative and quantitative chemical composition of the food, the number of calories available from the total administered, and the proportion of the total fixated in the body must be taken into calculation.

The normal artificially fed infant should manifest the same clinical evidences of good health and progress as are seen in the breast-fed infant. It should be comfortable, which he manifests in a happy disposition. He should be a good sleeper, and awaken regularly for his feedings, and there should be no more occasion for his crying than in the case of the breast-fed baby. His temperature should show maximum excursions of 1° to 2° F. daily. He should have large quantities of subcutaneous fat, and his muscular tissue should be well developed. The turgor of his tissues should be normal. The latter can be estimated by the eye and by palpation. The muscles may be taken between the fingers, and their firmness or softness estimated in this way. By raising a fold of the skin we may determine whether the panniculus adiposus is well developed. The stools, which of necessity must vary with the diet, are firmer and drier and much paler than those of the breast-fed infant, and he should pass one or two daily. Except in the presence of large amounts of carbohydrates, and more especially malt sugars, they are alkaline in reaction, and have a foul odor.

Therefore, we see that the criterion of good health for the artificially fed infant depends on many things, which together make up the condition of the infant. And we again desire to emphasize that the impression of the general well-being of the infant is a much safer method of estimating its progress than a study of his weight-curve alone.

We have learned to recognize the study of the infant's *weight* as one of the simplest and most reliable clinical factors in estimation of the infant's progress. And while of necessity the diet of different infants necessary to normal weight increases must vary within very considerable limits, the scale offers information which is of inestimable value.

The following may be taken as working averages for comparative purposes, and the estimation of over- and under- weight in infants coming under observation.

Average *weight at birth* 7 pounds (3200 Gm., or about 3333 Gm.).

Average *initial loss* 10 ounces (300 Gm.) or about one-tenth of the body weight at birth.

Birth weight regained usually by the fourteenth day.

Weight is *doubled* at the end of the fifth month.

Trebled at the end of the first year.

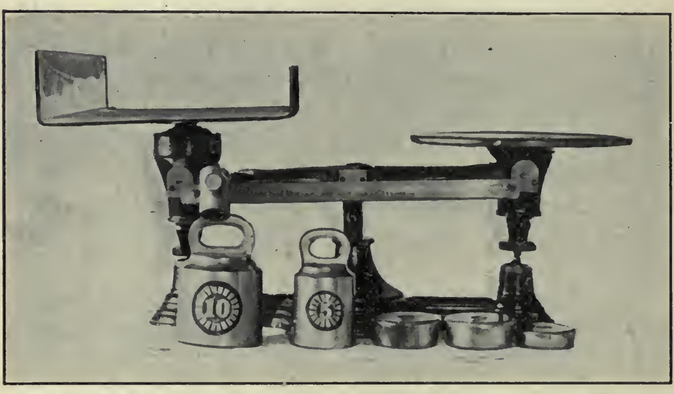

Fig. 8.—Scale for weighing infants.

Average *weekly gain* during the first five months should approximate 5 ounces (150 Gm.), during the remainder of first year 4 ounces (120 Gm.).

Yearly gain during the *second year* 6 pounds (2727 Gm.).

Gain during the *third year* 4.5 pounds (200 Gm.).

Gain from the *fourth* to the *eighth* year, 4 pounds annually (1800 Gm.).

Gain from the *eighth* to the *eleventh* year, 6 pounds annually (2700 Gm.).

An accurate scale is necessary equipment for proper infant feeding. Parents should be encouraged to purchase a balance scale with a large scoop.

However, it is not sufficient to base the determination of the amount of food on the weight of the baby alone, since two infants of the same weight may have decidedly different nutritional requirements, dependent upon various factors. The fat baby requires less food per pound than the thin baby—the overfed less than the underfed infant; and the sick baby must of necessity be fed within its limits of tolerance during the acute part of its illness, and the body losses must be compensated by increases in the diet beyond those which we have learned to consider as the normal feedings per pound body weight, as its tolerance for food permits during convalescence.

A healthy infant should, therefore, show a regular gain within certain limitations. It is not absolutely necessary for an infant to add to its body weight every day, as daily irregularities are rather the rule than the exception. The relation of the time of weighing to the feeding, defecation, and urination are factors which must always be taken into consideration. Therefore under normal conditions it is sufficient to *weigh the infant once a week*. It is especially wise to impress this upon a nervous mother.

Further, we must not forget that the weight curve of the nursing infant and that of the artificially fed infant differ widely, so that they cannot be compared directly. The artificially fed infant, although in the beginning gaining less than the breast-fed infant, in the course of a year reaches the same weight as the breast-fed infant, who at first showed larger gains, but later lagged somewhat in its gains. Much more important than the weight itself is the rising series of successive weight figures.

The clinical aspects, that is, *the general well-being of the infant must be given equal importance with the percentage and energy value of the formula.* In a consideration of the latter two important factors in successful feeding, *the chemical composition must be considered of equal importance with the caloric value.* Otherwise one meets with profound disturbances due to feeding of insufficient or excessive amounts of the components of the diet, difficult of interpretation.

It may therefore be stated that the infant must be fed amounts of fat, protein, carbohydrates, and salts and water suitable to its constitution, age, and physical development, and that these ingredients should be in proper proportion and of sufficient quantity to meet the caloric requirements of its tissues for growth and development. Again, we must not overlook the fact that the constituents of the diet must be in such form as to allow of normal digestion and assimilation.

We have spoken of the wide range of tolerance of infants to their foods, and have mentioned that this, in all probability, accounts to a very great degree for the fact that so many men have been successful in the feeding of infants on a variety of mixtures which varied greatly both quantitatively and qualitatively. There is in all probability another factor which is important in explaining these successes, namely, the fact that to a certain extent fats, carbohydrates, and proteins are interchangeable in their metabolic functions.

Proteins. After passing through the intestinal wall proteins have three functions to perform: (1) to replace used protein (lost through urine, sweat, digestive juices, cell destruction, etc.); (2) to satisfy cell growth, which would be impossible without proteins; (3) to furnish fuel for part of the dynamic loss (fats and carbohydrates are the natural fuel, the protein combustion being incidental only).

There is three times as much protein in cow's milk as in human milk. The reason for this is obvious, when we recall that the ratio of the growth of the calf to that of the infant is about as 2 to 1. Furthermore, the protein in cow's milk consists chiefly of casein (3.02 per cent.) and little lactalbumin (0.53 per cent.), while human milk contains 0.59 per cent. of casein and 1.23 per cent. of lactalbumin.

The proteins are characterized by containing nitrogen. If the nitrogen is determined in the food eaten during the period of the experiment, it is evident that a balance may be struck which will determine whether the body is receiving in the food as much protein nitrogen as it is metabolizing and eliminating in the excreta. If there is a plus balance in favor of the food, it is evident that the body is laying on or storing protein, while if the balance is minus, the body must be losing protein. During the period of growth, in convalescence, etc., the body does store protein, and under these conditions the balance is in favor of the food nitrogen.

It is important also to bear in mind that nitrogen or protein equilibrium may be established at different levels in order to explain the good feeding results with what may be an excessive protein diet. That is, an infant who has been receiving 1.5 Gm. of protein per Kg., and who has excreted the greater part thereof, retaining only such portion as is needed for the body growth, will, upon being fed larger quantities, retain only a similar amount for body growth, excreting the difference in the urine, sweat, and feces. The true cell life does not depend on what has been ingested, absorbed and temporarily fixated, to be eliminated soon afterwards, but on the constant and stable fixation. The body may become adapted to overfeeding and overfixation, but this is usually of only a short duration, and the excretion of the oversupply is never long delayed. Experimentally, it is found that there is a certain low limit of protein which just suffices to maintain nitrogen equilibrium. Rubner found that when 5 per cent. of the total energy intake was in protein that it was sufficient for maintenance, and that even 4 per cent. was sufficient to supply its actual need when amply supplied with carbohydrate. However, 7 per cent. was necessary to keep up the normal growth.

Examination of the dietaries of civilized races shows that, on the average, 100 to 120 Gm. of protein are used daily by an adult man. A variable portion of this amount passes into feces in undigested form, but we may assume that about 100 to 105 Gm. are absorbed, and actually metabolized in the body. If we take into account the weight of the body, this amount of protein may be estimated as equivalent in round number to 1.5 Gm. of protein, or 0.23 Gm. nitrogen, per kilogram of body weight. Chittenden believes that the daily quota of protein per kilogram of body weight may be reduced to one-half this quantity, from 1.5 Gm. to 0.75 Gm. of protein, or 0.12 Gm. of nitrogen, per kilogram body weight.

If the body can be kept in good condition upon 0.75 Gm. per kilogram per day, will an ingestion of more than this (say twice as much) prove injurious or beneficial or indifferent to the body? The full and satisfactory answer to this question must be deferred until more experience is obtained. The newer conceptions in regard to the digestion and nutritive history of the protein foods certainly seem to favor the adoption of a low protein diet. Mankind, when left to the guidance of the natural appetites, has always, when possible, adopted the high protein level of 90 to 100 Gm. per day. That mankind has made a mistake in adopting the higher protein level can hardly be claimed on the basis of our present knowledge.

The chief demands for protein are to compensate for wear and tear, and to provide for growth.

Sugars and starches, when added to a diet sufficient to meet an infant's needs, will, temporarily at least, cause a greater nitrogen retention. Fats have little or no such influence. Nitrogen to be retained must be built up into living protoplasm, and to accomplish this salts must be available. Unless they are present, the nitrogen is again excreted. Approximately 1.7 Gm. of ash are retained for each 1 Gm. of nitrogen (Howland), or 0.3 Gm. of ash for each 1 Gm. of protein.

Hoobler believes that the protein needs of the infant are supplied when 7 per cent. of its caloric needs is furnished in protein calories, and states that three-fourths of an ounce of whole or skim milk, or 0.6 Gm. of protein per pound body weight is sufficient to meet these needs. To make up the deficiency in the caloric needs, he adds for each ounce of whole milk one-third of an ounce of sugar or cereal.

Rubner was able to promote normal growth when 0.7 per cent. of the total energy intake was in proteins.

Cowie finds the protein requirement in a two- to twelve- months infant to average 1.1 Gm. per pound.

Dunn states that 1.0 Gm. to 1.5 Gm. of protein daily per kilogram of body weight is necessary for the normal infant.

Camerer states the following requirements for each kilogram of body weight in a child between 2 and 4 years of age: proteins, 3.6 Gm.; fat, 3.1 Gm.; carbohydrates, 9.2 Gm.; and water, 75.3 Gm.

It has been our custom to feed approximately 1.5 ounces of milk to a pound of body weight to the healthy normal infant, which would represent 1.5 Gm. of protein per pound of body weight.

Notwithstanding what has been said on theoretical and experimental studies of the protein needs of the artificially fed infant as compared with the amount of protein as received by the breast-fed infant, it must be granted that casein, the chief protein of cow's milk, as given in ordinary dilutions to the infants is sufficient to cover entirely the protein needs of the infant, and that its excess rarely causes nutritional disturbances when the tendency to large curd formation is prevented by boiling or alkalinizing the milk.

We have therefore continued to use the protein as contained in 1.5 ounces of milk per each pound of body weight of the normal infant, and in the underfed we have not hesitated to increase this quantity to an amount equal to 2 or even 2.5 ounces per pound, thereby approximating 1.5 ounces per pound of what the baby should weigh for its age. Increases of milk in the diet must be gradual, the additions being guided by the child's ability to handle the food. From what has been stated, it may be inferred that it is wise to establish the protein content in a diet which may then be supplemented by fats, carbohydrates, and salts, because protein is the tissue builder and must necessarily be a basic constituent of all diets.

Fats. Fats are necessary to normal growth and nutrition of the human body. But they to a greater extent than the other food elements can be replaced by proteins and sugars, more especially the latter. This explains the fact that infants fed on low fat mixtures, more especially proprietary foods, such as condensed milk, will continue to gain in weight. However, such development cannot be considered as normal.

Fats furnish part of the heat energy necessary to maintain the body temperature. They are stored as a reserve food. The fat is a protein saver, and when supplied in proper amount but little protein is used for the production of animal heat, thereby allowing for greater protein retention for the growth of the body tissues.

Under normal conditions, the average infant will digest from 2 to 3.5 per cent. of fats. However, some infants digest fat badly, and when a fat intolerance is once established it is overcome only with great difficulty. In such cases it is necessary to throw the burden of furnishing the extra food necessary on the carbohydrates; and carbohydrates in large quantities are unsafe food for the infant. Such a catastrophe should be avoided, as infants receiving an insufficient amount of fat rarely thrive satisfactorily. We should therefore aim to stay within safe limits. And it has been our experience that most infants will thrive well on the amount of fat furnished by the use of 1.5 to 2.0 ounces of whole milk per pound body weight. When moderate quantities of fat are fed, we avoid the acute clinical picture of fat overfeeding associated with vomiting and diarrhea, and not infrequently a high temperature, and occasionally convulsions. On the other hand, the moderate quantity of fat contained in the diet necessitates a high percentage of carbohydrate feeding, which in turn avoids the so-called fat-soap stools, with their tendency to rob the body of an excessive amount of calcium and magnesium. For the formation of a fat-soap stool it is necessary that we have an insufficiency of carbohydrates and a relative excess of proteins, as putrefaction is necessary for the production of these stools, while fermentation opposes their formation. And in the presence of excessive fermentation the putrefaction is limited.

It may therefore be stated that while the tolerance for fat of cow's milk varies greatly in different individuals, most infants, however, will digest and assimilate 1.5 to 2.0 Gm. of fat per pound body weight daily, which is the quantity represented in 1.25 to 2.00 ounces of average cow's milk. This quantity will also supply the body needs for growth and development, when associated with a sufficient carbohydrate content in the food.

Carbohydrates. They are used chiefly to supply heat and energy, to supply in part material for fat foundation, thereby replacing in part the fat waste. Because of their high caloric value they supply a large amount of energy. They are efficient sparers of protein, and will supply energy in case of fat insufficiency in the diet. Synthetically, they are converted into glycogen in the body. Fat is formed from sugar by the subcutaneous cells, which are especially adapted to this function. Sugar is reduced to CO_2 and water, which may be measured by the respiratory metabolism. Normally, sugar is absorbed from the small intestine in greater part, and is not found in the feces. If absorbed in sufficient quantity, they will cause a rapid increase in weight. When insufficient carbohydrate is supplied to the body, it is obtained by breaking down the body protein.

In general, infants have a very high carbohydrate tolerance—much higher than the adult—and even infants suffering from certain forms of nutritional disturbance may retain their ability to metabolize sugar, even though it may have been reduced for fat and proteins. Some infants do not handle sugar well, and among these are certain forms of gastro-intestinal disturbances, eczema, etc.

During recent years much has been written on the superiority of one form of carbohydrate over the other. We can practically exclude the monosaccharides in the consideration of the subject, and speak only of the disaccharides, of which lactose, saccharose (cane-sugar), and maltose are the ones used in infant feeding, of the polysaccharides, as represented by the cereal flours and dextrin, and last, of the mixture of disaccharides and polysaccharides, together with other substances, these mixtures being represented by the various infant foods on the market.

Sugars. Of recent years there has been a considerable discussion on the comparative nutritive value of milk-sugar (lactose) and cane-sugar (saccharose). In our own experience we have found little to recommend one over the other in so far as their nutritive value and the limit of tolerance is concerned, except as we have seen a laxative effect from the use of lactose, which is usually not present with the same quantities of saccharose. This is, however, not seen in all infants. Maltose is not used pure, but as previously stated, in the form of various compounds in infant feeding. It may therefore be stated that cane-sugar will answer all requirements for most cases, but should rarely be used in amounts larger than 3 to 4 per cent. of the total mixture, because of its intense sweetness. It may be also recommended from the standpoint of economy.

In the presence of extreme colic, it is often wise to change the form of sugar that the infant is receiving, as the individual infant may show an intolerance for one or the other sugar.

Quantities. Cane- and milk- sugar may be added to the diet in the following quantities:

Infants under 6 pounds—0.5 ounces in twenty-four hours.
Infants between 6 and 10 pounds—0.75 to 1.00 ounces in twenty-four hours.
Infants between 10 and 14 pounds—1.00 to 1.25 ounces in twenty-four hours.
Infants over 14 pounds—1.5 ounces in twenty-four hours.

Approximately, therefore, about 1 ounce of sugar is added in twenty-four hours for each 10 pounds of body weight, or about $\frac{1}{200}$ of the body weight in twenty-four hours.

Including the sugar contained in the milk, and exclusive of the cereal, the infant should average from 4.0 Gm. to 6.0 Gm. of carbohydrates per pound body weight to furnish its needs.

Dextrin and maltose compounds can frequently be added to the diet to advantage in the presence of stationary weight. It must, however, be remembered that their relationship to constipation varies greatly, dependent upon their malt, dextrin, and potassium carbonate content. Thus we find that those of the proprietary foods containing a considerable percentage of dextrin, in the absence of potassium carbonate, are constipating (Horlick's malt food, Mead's dextrimaltose); while those with a higher maltose content, together with potassium carbonate (Borcherdt's dri malt soup and Mellin's food), are laxative.

Cereal Flours. They can be added to the diet of most infants early in life in quantities varying from 1 to 2 per cent. of the total quantity of the milk mixture to good advantage. Such an addition to the food frequently results in rapid weight increases, and general improvement of the infant. In older infants, cooked cereals may be used in place of the starch solutions. We have reason to believe from clinical experience that the flours made from cereals have a decided advantage over the dextrinized flours on the market. Whether this is due to vitamines contained in the former or to some other distinctive property we are unable to state. The cereals also have a decided influence on the calcium and magnesium balance. The cereals cause retention of these salts, which may have a favorable influence on the weight.

Salts. Salts are necessary in digestion, and in every step of metabolism, from absorption to excretion and secretion. The rôle of salts in both normal and pathological conditions has been given constantly increasing importance in the last few years.

Human milk contains 0.2 Gm. of ash in 100 mils, and cow's milk 0.78 Gm. of ash in 100 mils. The difference in percentage in the human and in the cow's milk is equalized by the body using only what is necessary for its life and growth. The salts are absolutely necessary for the life of the organism.

While all the salts are in larger percentage in cow's milk than in human milk, the relative proportions of the different salts differ greatly. In general, cow's milk contains relatively a very large amount of calcium phosphate, while the proportion of potassium salts and iron in cow's milk as compared with human milk is relatively small. There is a great difference in the form in which phosphorus is present in human and in cow's milk. In human milk three-quarters of the phosphorus is in organic combination, while in cow's milk only one-quarter is in organic combination. The iron in neither human milk nor in cow's milk is sufficient to meet the demands in the first year of life; the infant must depend on the iron stored during fetal life. The following table gives percentages of different salts in 100 parts of ash of the human and of the cow's milk.

	K_2O	NaO	CaO	MgO	F_2O_3	P_2O_5	Cl
Human milk ..	30.1	13.7	13.5	1.7	0.17	12.7	21.8
Cow's milk ...	22.14	15.9	20.05	2.63	0.04	24.7	21.27

The inorganic salts in human milk consist mainly of the alkaline bases, potassium and sodium, while in cow's milk the calcium and magnesium account in greater part for the difference in the total mineral content of the two milks. From the preceding table it becomes evident that in higher dilutions of cow's milk the potassium and sodium content must suffer most. Such a long-continued feeding of an insufficient amount of potassium and sodium may affect the infant's development to a serious extent. Human milk also contains about four times as much iron as cow's milk, and dilution of cow's milk results in a decrease in the iron content, which must not be carried too far unless supplemented by other iron-containing food.

"Therefore the mineral metabolism of the artificially fed infant differs greatly from that of the breast-fed infant. The infant receiving cow's milk, with its greater salt contents, lives on a higher plane of mineral metabolism than does the one receiving the breast milk. He absorbs 60 per cent. of the total ash, and retains only about 15 per cent., while the breast-fed infant utilizes to the full his opportunities, and absorbs 80 per cent. of the ash, and retains 40 to 50 per cent. In the majority of infants this excessive salt intake undoubtedly does no harm; the surplus is not absorbed, or is merely eliminated.

"Sodium and potassium are usually well retained, unless severe diarrhea is present, or there is an excess of fat or of sugar in the diet. Under such circumstances they are lost, and the loss is badly borne, and cannot indefinitely be continued. When all available alkalies have been drawn on, the infant breaks down his own tissue to furnish more of these substances, which is an explanation, for a part at least, of the excessive nitrogen excretion under such conditions. When diarrhea ceases, and the intake is sufficient, a positive balance is rapidly instituted.

"The metabolism of calcium has been largely studied, on account of its close relationship to rickets and tetany. Calcium is so largely excreted by the bowel that it is impossible to say how much is absorbed, plays part in the organism, and is then excreted by the intestine, either because it is in excess, or because (as in the case of rickets) the body cannot utilize it. This is also true of magnesium, and to a much less extent of sodium and potassium" (Howland).

The salts are necessary for building up of the body tissue, and each gram of protein retained and built into body tissue requires approximately one-third of a gram of ash.

Water. The quantity of water necessary for the infant is not only of theoretical, but also of vast practical importance. There are many breast-fed infants who obtain a food which is very rich in other nutritive substances, but contains only a small amount of water. These infants may not gain well in weight unless water is added. And, besides that, in sick infants it is occasionally necessary to feed them (especially in cases of vomiting, anorexia, infections) with concentrated food, and in these cases the total water intake necessary must not be lost sight of.

In regard to water retention Meyer* found three classes of cases: (1) those in which there was a decrease in weight when the food was concentrated, and the weight increased only after addition of water; (2) those where the weight remained the same on a concentrated food, and there was an increase after the addition of water; and (3) those in which the addition of water made no difference, but who did well on a concentrated food. He found that the water need decreased with increasing age—that on artificial food the water needs were 89 Gm. per Kg. body weight in twenty-four hours at the beginning, and 80 Gm. at the end of the first year; while in breast-fed infants the water need amounted to 134 Gm. to 140 Gm. per Kg. in twenty-four hours.

Water is absolutely necessary for life, and manifestations of life are impossible without water. The lack of or inadequacy of water are much more dangerous to the infant than a corresponding deficiency in the food. Excess of water, however, exerts also an unfavorable influence on the organism. Immunity is considerably dependent on the physiological water content of the body.

Estimation of the Caloric Contents of the Food as a Check on Over- and Under- feeding. Calorimetric estimations of the diet must be considered only as a check on under- and over- feeding, and not as a method of feeding. In the infant whose diet usually consists of milk or its constituents and sugar and cereal flours, this is a very simple matter. It should, however, be remembered that there are considerable variations in the caloric

* L. F. Meyer, Zschrft. f. Khlk. 1912, 5, 1.

requirements of normal babies. The fat and well-nourished infant will require less food to maintain its body heat than the emaciated one. The sick baby will rarely be able to digest its full needs as estimated by its body weight. Therefore as in every other phase of infant feeding, the individual infant must be given primary consideration. It must be remembered that the nutrition of the baby depends upon the quantity of the food assimilated, and not upon the quantity ingested. Less food is being absorbed and utilized in the infant with a deficient power of digestion, and overfeeding will retard the infant's progress. A comparative estimate of the infant's diet, with a theoretical minimum, is of special value in cases of doubt as to whether the retarded progress is due to insufficient food or defective digestion and assimilation.

Under this system the physician reckons the minimum daily caloric requirements, either from the present weight of the baby or what it should weigh in health, and then chooses the food necessary to meet this requirement, bearing in mind that the fat, carbohydrate and protein contents of the diet must not only meet the caloric requirements, but also be properly proportioned, so as to contain the proper number of grams of each of the constituents to meet the infant's needs for growth and development.

Heubner and Rubner gave us the first definite estimates as to the caloric needs. They found that the average healthy infant after birth requires on the average 100 calories per kilogram body weight, from six months to the end of the first year—approximately 85 calories per kilogram body weight—and that 70 calories per kilogram body weight is the energy quotient on which a baby would maintain a weight equilibrium.

Dunn places this minimum caloric requirement for artificially fed infants as follows:

Birth to 6 months ...	120 cal. per Kg.	(55 cal. per pound)
6 to 12 months	100 " " "	(45 " " ")
12 to 24 months	90 " " "	(40 " " ")

Dennett* gives the following figures:

Fat infants over 4 months of age ..	40 to 45 cal. per pound
Average infants under 4 months of age and moderately thin infants of any age	50 " 55 " " "
Emaciated infants (varying with the degree of emaciation)	60 " 65 " " "

Brady† gives the following figures as his experience with institutional children: 50 to 55 calories for each pound during the first 6 to 8 months of life.

Our own experience coincides with those of Dennett and Brady in that we find that the figures of Heubner do not meet the requirements of any except the well-nourished infants. Underfed infants not suffering from decomposition (marasmus) must be fed food of a higher caloric value per pound body weight than the normal infants, and while such infants must be fed minimal quantities when first seen, for a proper gain in weight their normal weight must be estimated and their diet gradually approximated to the needs of the weight that they should normally have.

Average infants under 2 months of age ..	30 to 45 cal. per ℔	(65 to 100 per Kg.)
Average infants over 2 months of age ..	45 " 55 " " "	(100 " 120 " ")

* Infant Feeding, J. B. Lippincott Co., Philadelphia, page 58.

† J. M. Brady, Institutional Care of Infants, Archives of Ped., 1917, 34, 356.

Premature and thin infants under 2 months of age	50 to 65 cal. per ℔ (110 to 140 per Kg.)
Thin infants older than 2 months, depending upon their general condition .	55 " 70 " " " (120 " 150 " ")

During the first few weeks of life of the artificially fed infant it is usually difficult to approximate these figures (see p. 159).

Increases in quantity of food should always be gradual, especially in the presence of malnutrition, and the infant carefully observed, and increases made only as the tolerance for food permits.

Estimation of the caloric contents of the food is *not a feeding method* and should be used only as a check on over- and under- feeding, the scale, stool, and general condition, and particularly the disposition of the infant, being the ultimate guide for dietetic changes.

Energy quotient is the number of calories which the infant is getting per pound or per kilogram of body weight. To determine the energy quotient of the diet multiply the number of ounces of each food ingredient of the food mixture by their caloric values, add the products and divide the sum by the number of pounds or kilograms of the baby's weight.

CALORIC VALUES OF 1 OZ. (30 GM.) OF VARIOUS FOODS.

	Calories
Cow's milk	21
Human milk	21
16 per cent. cream	54
Skim milk	11
Buttermilk	11

	Calories.
Buttermilk mixture	21
Albumin milk	12
Chymogen milk	21
Keller's malt soup	25
Cane-sugar (by weight)	120
Maltose-dextrin compounds (average)	110
Malt-soup extract, dry, by weight	90
" " " by measure	132
Flour, by weight	100
Cereal waters (1 oz. cereal to quart)	3

The following table gives equivalents of 1 ounce by weight and the domestic measures of carbohydrates used in artificial feeding of infants:

	By weight	By measure	Table-spoonfuls	Dessert-spoonfuls	Tea-spoonfuls
			leveled with a knife.		
Cane-sugar	1 oz.	1.00 oz.	2	3	6
Milk-sugar	1 "	1.50 "	3	4.5	9
Dextri-maltose	1 "	1.50 "	3	4.5	9
Flour (wheat)	1 "	2.25 "	5	7.5	15
Flour (barley)	1 "	1.50 "	3	4.5	9
Barley (pearl)	1 "	2.50 "	5	8	15
Oats (rolled)	1 "	2.50 "	5	8	15

1 tablespoonful = 1.5 dessertspoonfuls = 3 teaspoonfuls.

Practical Application of Milk Dilutions with Addition of Carbohydrates in Infant Feeding. In the application of the rules for the feeding of normal, healthy infants, it must be remembered that each infant must be fed to meet its individual requirements, and the rules modified so as to meet the demands of the individual baby. If milk dilutions, with the addition of carbohydrates are used, the simplest and most natural standard would be one that would tell us how much milk and carbohydrates per pound or per kilogram body weight the baby should get. To be exact we should express, or at least be aware, of the number of grams of proteins, fats, carbohydrates and salts that the infant is receiving for each pound of its body weight. We believe that if statistics on infant feeding were collected on this basis rather than in percentages of the ingredients in the milk mixtures (the total mixture being of such variable quantity) the collected data would be far more valuable as a basis for future work in infant feeding.

In every instance the general health of the infant is of the greatest importance in estimating its capacity for assimilating the diet.

To meet *protein* and *fat requirements,* the average normal infant will require each day a *minimum* of 1½ ounces (45 mils) of cow's milk per pound of body weight, exclusive of the sugar and starch which are added in preparation of the mixture.

Practical experience has taught us that infants under five months of age will frequently require amounts approximating 2 ounces (60 mils) of cow's milk per pound body weight, except during the first few weeks of life, when smaller quantities of whole or skim milk are indicated (see p. 159). With the institution of a mixed diet, the infant thrives with less milk per pound body weight.

In beginning feeding with cow's milk, mixtures must always be started as weak formulæ, more often using only 1 ounce (30 mils) of cow's milk to a pound body weight, gradually increasing the strength to meet the infant's needs.

Underweight infants should at first be fed according to their present weight, gradually increasing the strength of the mixture as rapidly as consistent with the baby's ability to handle the diet, and thus approximating the needs of a full weight baby of the same age. These babies will frequently take over 2 ounces (60 mils) of milk per pound body weight.

Number of Feedings in Twenty-four Hours. Three-hour intervals at the start, with 7 feedings in twenty-four hours, for the first month (6-9-12-3-6-10-2), 6 feedings during the second and the third month (6-9-12-3-6-10), 5 feedings by the fourth to the fifth months (6-10-2-6-10), according to the individual needs of the child.

Premature and delicate infants with a tendency to vomit are exceptions, and may be fed smaller amounts at more frequent intervals, even two hours, if indicated. Catheter feeding may be necessary, in which case the longer interval will usually answer.

Amounts at Each Feeding. From birth to the fifth month the average healthy infant may be satisfied with an amount of food approximating 2 ounces more per feeding than the infant is months old (1 month, 3 ounces; 2 months, 4 ounces; 3 months, 5 ounces; etc.). Exceptionally, infants cannot take this amount at each feeding, and when vomiting is the result of overfeeding, the quantity can be reduced and an extra meal substituted.

After the fourth month the average infant will take daily 1 quart of the food mixture.

When more than 1 quart of milk mixture is needed to properly nourish the infant, we have reached the age when a mixed diet should be instituted.

By the sixth month four meals of 8 ounces each of milk mixture may be given, and a fifth meal of broth and vegetables (see rules for mixed diet, p. 155).

Water to be Added. In our own experience we have found that a concentrated milk mixture does not disturb the infant's digestion when the milk is boiled or alkalinized by sodium citrate, sodium bicarbonate, or lime-water. The amount of water is calculated by multiplying the number of feedings by the amount of each feeding, and subtracting the milk to be given.

Example: Baby aged 3 months should receive 5 feedings of 5 ounces each (age in months plus 2) or a total of 25 ounces for the day. Subtracting 16.5 ounces (11 pounds body weight and 1.5 ounces of milk for each pound) gives us 8.5 ounces as amount of water to be added.

Carbohydrates to be Added. Having the necessary amount of milk and water, we ascertain the carbohydrates to be added.

Cane-sugar answers our requirements for most cases.

Milk-sugar acts as a laxative in many infants. Unless the laxative effect is desirable, it has no advantage.

Maltose and dextrin compounds are acceptable to the infant's digestion in relatively larger quantities. They are not as sweet as cane-sugar.

Because of the high dextrin content, some of the products on the market (Horlick's malt food, Mead's dextri-maltose) may be constipating. Others which have a higher maltose content (Borcherdt's dri malt soup, Mellin's food, both of which also contain potassium carbonate) are laxative.

Cane- and milk- sugars are added in such quantities that the final mixture contains 3 to 5 per cent. of sugar in addition to the sugar in the cow's milk. Cane-sugar is much sweeter than milk-sugar, and the infant will occasionally refuse a mixture containing over 3 per cent. of cane-sugar.

Starch may be added to the diet in quantities of 1 to 2 per cent. of the whole mixture in the form of cereal waters. We do not hesitate to add cereal water to the diet after the infant is one month old, and find it especially valuable in those cases in which we are feeding 3 per cent. or more of cane-sugar, and in which the infant takes a dislike to its food because of the intense sweetness of the mixture.

Maltose and dextrin compounds may be added in quantities up to 6 per cent. of the total mixture.

Roughly, the following quantities of cane- or milk-sugar will answer the carbohydrate needs of the infant:

Infants under 6 pounds—0.5 ounce in twenty-four hours (2700 Gm.—15 Gm.).
Infants 6 to 10 pounds—0.75 to 1.00 ounce in twenty-four hours (2700 to 4500 Gm.—22.5 to 30 Gm.).
Infants 10 to 14 pounds—1.00 to 1.25 ounces in twenty-four hours (4500 to 6400 Gm.—30 to 37.5 Gm.).
Infants over 14 pounds—1.5 ounce in twenty-four hours (over 6400 Gm.—45 Gm.).

To Break the Curd to Assist Digestion of Cow's Milk. Many infants can digest raw cow's milk. When not well taken, the tendency to formation of large protein curds is relieved by boiling the milk from two to three minutes over the flame, or, better, by putting in a double boiler and heating until the water in the outer vessel boils eight minutes. Although the curd is less finely divided by the use of the double boiler, as compared with boiling on the direct flame, it answers the purpose of most infants, and causes fewer changes in the milk.

Addition of sodium citrate to the milk mixtures also prevents formation of hard protein curds. Bosworth and Van Slyke have shown that increasing amounts of sodium citrate added to the milk increases the coagulation time up to the point when 1.7 grains (0.1 Gm.) per ounce (30 mils) is added, after which the milk does not coagulate at all. Sodium which is added replaces some of the calcium in the caseinate, and forms sodium caseinate of calcium-sodium caseinate, and when rennin is added this double salt is changed to calcium-sodium-paracaseinate, which in the presence of sufficient quantity of sodium does not curdle. Sodium citrate may be prescribed either in 5-grain tablets, adding approximately 1 grain for each ounce of milk in the mixture, or a prescription may be written in such form that each teaspoonful will contain sufficient sodium citrate for the day's food.

When lime-water is added to cow's milk until it is neutral or faintly alkaline to phenolphthalein, a basic calcium casein is formed which is not acted upon by rennet, and will not form a curd, even in the presence of lime salts (Van Slyke). Casein is not coagulated by rennin when the solution is alkaline. When a sufficient amount of an alkali is given, the milk mixture remains neutral or alkaline in the stomach, even after the stomach has secreted acid, and large protein curds do not form then. Lime-water is commonly used in amounts equaling 5 per cent. of the milk in the mixture (1 ounce to 20 ounces of milk).

Not infrequently we have found the adding of citrate of soda or lime-water to boiled milk of advantage in the difficult feeding cases, and in the presence of vomiting.

Mixed Diet for Young Infants. As early as the second or third month, 1 or 2 teaspoonfuls of orange juice may be given daily. This in part at least counteracts the effect of boiling. Start with 5 drops diluted with water, twice daily, and increase gradually.

Fifth month, a little well cooked cereal may be added to one of the meals (begin with 1 teaspoonful), adding part of the bottle of milk to it, the meal being finished by the remainder of the bottle.

At sixth month, infants readily take a broth and vegetable meal as a substitute for one of the milk feedings, in the form of a vegetable and meat soup. Begin with 1 ounce, and follow by a second bottle containing the milk mixture with 1 ounce less than full feeding. Gradually replace an entire milk feeding.

Ninth month, a vegetable soup or a clear broth (chicken, lamb, or veal), and toast or zwieback crumbs, with an additional portion of stewed fruits (apples, prunes) or a strained vegetable (spinach, carrots, or turnips). The broth is usually given in the same quantity as the bottle, if given alone, or somewhat less if either the tablespoon of vegetable or fruit is given in addition.

Caloric Values of Foods.

	Amount	Cal.
Apple sauce	1 ounce	30
Bacon (slice)	1/6 ounce	30
Bread	average slice, 33 Gm.	80
Butter	1 pate (1/3 ounce)	80
Cereal (cooked)	1 heaping tablespoonful (1 ounce)	50
Carrots (cooked)	1 ounce	13
Crackers (soda or Graham)	1 ounce	100
Cream (16 per cent.)	1 ounce	54
Custard	1 ounce	60
Egg	1 (1.5 ounces)	80
Egg (white)	1	30
Egg (yolk)	1	50
Gelatin	1 ounce	50
Malt extract	1 ounce	89
Meat	1 ounce	50 to 70
Milk (whole)	1 pint	350
Milk (whole)	1 ounce	21

	Amount	Cal.
Potato (whole)	1 medium sized	90
Potato (mashed)	1 heaping tablespoonful	70
Rice (boiled)	1 tablespoonful	60
Soup (vegetable)	1 ounce	15
Soup (chicken)	1 ounce	8
Toast	average slice	80
Vegetables (peas, beans, carrots)	1 heaping tablespoonful	30
Vegetable (cooked spinach)	1 heaping tablespoonful	16

These caloric values are approximate for the most part, but are sufficiently accurate for practical purposes. Thus the caloric value of a particular menu can be easily figured.

Feeding Example No. 1. Infant *age three months* should weigh 11 pounds (average birth-weight 7 pounds, plus 4 pounds, representing a gain of 5 ounces weekly for thirteen weeks). Estimating 1.5 ounces of milk per pound body weight, give 16.5 ounces of milk (346 calories). Now, figuring that the infant should receive 25 ounces of food daily, 5 ounces at each feeding (age in months plus 2 ounces) for 5 feedings, and adding 4 per cent. cane-sugar, or 1 ounce (120 calories), a total of 466 calories, or about 42 calories to the pound body weight. To this 8.5 ounces of water should be added to make the total mixture 25 ounces.

For practical purposes the cow's milk may be considered as averaging:

Proteins	3.5	per cent.
Fat	4.0	" "
Carbohydrates	4.0	" "

Thus, in the milk mixture in feeding example No. 1 ordered for a 3-months-old infant, weighing 11 pounds, we have 42 calories per pound, and we will now calculate the percentages of the various ingredients in the mixture, and the grams of each ingredient per pound body weight.

	Protein	Fat	Carbo-hydrate	Salts	Cal.
Milk, 16.5 ozs. = 495 mils ...	17.3	19.8	19.8	3.46 Gm.	346
Water, 8.5 " = 255 " ...	....	....	....	.... "	...
Sugar, 1.0 oz. = 30 Gm. ...	....	....	30.0	.... "	120
Total mixture, 25.0 ozs. = 750 mils ...	17.3	19.8	49.8	3.46 Gm.	466
	2.3	2.64	6.6	0.46 per cent.	
For each pound body weight .	1.575	1.8	4.5	0.31 Gm.	42

We thus find that the infant fed on the prescribed diet receives 25 ounces of the mixture containing

Protein	1.575	Gm. per pound body weight
Fat	1.8	" " " " "
Sugar	4.5	" " " " "

the mixture containing

Protein	2.3	per cent.
Fat	2.64	" "
Sugar	6.6	" "

and 42 calories per pound of body weight, all of which may be considered as a safe minimum. The mixture may readily be strengthened to meet indications for more fat and protein by the addition of milk, and more carbohydrate by the addition of flour and sugar.

Feeding Example No. 2. Child *age eight months* should weigh 17.25 pounds (average birth-weight, 7 pounds) which should be doubled in the first five months (14 pounds), plus a gain of 4 ounces a week for the remaining thirteen weeks (3.25 pounds). The following mixture will be prepared: 1.5 ounces of milk per pound body weight equals 26 ounces (546 calories); water to make one quart, equals 6 ounces; sugar, 3 per cent., equals 1 ounce (120 calories); starch, 1 per cent., equals 0.3 ounces (30 calories); the total being 696 calories, or approximately 40 calories per pound. This is to be fed in four feedings of 8 ounces each, and the fifth may be replaced by a soup and vegetable meal. A small cereal feeding (1 tablespoonful) can also be given with 1 or 2 of the bottles, pouring part of the bottle of milk over it, and finishing the meal on the remainder of the bottle. (See also Mixed Diet.)

	Protein	Fat	Carbo-hydrate	Salts	Cal.
Milk, 26.0 ozs.=780 mils ...	27.3	31.2	31.2	5.46 Gm.	546
Water, 6.0 " =180 " ...	....	....	....	.... "	...
Sugar, 1.0 oz. = 30 Gm. ...	....	....	30.0	.... "	120
Starch, 0.3 " = 9 " ...	....	....	9.0	.... "	30
Vegetable soup, 8.0 " =240 mils ...	2.0	4.5	8.0	2.4 "	144
Cereal, one heaping tablespoonful, 1.0 oz. = 30 Gm. ...	....	....	15.0	.... "	50
Total mixture	29.3	35.7	93.2	7.86 Gm.	890
For each pound body weight .	1.7	2.1	5.5	0.46 "	52

Further needs of the individual case can be supplied by concentrating the milk until whole milk is given, the carbohydrates in the mixture being gradually decreased and given in another form, as gruel, custard, etc.

Artificial Feeding During the First Weeks of Life. The rules as given for infant feeding are hardly applicable for feeding during the first one or two to three weeks of the infant's life. The infant's first feedings should consist of higher dilutions of either whole or skim milk, should be boiled, and sugar added in smaller percentages than suggested for the older infants. Such mixtures must of necessity show a lower caloric value than will meet the infant's needs for growth and development, but, as suggested, the mixture for the newborn should be composed of weak formulæ, and increased according to the infant's tolerance. The following table of mixture will act as an outline for average cases:

Diet for Newborn Infants During the First Four Weeks of Life.

	1st 48 hours	3-4 days	5-6 days	7-8-9 days	10-11-12 days	13-14 days	3d week	4th week
Milk (whole), ozs.	..	..	...	3	4	6	8	11
Milk (skim), ozs.	..	6	8	5	4	4	2	...
Sugar (cane), dr.	1	1	2	2	2	3	4	6
Water (boiled), ozs. ..	16	10	8	8	8	8	8	10
Calories in mixture ..	15	81	118	148	158	215	250	321
Feedings:								
Amount in ozs.	1	1	1.5	1.5	2	2	2.5	3
Number daily	7	7	7	7	7	7	7	7
Intervals in hours ..	3	3	3	3	3	3	3	3

The above mixtures should be boiled for three minutes over the direct flame or in a double boiler. If the latter is used, the water in the outer vessel should be boiling for eight minutes. Add boiled water to make up the original quantity.

Method of Feeding a Baby from the Bottle. Babies should be fed while they are lying on their beds, the upper part of the body being somewhat elevated by means of a pillow of proper thickness. The baby should be turned slightly on the right side, as it has been found that the stomach empties itself sooner in that position.

The bottle should always be held by the nurse or attendant, until it is empty. From fifteen to twenty minutes should be occupied with the meal.

Do the above rules furnish mixtures of a quality and quantity proper to meet the infant's needs? If proper mixtures they should

(1) Contain approximately

Protein	1.5 to 2.0 Gm.	for	each	pound	of	body	weight
Fat	1.5 " 2.0	"	"	"	"	"	"
Carbohydrates ..	4.0 " 6.0	"	"	"	"	"	"

(2) Calories per pound body weight for normal infant:

Under 2 months of age	30 to 45 calories
Over 2 months of age	45 " 55 "

(3) Percentages in the mixtures.

It is well to know the percentages of the various ingredients in the diet, as they will assist in the proper interpretation as to the etiology of food disturbances.

Fat. Infants, according to their age, under normal conditions, digest from 2 to 3.5 per cent. of fat. Some infants digest fat badly, consequently in some cases it is necessary to give skim milk.

Proteins. In the average feeding mixture for infants under 10 months, 2 to 3 per cent, of proteins are well taken.

Carbohydrates. They should, as a rule, not exceed 6 to 7 per cent., the average amount in human milk, including the sugar contained in the milk before its modification.

Summary.

I. Preparation of the mixture.

1. Calculate the baby's normal weight.

2. Calculate the amount of cow's milk to be used in the preparation of the mixture, taking 1.5 ounces of cow's

milk per pound of normal body weight at that age, which is a safe minimum for a healthy infant.

3. Calculate the total daily amount of the mixture by multiplying the amount of each feeding (age in months plus 2 ounces) by the number of feedings.

4. Add water to make the mixture up to this total amount.

5. Add 3 to 5 per cent. of sugar, and later 1 per cent. of starch.

6. Make the curd more digestible by boiling or alkalinizing the mixture.

II. Checks on the above mixture.

1. Number of grams per pound body weight of each food ingredient in the mixture.

2. Percentage of each ingredient in the mixture.

3. Total caloric value of mixture and caloric value per pound body weight.

III. Remember that—

1. Orange juice or codliver oil additions to the diet should be started by the second or the third month.

2. When more than 1 quart of milk mixture is needed to properly nourish the infant, the age is reached when a mixed diet should be instituted.

3. These amounts are relative, and must be increased or decreased according to the infant's progress and individual needs, *the above rules furnishing a safe minimum for a healthy infant.*

4. The above amounts are usually insufficient for the underfed infant after it has become accustomed to the diet. Frequently it is necessary to approximate the requirements of a normal baby of that age.

5. Premature and underfed infants must at first be fed smaller amounts.

6. *The food formula of a baby clinically healthy and making a satisfactory gain in weight should not be changed without a well-defined indication.*

Explanatory Note. For practical purposes we have used pounds for weight, and ounces for measuring fluids, because of the common use in the home of avoirdupois scales, and bottle and measuring glass graduated in ounces. We have also calculated 1 oz. = 30 Gm., and 2.2 lbs. = 1 Kg.

CHAPTER V.

FEEDING IN LATE INFANCY AND EARLY CHILDHOOD.

Feeding During the Last Quarter of the First Year. The following diet list will serve as an example for feeding during this period:

Nine to twelve months diet.

6.00 A.M. Milk mixture, 8 ounces. Milk, 6 ounces; water, 2 ounces; sugar, 2 level teaspoonfuls.

8.30 A.M. Orange or prune juice, ½ to 1 tablespoonful (0.25 to 0.5 oz.). If preferable, this may be given with the 10 A.M. or 2 P.M. meal.

10.00 A.M. Milk mixture, 8 ounces. Cereal (farina, oatmeal, etc.), 1 to 2 tablespoonfuls.

2.00 P.M. Vegetable soup or a clear broth (chicken, lamb or veal), with an additional portion of a strained vegetable (spinach, carrots, potatoes, etc.). Vegetables can be started by the ninth month. The broth is usually given in the same quantity as the bottle, if given alone, or somewhat less if a vegetable is given in addition. When starting the soup feeding, first replace 1 ounce of the 2 P.M. bottle by 1 ounce of soup in another bottle; then give 7 ounces of the milk mixture. Gradually increase soup and diminish milk until an entire bottle of milk is replaced by soup. Gradually cut water and sugar out of the milk mixture until full milk is given by the tenth or eleventh month.

6.00 P.M. Milk mixture, 8 ounces, and bread, zwieback crumbs or cereal.

10.00 P.M. Milk mixture, 8 ounces, if needed.

A slice of crisp bacon may be given to advantage during the eleventh and the twelfth months, probably best with the mid-morning meal.

Four feedings a day are usually sufficient during the early part of the second year. In such a diet the fruit juices which may be given once or twice a day should not be considered as meals, and may be given between the regular feedings. Whole milk is now fed, and should not exceed 1 quart daily. The sugar and water are decreased gradually.

Twelve to fourteen months diet.

6.00 A.M. Milk, 8 ounces.

8.30 A.M. Orange juice, prune juice, or apple sauce (1 oz.) If preferred, this may be given with the 10 A.M. or 2 P.M. meal.

10.00 A.M. Milk, 8 ounces, and cereal (farina, oatmeal, etc.) 1 or 2 tablespoonfuls, slice of crisp bacon.

2.00 P.M. Vegetable or cream soup and zwieback, toast, etc., or a clear broth (chicken, lamb or veal), with an additional portion of 1 tablespoonful of a strained vegetable (spinach, carrots, potatoes, etc.). The broth is usually given in the same quantity as the bottle, if given alone, but somewhat less if a vegetable is given in addition. A little scraped beef or beef juice may occasionally be added to the vegetable.

6.00 P.M. Milk, 8 ounces, and bread, zwieback or cereal, custard or pap.

10.00 P.M. Milk, 8 ounces, if needed.

Fourteen to eighteen months diet.

6.00 A.M. Milk 8 to 10 ounces

8.30 A.M. Fruit juice (orange juice, prune juice, or apple sauce) 1 to 2 ounces.

10.00 A.M. Cereal, 2 to 3 tablespoonfuls, with 2 ounces of milk or cream, followed by 6 to 8 ounces of milk. Toast, zwieback, crackers, or wafers may be alternated with bacon.

2.00 P.M. (1) Vegetable or cream soup and zwieback or toast, or (2) a clear broth (chicken, lamb or veal), with an additional portion of one tablespoonful of a strained vegetable (spinach, carrots, potatoes, etc.). The broth is usually given in the same quantity as the bottle, if given alone, but somewhat less if the vegetable is given in addition. Part or whole of a coddled egg with toast, zwieback or cracker crumbs can now be added to the above soup and vegetable meal.

The egg may be alternated with beef juice or scraped beef.

6.00 P.M. Cereal, 2 tablespoonfuls, farina, cream of wheat, oatmeal, arrowroot, custard or pap, with 8 ounces of milk. Part of the milk may be given over the cereal, or as bread and milk, or milk toast.

10.00 P.M. Milk, 8 to 10 ounces. (Can usually be left out by this time.)

Eighteen months to three years.

7.00 A.M. Stewed fruit or orange juice; cereal; crisp bacon, alternate with soft boiled or poached egg; Bread and butter or toast; milk or weak cocoa.

12 or 1 P.M. (1) Broth: meat or vegetable soup thickened with cereal. (2) Meat: lamb chops, scraped beef, chicken or beef juice. (3) Vegetable: baked or mashed potatoes; strained spinach, carrots, turnips or celery. (4) Dessert: gelatine, custard, cornstarch or rice-pudding, or other simple dessert.

6.00 P.M. Cereal and bread or cracker with milk. Baked apple, apple sauce or other stewed fruit.

Other Foods Permitted at Three Years.

Meats. Broiled or boiled fish, roast or stewed poultry, raw or stewed oysters, broiled beefsteak, roast or broiled beef or mutton—all in moderate quantities.

Eggs. Soft boiled, poached or scrambled, 1 or 2 daily.

Cereals and Breads. Oatmeal, hominy grits, wheaten grits, cornmeal, barley, rice, macaroni, etc. Light and not too fresh wheat and Graham bread, toast, zwieback, plain unsweetened biscuit.

Soups. Plain soup and broth of nearly every kind, preferably vegetable broth.

Vegetables. White potatoes, boiled onions, spinach, carrots, peas, asparagus (except the hard part), stewed celery, young beets, arrowroot, tapioca, sago.

Fruits. Nearly all, if stewed and sweetened. Of raw fruits, peaches are the best; pears, grapes freed from seeds, oranges.

Desserts. Light puddings, as rice pudding without raisins, bread pudding, plain custard, pap, wine jelly, ice cream, junket.

Foods to be Taken with Considerable Caution. Muffins, hot rolls, sweet potatoes, baked beans, turnips, parsnips, cabbage, egg plant, stewed tomatoes, fresh corn, cherries, plums, raw apples, huckleberries, gooseberries, currants, preserved fruits.

Foods to be Avoided. Fried foods of any kind, griddle cakes, pork, sausage, highly seasoned food, pastry; all heavy, doughy, or very sweet puddings; unripe, sour, or wilted fruit; bananas, cucumbers, nuts, coffee, alcoholic beverages.

PART IV.

Nutritional Disturbances in Artificially Fed Infants.

CHAPTER I.

MINOR DISTURBANCES.

1. Stationary Weight.

Stationary weight may be relieved by the addition of:

(1) One to 2 per cent. of starch (0.25 to 0.5 ounce, 8 to 15 Gm.), in the form of wheat, barley, or rice flour, or oatmeal or barley water to the day's feeding, or

(2) Addition of more sugar, if insufficient.

(3) One or 2 per cent. of fat (cream, 1 to 4 ounces, 30 to 120 mils), or

(4) Skim milk.

The ingredients to be added vary with the individual requirements and the preceding diet.

2. Vomiting.

The young infant vomits easily, and without effort. The weak sphincter at the cardia predisposes to regurgitation. Regurgitation of only small portion of the meal is designated as "spitting." This latter symptom has become less common since the introduction of the longer feeding interval, which allows the stomach to empty itself thoroughly before the next feeding. Other than too frequent feedings, too large an individual meal, and food too rapidly taken, are the most common causes of vomiting. These conditions can easily be remedied. Excessive handling and abdominal bands that are too tight are frequently causes of vomiting. Excessive feeding with fat, such as is frequently seen in formulæ made from cream mixtures and top milk mixtures, are common causes of vomiting, and should lead to reduction of the fat content of the food by replacing the contents in part by whole or skim milk. Excessive quantities of sugar in the diet may also cause vomiting. Vomiting due to the large tough protein curd of the raw milk can be obviated by boiling or alkalinizing the milk.

3. Colic and Flatulence.

Constipation is very frequently associated with colic and flatulence, disappearing with the institution of a proper diet.

More commonly the habitual colic, as seen in the young infant, may be taken as an evidence of gastric or intestinal indigestion, and may be due to one of several causes: (1) too much milk at proper intervals, (2) too frequent feedings, and (3) mixture too rich in fat, or (4) excessive in carbohydrates. Regurgitation and vomiting are commonly associated, and not infrequently diarrhea results. By careful study of the diet and observation of the stools the offending factor can in most instances be eliminated.

Excessive flatulence can frequently be eliminated by reduction or change in the kind of sugar and cereal gruels.

A reduction in all the elements of the food may be necessary temporarily in the presence of severe symptoms.

Feeding of powdered casein in amounts varying from 4 to 8 Gm., dissolved in 30 to 60 mils of water, two or three times daily, will relieve colic in many infants, in all probability due to lessening of intestinal peristalsis.

Not infrequently the crying due to underfeeding may be interpreted as colic. Reduction of the diet of these infants is a source of danger. If the stools are good, and there is no vomiting, and the baby is gaining in weight, one should be convinced that it is not the cry of habit before making changes in the diet.

The constant solicitude of nurses because the baby has "gas on the stomach" is unwarranted. All bottle-fed babies have gas in the stomach. They swallow it with their meals in the form of air. If the baby is gently raised in the sitting posture the gas will usually "come up." This may be done in the middle of a feeding if the stomach seems unusually distended. Occasionally severe attacks of colic may be relieved by a saline enema.

4. Constipation.

In breast-fed babies, and not infrequently in infants fed on boiled milk, we frequently find a sluggish rectum, which is evacuated to better advantage by the use of simple mechanical means than by the use of physics. A lubricated catheter, a simple suppository, made from glycerin or soap, or 1 to 2 ounces of a saline enema or sweet oil injection can be recommended. If properly used, they are not harmful, nor do they create bad habits which are often ascribed to them. A regular hour for their use, with proper training, creates regular habits, and in most instances the condition improves to such an extent that they can be discontinued. Most infants can be trained to regular evacuations by the fourth or fifth month. The infant should be well supported on the mother's lap, over a chamber, which she may hold between her knees. This is done to best advantage after a feeding, and a suppository may be used until the infant realizes that the operation is undertaken for a purpose,

In the presence of fat-soap stool it may be necessary to reduce the whole milk, substituting skim milk temporarily, and increasing the sugar.

In the presence of constipation, where the maltose-dextrin compounds have been used, a change to milk-sugar or cane-sugar, or one of the dextrin-maltose compounds containing a high percentage of maltose and potassium carbonate, is often beneficial.

Occasionally, the addition of cereal water to the diet is of benefit. The reverse, however, may be true.

When the infant is old enough, constipation is best relieved by the addition of vegetable or fruit purées.

When the above fail, the addition of 1 or 2 teaspoonfuls of milk of magnesia (magma magnesiæ, N. F.) to the day's feeding answers well for temporary use, or 1 or 2 tablespoonfuls of dri or liquid malt soup extract added to the day's feeding acts equally well.

In infants where constipation is distressing, and other dietetic changes fail, a week or two on Keller's malt soup usually works wonders.

Underfed infants frequently suffer from constipation. Such stools (hunger stools) are small, dark in color, and contain much mucus, and are associated with stationary weight. Increasing the diet relieves the constipation.

5. Abnormal Stools.

(1) **Curds.** Curds are seen as undigested masses, and may be formed from fat or protein, or a combination of the two.

Fat curds are far more common than protein curds, and are usually seen as small, soft, whitish or yellow masses, either sprinkled throughout the stools or not infrequently making up a large part of the stool. They are usually intermixed with mucus, which is present in excess. The chemical composition can easily be demonstrated by the usual tests for fat. Breast-fed infants very commonly show curds of this type, and usually they have very little pathological significance in these infants.

Protein curds are far less frequent, and present quite a different appearance. They are also seen only in the presence of feeding with raw milk. They appear as smooth, hard masses, of a yellowish-brown color, with white center when broken, and are usually larger than the fat curds. They are also smaller in number, and may be found mixed in feces which otherwise appears normal. The laboratory test (ether), which causes the fat curds to go into solution, results in hardening and toughening of the protein curds. This is an easy method of differentiation. Such stools have usually an offensive odor.

Treatment. *The fat curds,* if numerous, call for a considerable reduction in the fat percentage. The *protein curds,* if numerous and persistent, should lead one to reduce the protein, at least temporarily, or also to boiling or citrating the milk, which causes their disappearance. In a dyspeptic infant with hard curds in the stools, removing the sugar from the raw milk mixture, thereby lessening the frequency of stools and slowing peristalsis, may cause the hard curds to disappear—that is, a sugar diarrhea that caused a non-digestion of the casein has been remedied.

(2) *Loose, green stools* with a sour odor may be due to a high percentage of sugar, more commonly milk-sugar,

or, again, they may be due to an excess of fat. Such stools are usually frequent, and, if the dietetic error is not corrected, may lead to nutritional disturbances. Stools of similar appearance, which are not infrequently seen in breast-fed infants, have far less significance, and should not lead to weaning if the child is making at least a fair progress. In the artificially fed, the treatment consists in the careful study of the diet, with removal of the cause, when found.

(3) *Fat-soap Stools.* These are light-colored, large, dry stools, which do not adhere to the napkin, and are seen in feeding in which cream or cow's milk is in excess. They are described more fully under Disturbed Metabolic Balance.

(4) *Starvation stools* have already been described.

(5) *Blood in Stools.* This may be associated with many different conditions, and the character of the stool differs with the source of the hemorrhage into the intestinal tract, and may vary from a tarry stool to one containing bright blood.

6. Milk Idiosyncrasy.

A few infants show a true idiosyncrasy to cow's milk, which is overcome only with great difficulty, even when the milk is carefully modified. The true cause of this condition is still in dispute. However, it may be said that some of these cases are undoubtedly due to anaphylaxis. On the other hand, some of them are undoubtedly not explained on this basis. Infants suffering from such idiosyncrasy will usually refuse the milk, and when it is forced upon them it results in vomiting, diarrhea, and frequently an urticario-erythematous rash. Cow's milk feeding in these cases is often associated with a low-grade fever. The symptoms speedily subside upon the administration of castor oil and the withdrawal of milk. This class of cases offers great difficulty in feeding during the first year of life, as carbohydrates must necessarily form a considerable portion of their diet. Broths, cooked cereals, and vegetable purées should be gradually added to the diet as soon as they can be digested.

CHAPTER II.

GENERAL CONSIDERATION OF NUTRITIONAL DISTURBANCES.

OUR ideas on this subject have undergone considerable change during the past few years. Older authors viewed the nutritional disturbances as conditions limited to the stomach and bowel, and likened them to similar conditions in the adult, with the exception that more serious results were to be expected in the infant because of the slight physiological resistance. The infant's body is more favorable to a severer course.

For many years the classification of Widerhofer, of the Vienna school, first published in 1880, and based on an anatomico-pathological basis was the one in general use. These he grouped as follows:

1. Functional disturbances, as acute and chronic dyspepsias.

2. Enterocatarrhs, with more or less marked histological changes and clinical findings.

3. Follicular enteritis, with deep-seated inflammatory and ulcerative changes, especially in the large intestine.

4. Cholera infantum (this latter, a severe type of enterocatarrh, was classed as a distinct clinical entity).

Clinical observation soon convinces one that the cases do not follow the distinct types in the above classification, mixed and progressive types being the rule. In many instances far-reaching after-effects remain, and, again, in others of the severest types few if any anatomical lesions were demonstrable at autopsy. Especially in young infants we find marked and often general disturbances following in the wake of what seemingly were localized gastro-intestinal lesions, with the result that the systemic and not the intestinal symptoms were of more serious import. Again, we know that many findings formerly attributed to invasion of bacteria or their toxins can now be attributed directly to improper metabolism of the food ingested.

To avoid confusion in our discussion of this vast field of nutritional disturbances, we will first consider the *food injuries,* and speak only of the infections incidentally as they affect the former, and at a later period discuss the *infections* more directly.

Food Injuries. The nomenclature covering this subject has also changed, and we now adopt the term "Nutritional Disturbances" in place of "Gastro-intestinal Diseases," the former covering the functional and anatomical disturbances, as well as the bacterial and food traumas. It is, however, necessary in order to justify the newer nomenclature to look upon nutritional disturbances not as localized in the gastro-intestinal canal, but as general affections involving the whole organism in one of the most vital of its functions. The gastro-intestinal symptoms form only a part of the clinical picture; therefore, in its fullest conception the mental state, changes in the temperature, pulse, respiration, etc., may become as important in their interpretation as the diarrhea. Two schools of pediatrics have given us the nucleus for our present views on nutritional disturbances and their classification—those of Czerny and Finkelstein. Czerny's work antedated that of Finkelstein by several years, and he based his classification on what he considered injuries due to overfeeding with individual food elements. These he called "food injuries," and described them as due to fat, starch, sugar, protein, and salts, individually or in combination, either when given in excess, or when given to an infant with lowered tolerance for these food elements.

Finkelstein viewed the nutritional disorders from a broader standpoint. He considered them *"as the gradual development of an increasing intolerance for food"*—step by step, from the mildest disturbances, in which the only striking symptom is failure to gain in weight, through the severer dyspepsia, up to the final stage of intoxication, when the infant is in a state of *"metabolic bankruptcy."* In his classification we see one increasing process, the important factor of which is found in the fact that the infant can tolerate less and less food, until finally any food in any amount acts harmfully. The stages of the various disorders under the Finkelstein classification must therefore necessarily merge gradually into one another, and lack in definiteness, and at times present a picture so complicated that an exact diagnosis as to the stage be temporarily impossible.

Etiology in General. Before entering upon a general discussion, it may be wise to review some of the theories promulgated for the advantages of human over cow's milk in infant feeding. Biedert believed that the decomposition products of protein digestion were the important factors. This idea has not been substantiated clinically. Hamburger advanced the idea that the albumins foreign to the human body contained in cow's milk were important factors. This also has not been proven. Czerny believes that the fat, and, again, the sugar, are the important factors. L. F. Meyer believes that the whey content, and more especially the high salt content of whey (0.75 per cent. as compared with 0.2 per cent.

in human milk), predisposed to intestinal injury, following which trauma fats and sugars play an important part. Marfan, Escherich, Pfaundler, and others believed that specific protective bodies of unknown nature were contained in raw human milk, which are of vast importance as immunizing bodies.

Of greatest importance as etiological factors, as viewed by Finkelstein, are the fermentation products of the fats and carbohydrates, which result in the formation of the lower fatty acids (lactic acid, butyric acid, etc.). Protein decomposition is evidenced only by its causing increased intestinal secretion, a very bad odor of the stool, and a tendency to constipation, except in the presence of large, raw curds, with their tendency to mechanical irritation. The acids formed by fat and carbohydrate metabolism when in excess result in increased peristalsis, increased secretion of mucus, etc. They may also interfere directly with intestinal digestion, or cause irritation of the intestinal wall itself. In mild cases this may result only in impaired growth and progress, but in the severer types of nutritional disturbances there is breaking of the normal relation between intestinal digestion and the parenteral cellular metabolism, whereby the whole body function may be impaired, due to toxic products escaping through the intestinal wall into the general circulation, or, again, products necessary to normal growth may be lost into the intestinal tract.

We know that bacteria and their toxic products, as encountered in the food administered, are less often the offending factor than formerly supposed, and that improper food either qualitatively or quantitatively are of equal or greater importance in the causation of nutritional disturbances. *Food injuries* can therefore be due to: (1) underfeeding by a generally restricted or an improperly balanced diet, (2) overfeeding with a food of proper or improper proportions, (3) lessened tolerance for food.

1. *Nutritional Disturbances Following Underfeeding.* We recognize two types: (1) qualitative and (2) quantitative. Sooner or later the results are similar. The former diets, *qualitatively* wrong, are frequently seen where theoretically the caloric requirements are met, but one or more of the necessary food elements are in excess and the mixture short in the required amounts of others. An example of this is seen in feeding of carbohydrate-rich foods as condensed milk, malted milk, etc. When the minimum requirements for growth and development, at least for both organic and inorganic salts are met in such a diet, the organism may be able to overcome the excess of one ingredient, but if this is not true, sooner or later some grave complications will result. When we feed less than a sustaining diet of 32 calories per pound body weight, or 70 calories per kilogram, we soon have the results of a *quantitative* inanition, with all of its undesirable results.

2. *Nutritional Disturbances Due to Overfeeding.* This is probably the most important of all etiological factors, and may be due to a diet of correct proportions, but quantitatively too great for the individual case, or a diet with an excessive amount of one or more constituent ingredients.

To judge such errors in diet, each individual infant must be studied as a distinct entity.

3. *Nutritional Disturbances Due to a Primary Lessening of Tolerance to Food.* Many factors can cause such a state of affairs:

(*a*) Intercurrent illness, with impairment of the digestive function. Bacterial infections are probably the most common, and may be either general or localized infections.

(*b*) Heat of summer, with its depressing influence on the organism.

(*c*) Spoiled milk, due either to bacteria contained or their products.

(*d*) Improper hygienic conditions, with their resulting depression.

General Symptomatology. The varied symptomatology of the nutritional disturbances can only be realized when we consider the numerous factors involved in the process of nutrition. We must, therefore, consider the digestion of foods in, and their absorption from, the intestinal tract, the replacing and upbuilding of the body tissues, heat production and regulation, and the control of the functions of all organs and tissues. That nutrition influences all of these functions is evidenced by the disappearance of the so-called alimentary fever, by the withdrawal of food. This is also true of certain forms of albuminuria. We also find cerebral and spinal symptoms as well as cardiac and respiratory changes, which readily disappear with a corrected diet.

By the development of the foregoing symptoms in their various phases, and under varied conditions, we can expect the most divergent clinical pictures. The individual type varies directly with the general condition of the infant, as well as with the predominating dietetic elements. All infants suffering from nutritional disturbances have a *lessened food tolerance.* This has a far-reaching effect, even to the involvement of the most remote tissues and cells, which, again, is evidenced by a general weakening of all body functions. The end result is a *paradoxical reaction* to food intake, which is evidenced by loss of weight, irregularities in the temperature curve, etc., on food administration beyond the point of tolerance. These evidences of disturbed metabolism vary directly with the variety and quantity of food intake, and with the degree of metabolic disturbance which has preceded. A good example of this reaction is seen in the following series of cases: Three infants each are fed 30 Gm. of sugar daily, added to their ordinary diet. The first baby, a well one, gains in weight somewhat more rapidly than previously; the second develops diarrheal stools, a slight irregularity in the temperature curve, and its weight remains stationary; while the third infant, which was more deeply involved, develops a temperature of 101° and over, very frequent stools, and loses 100 Gm. in weight in twenty-four hours. Lowered resistance is not alone evidenced in the reaction to food, but also are lessened immunity to infection, and marked depression by hot weather. All of these may be followed by severe systemic infections, and markedly retarded convalescence.

The normal healthy infant with a well-balanced metabolism reacts to food as follows:

1. An elastic, pink skin, a well-developed panniculus adiposus, well colored mucous membrane. Its tissues should feel firm.

2. One should expect certain muscle and bone development according to the age of the infant.

3. A uniform rectal temperature (98° to 99° F.), almost a monotheria. Any considerable deviation is abnormal.

4. It should show a regular, steady gain in weight.

5. The bowel movements should be regular, and should vary with the food ingested.

6. Its disposition should be happy, and its nervous functions normal. It should sleep well, and be satisfied with feedings at three- to four- hour intervals.

7. It should show a wide tolerance for food, both as to the diet as a whole, and to the individual food element.

8. Renal, circulatory, and respiratory functions should be normal.

Bearing in mind the attributes of the healthy infant, we are now in a position to review the factors leading to and influencing our present conceptions of the nutritional disturbances, based on an ascending series of pathological stages in those infants whose tolerance for food has been overstepped either because of overfeeding or because of diminished or abnormal tolerance on the part of the baby itself.

Classification of Nutritional Disturbances. The older classification into acute and chronic dyspepsia, entero-catarrh, ileo-colitis, and cholera infantum must be discarded in the light of our new knowledge, and the whole reclassified, with the view in mind that the gastric and intestinal symptoms are only local evidences of a general systemic involvement, with the clinical picture varying as to the predominating food elements, the preceding general condition of the infant, and the knowledge that changes are rapidly seen from one type to another through the influence of various exogenic factors.

For our purposes we will combine the essentials of the Czerny and Finkelstein classifications into a working basis.

Group I. *Nutritional disturbances* (food injuries) due to *overfeeding* (overstepping the infant's food tolerance).

(*a*) Light forms, without destructive lesions.

(1) *Disturbed metabolic balance.*

(2) *Dyspepsia.*

(*b*) Severe forms, with destructive lesions and general disturbances of the whole organism.

(3) *Decomposition.*

(4) *Intoxication.*

The reaction to food administration is the basis of this classification, and the degree of reaction depends directly upon the preceding food injuries. It must also be remembered, as previously stated, that one form leads rapidly into the next, if the errors in the diet are not remedied, or when secondary infections complicate the picture.

Group II. *Nutritional disturbances* due to *underfeeding.* (Insufficient food. Inanition.)

(*a*) Quantitative inanition.
(Pyloric stenosis, pylorospasm, etc.).

(*b*) Qualitative inanition.

(1) Excessive starch (flour) feeding. Not due to excess of starch alone, but to the lack of other ingredients in the diet.

(2) Scorbutus.

(3) Rachitis.

Group III. *Secondary nutritional disturbances,* following lowered resistance and lessened food tolerance, due to (*a*) *Heat,* resulting in systemic depression, and often associated with spoiled foods (milk, etc.).

(*b*) *Infections from within the intestinal tract* (enteral).

(1) Non-specific intestinal infections (ileocolitis, etc.).

(2) Specific intestinal infections (typhoid, paratyphoid, dysentery, etc.).

(*c*) *Systemic infections* (parenteral). Otitis, pyelitis, pneumonia, etc.

Group IV. *Nutritional disturbances* due to congenital debility, anomalies or idiosyncrasies, with resulting abnormal metabolism.

Food qualitatively normal.

(*a*) Exudative diathesis (eczema, etc.).

(*b*) Psychoneuropathic diathesis.

(1) Neuropathic (strict sense).

(2) Spasmophilia (tetany, convulsions, etc.).

(3) Habitual vomiting.

(4) Pylorospasm.

The following scheme may be used for classifying the main types:

Dis. Met. Balance	Dyspepsia	Decomposition	Intoxication
Lessened fat tolerance. Food of sufficient caloric value.	Lessened fat and carbohydrate tolerance. Rel. excess of sugar in the food.	Tolerance lowered to all food elements.	Follows other forms, especially when a diet rich in whey and sugar is not corrected.
Stationary weight.	Stationary weight or moderate loss.	Rapid loss of weight.	Rapid loss of weight.
Slight variations in temperature.	Moderate fever.	Subnormal temperature.	High fever.

DIS. MET. BALANCE	DYSPEPSIA	DECOMPOSITION	INTOXICATION
Constipation with fat-soap stools.	Diarrhea, green, mucus, curds, acid.	Often history of diarrhea. May be constipated.	Diarrhea, watery, blood, etc.
Absence of acute symptoms, general loss of turgor.	Acute gastro-intestinal symptoms.	Weak, slow, small pulse. Hunger. Vomiting.	Rapid, weak, small pulse. Rapid, pauseless respiration. Hunger. Vomiting. Collapse. Glycosuria. Albuminuria. Anuria. Leucocytosis.
Sensorium not involved.	Sensorium not involved.	Sensorium not involved.	Sensorium markedly involved. Nervous symptoms may outweigh intestinal symptoms.
Favorable reaction to reduction of fat and increase of carbohydrates in the diet.	Rapid repair on withdrawal of improper food.	Starvation dangerous, also great danger in overfeeding.	Improvement on withdrawal of food.

CHAPTER III.

DISTURBED METABOLIC BALANCE.

Synonyms. Weight disturbance, disturbed balance, fat constipation, malnutrition, atrophy of moderate degree, Bilanz-Stoerung (Finkelstein), Milchnaehrschaden (Czerny-Keller).

This represents the mildest stage of nutritional disturbances, and results from administration of food beyond the infant's limits of tolerance, resulting in retardation of development, both qualitatively and quantitatively, however, without marked general symptoms of disease. This condition is clinically characterized by pallor, restlessness, disturbed sleep, constipation, usually associated with fat-soap stools, and stationary weight. Fortunately, this clinical picture is less frequently seen than formerly, when cream and top milk mixtures were more extensively used.

Etiology. It is seen under a variety of conditions:

1. Most cases are caused by a relatively high *fat* content of the food, *i.e.,* a relative overfeeding with whole milk, in the presence of moderate amounts of carbohydrates; therefore we have improper proportions of carbohydrate and fat. In the presence of excessive amounts of carbohydrates we are more likely to see a *dyspepsia.* Proteins also play an important rôle in the causation of the clinical picture of this disease, in that in the presence of a relative overfeeding with proteins an alkaline intestinal reaction necessary to the production of fat-soap stools is brought about. The symptoms usually follow a

period of good progress, which ceases more or less abruptly.

2. Cases in which the milk mixture is theoretically quantitatively correct, but in which the infant suffers from a congenital idiosyncrasy to milk. Many of this class of cases are associated with exudative diathesis.

3. Following lowered food tolerance due to intercurrent infections, either parenteral or enteral.

Artificially fed infants are almost exclusively affected, probably because of the high carbohydrate and low protein content in the breast-fed infant's food. This condition was first described by Czerny under the name of Milchnaehrschaden, having been first noticed in those infants who received large quantities of fat in the food. This may be due to an absolute excess of fat, as seen in the first group, or a relative excess of fat, as seen in the second group of infants having an idiosyncrasy toward milk. Fortunately, in these infants the tolerance for carbohydrates has in most cases not been reduced, and therefore the fat in the food can to a great degree be replaced by sugar and cereals.

Pathogenesis. As fat-soap stools are so frequently regarded as the basic symptom in the diagnosis of disturbed metabolic balance, we will first emphasize their significance. The fat-soap stool must be viewed as an effect, and not as the cause, of this intestinal disturbance.

The condition is not a fat indigestion, but a disturbance in salt metabolism, based on a relative overfeeding of fat in the presence of a relative carbohydrate underfeeding, and enhanced by a relative excess of protein.

There is an increased excretion of the alkalies by increased combining of alkalies with fatty acids, and through loss of alkalies by increased intestinal secretion.

The alkalies most involved in the formation of the fat-soap stools which are so commonly seen in this condition are calcium and magnesium. There is, however, also a decreased sodium and potassium retention, as evidenced more especially by increased excretion in the urine. This loss of calcium and magnesium through the stools, and inability to retain sodium and potassium, and thereby secondarily a loss in water retention, soon leads to weight loss. The fat-soap stools as stated, contain an excess of calcium and magnesium soaps, and less fatty acids and neutral fats than seen in the normal stools.

To obtain such a stool, there must be a strong alkaline reaction in the large intestine, and the food elements of the diet are important factors in the production of this reaction.

Fats. An excess of fats in the food leads to an excess of fatty acids in the intestine, with a tendency to the formation of an acid reaction of the intestinal content. To combine with these, alkalies are withdrawn from the body, if insufficient in the intestinal tract.

Proteins cause secretion of a large quantity of intestinal juice which is alkaline. This in time tends to produce an alkaline intestinal reaction, if not counteracted by excessive fermentation, the former being favorable to the formation of fat-soap stools. In all probability the great calcium content of cow's milk (4 to 1), as compared with breast milk, also offers another factor in the tendency to formation of calcium soaps.

Carbohydrates. In the presence of sufficient fermentable carbohydrates (disaccharides) in the diet, the intestinal reaction becomes acid, the products of fermentation counteracting the tendency to alkaline reaction, and thus preventing the formation of fat-soap stools.

The withdrawal of excessive amounts of alkalies from the system disturbs the acid-alkaline equilibrium, creating a relative excess of acids, *i.e.*, the formation of an acidosis. This is evidenced by the increase of the ammonia coefficient in the urine, *i.e.*, the relation between the ammonia and the total nitrogen products.

In *disturbed metabolic balance* we find a striking example of a *paradoxical reaction*, namely, increasing the food (milk or fat) makes the condition worse, and causes weight loss, diminishing the food, a return to normal, and if properly changed, even though lessened, a gain in weight.

The clinical picture is due to:

1. Excessive withdrawal of salts from the body tissues, due to fat and protein overfeeding.

2. A relative insufficiency of carbohydrates.

The stools are dependent upon overfeeding with milk, with insufficiency of carbohydrates. To be considered pathological, they must be accompanied by systemic manifestations.

The same stool may be seen under normal conditions in high protein and low fat feeding, more especially in the feeding with boiled milk, as a strong alkaline intestinal reaction is the paramount condition upon which their formation is dependent.

Symptoms. There is a retarding of development qualitatively and quantitatively, the infants frequently being undersized, without showing marked general symptoms of disease.

1. Weight. Notwithstanding proper or even excessive caloric intake, there may be no gain in weight, or an irregular increase, however, under the normal. (Stationary weight or insufficient gain in the infant corresponds to a

loss in weight in the adult. Stationary weight in an infant alone leads to the picture of malnutrition and marasmus.)

2. Temperature. Usually we find daily oscillations from 1° to 2°, with a tendency toward subnormal.

3. The child is restless.

4. Sleep is disturbed.

5. The skin is pale, with loss of elasticity and turgor. Intertrigo and eczema are frequently seen.

6. Muscles are soft and flabby.

7. Regurgitation and vomiting are frequent.

8. Abdomen tympanitic.

9. Stools. In excessive milk feeding the common type is the fat-soap stool, which is foul-smelling, dry, light in color (gray to white), friable, and does not stick to the napkin. The pale color is due to the reduction of bilirubin to urobilinogen. The odor, in part at least, is due to the decomposition of protein. In the presence of excessive carbohydrates this stool may be lacking, due to the presence of a slight dyspepsia.

10. Immunity is lessened with resulting furunculosis and susceptibility to respiratory, gastro-intestinal, and genito-urinary infections.

11. Urine is usually *ammoniacal,* and contains an excess of sodium and potassium salts.

Diagnosis must be based on the clinical picture and feeding history, as follows: sufficient caloric intake (100 calories per kilogram), with relative excess of fat and protein, and insufficiency of carbohydrates, absence of diarrhea, stationary weight, and lack of proper development, all in the absence of any other causative factor.

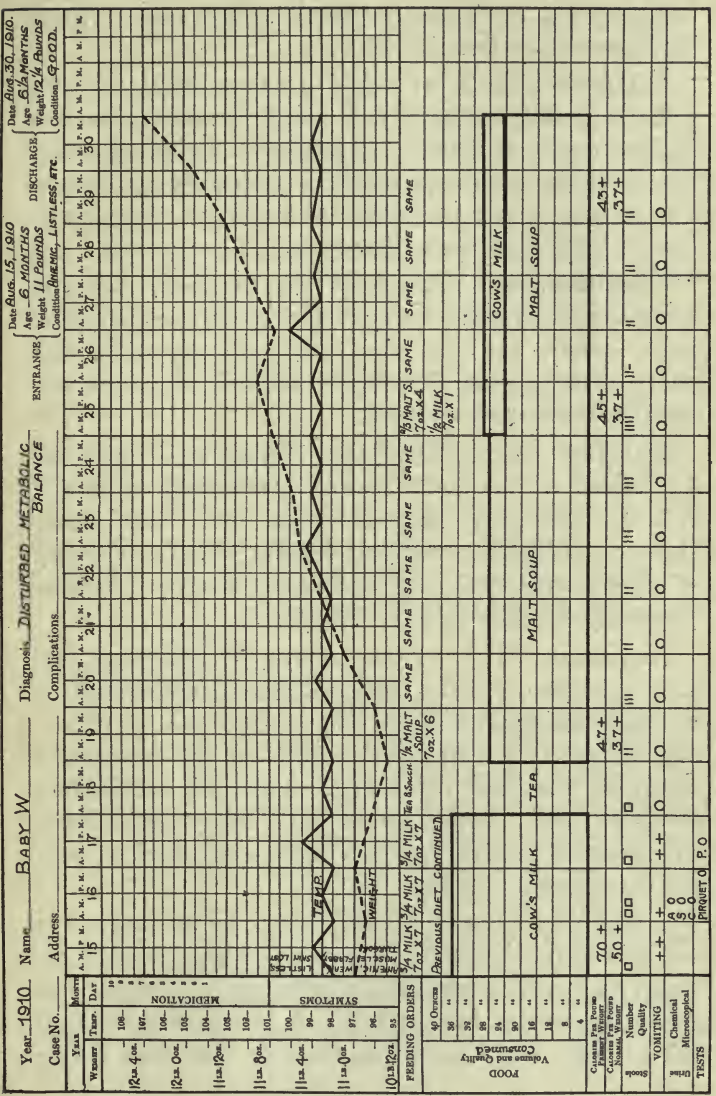

Fig. 9.—Chart showing hospital record of an infant with disturbed metabolic balance.

Underfeeding and all past illnesses which might retard development must be excluded.

Prognosis is very favorable in uncomplicated cases, with a properly instituted diet. In the average case two to three weeks is required to overcome the constipation, and to obtain a gain in weight. Occasionally a severe type is seen which is difficult to overcome, most common in infants with an idiosyncrasy to cow's milk.

Complications. Because of the lowered immunity, infections are common, especially of the nasopharynx, lungs, middle ear and skin and gastro-intestinal and genito-urinary tract. Exudative diathesis is not an uncommon associated condition.

Sequellæ. Disturbed metabolic balance is often the forerunner of the more serious nutritional disorders, such as dyspepsia, decomposition, and intoxication. Chronic constipation frequently results, due to the atony of the intestinal wall and abdominal muscles. Rickets frequently develops in these infants.

Treatment. To institute a proper treatment, we must remember that the clinical picture is not dependent on gastro-intestinal findings only, but also on an abnormal intermediary metabolism (therefore the designation Disturbed Metabolic Balance), and that fat overfeeding primarily, and a carbohydrate insufficiency secondarily, are causative factors, and that protein overfeeding may be an important element.

1. *Diet with Human Milk.* This is by all means the best treatment, especially in young infants. Weight increase may be slow at first, probably due to low salt and protein content of human milk. A loss of more than 6 to 10 ounces over a period of three or four days is fre-

quently seen. More than this should lead one to suspect an error in diagnosis. This loss may be due, as stated, to stopping of a food rich in proteins and salts, and substituting one low in the same. This stage is passed in about four days, when the system adapts itself to the new food ingredients. Temperature and pulse do not change, and the stools assume a breast-milk-stool character. If the stage of reparation is slow, and the child does not gain in weight, the substitution of one meal rich in protein and salts daily will frequently help (buttermilk or skim milk). Mother's milk also helps to increase the immunity.

2. *Diet with Artificial Foods.* In pathogenesis of this condition the milk fat plays the most important rôle, and this is best counteracted by replacing it with well-tolerated carbohydrates. Protein tolerance is usually little impaired, so that high percentage may be retained in the diet in the presence of increased carbohydrates.

(1) In *simple cases* reduce the quantity of milk and add carbohydrates in the form of sugar and starches.

(2) In *severer cases*

(*a*) Malt soup (Keller's) is exceedingly valuable. Malt soup is indicated in the presence of fat-soap stools which soon become pasty and of mahogany-brown color; the best results with malt soup are obtained in infants from three to six months of age. After six months more milk than given in the original formula must be added to increase the protein content of the diet.

(*b*) Buttermilk or skim milk mixtures (containing two carbohydrates, *i.e.,* sugar and flour). The action of both is the same. Occasionally it is necessary in young infants to reduce the sugar recommended in the original formula (see Buttermilk Mixture, p. 284).

(*c*) Brady's buttermilk mixture No. 1 (p. 284).

Change of the diet is followed by better sleep, improved turgor, skin becomes less pale, less variation in temperature. Stools change from soap stools to (1) yellow-brown, alkaline and fair consistency, when buttermilk mixtures are fed, (2) acid, softer, mahogany-brown color when malt soup is fed.

These results of treatment are due to the fact that the tolerance for carbohydrates is high, and protein tolerance is little impaired. Each case should be watched to see if an excess of carbohydrates is not being given in the new diet, which is indicated by (*a*) restlessness, (*b*) stopping of weight increase after an early rise, (*c*) alimentary fever (irregular), (*d*) too frequent stools. If the cow's milk mixtures are not well tolerated, human milk is indicated.

The above mixtures should be gradually replaced by ordinary milk mixtures after two to eight weeks.

In infants over six months of age one of the most constant and brilliant therapeutic results follows the use of a limited amount of milk (boiled or citrated) and the free administration of toast, zwieback, rusk, and cooked cereals given in increasing quantities up to amounts that will bring on a steady gain of 6 to 8 ounces a week. To this diet broth or vegetable soup and orange juice should be added soon. In other words, *if a baby of six or seven months does not gain on ordinary milk mixtures, it should be fed like a normal baby of nine or ten months,* with the single exception that the milk should be kept rather low, or at least given cautiously, and preferably boiled or citrated, or both. In many cases this can be done even in the fifth month.

CHAPTER IV.

THE STAGE OF DYSPEPSIA.

Synonyms. Stadium dyspepticum, indigestion, Zuckernaehrschaden.

Etiology. Dyspepsia may develop either primarily in a healthy child or as a sequel of disturbed metabolic balance, when the insufficiency of the intestine has become such as to make it impossible to avoid development of pathological fermentation. This may be due either to absolute or relative overfeeding, or because of primary influence, which tends to decrease the food tolerance. The products of fermentation cause increased peristalsis, which leads to the chief symptom of dyspepsia, *diarrhea.*

The most important factors may be enumerated as follows:

1. Errors in diet with milk of good quality: (*a*) overfeeding with diet of normal proportions (too frequent and too much); (*b*) feeding with a diet of improper proportions (excess of sugar, etc.); (*c*) excess of raw milk, with resulting mechanical irritation, due to large, hard protein curds.

2. Extremes of temperature, heat of summer and cold of winter, with resulting systemic depression.

3. Feeding with infected milk (decomposition products of milk and bacterial toxins).

4. Infections of the gastro-intestinal tract (*enteral infections*).

5. Systemic infections (otitis, pharyngitis, pyelitis, etc.), associated constantly with a lessened tolerance for food (*parenteral infections*).

6. Congenital lowered tolerance to cow's milk.

In practice, especially in young infants, frequently we do not observe the stage of disturbed metabolic balance, because dyspepsia develops directly, due to a relative excess of sugar in the food.

Pathogenesis. We will discuss in detail the second group of cases, those due to feeding with a diet of improper proportions.

The symptoms of dyspepsia are brought about by increased acid fermentation, which causes increased peristalsis, and increased intestinal secretion, with resulting loss of body fluids. Pathological breaking down of carbohydrates (sugars, flour) is to be regarded with greatest probability as primary. It is probable that the fat in most cases is involved only secondarily, as a result of the increased peristalsis, fermentation, etc. The same amount of fat is commonly tolerated perfectly if the sugar is lessened sufficiently. It is also probable that the fat has an unfavorable influence on the sugar tolerance. That the decomposition products of casein do damage to the intestines could not be demonstrated. On the contrary, it was found that by sufficient doses of casein the pathological fermentation could be combated, and thus the casein has a directly curative influence, as seen in the tendency to formation of fat-soap stools. By reduction or complete withdrawal of carbohydrates the pathological fermentation can in almost all cases be decreased, and also the peristalsis, and this seems to prove that the carbohydrates are the primary cause of this condition. The different carbohydrates show different tendency to fermentation. Milk-sugar ferments most easily, less easily the cane-sugar, and least the dextrin-maltose preparations.

By clinical experiments it was found that the tolerance of even the same intestine towards carbohydrates is not always the same, and that it also depends to a certain extent upon the quality of the fluid in which they are dissolved or suspended. The same amount of sugar given with large quantities of whey produces much more easily dyspeptic symptoms than the same amount of sugar administered in less whey or in water. From this it follows that in pathogenesis of dyspepsia of artificially fed infants the whey is also of importance, this being in all probability due to the quality and quantity of the whey salts.

Symptoms. Dyspepsia is characterized clinically by acute gastro-intestinal symptoms, the most marked of which are the stools, which are increased in number, and of an abnormal quality. The organism does not show signs of any deep-seated general changes; weight loss is moderate or the weight remains constant. Temperature is moderately increased, and repair is rapid with the withdrawal of improper food.

Several general symptoms are usually absent in the early stages. The mind is clear. The heart action is not rapid. Respirations are not greatly increased. The baby is restless and fretful, cries a great deal of the time, sleeps brokenly, and sucks its hands and other objects as if hungry. The face soon becomes drawn, and the tissues more or less flabby through loss of body fluids. The skin shows little change. Temperature is moderately increased.

Weight. The weight loss varies directly with the loss of body fluids through the increased intestinal peristalsis and consequent diarrhea.

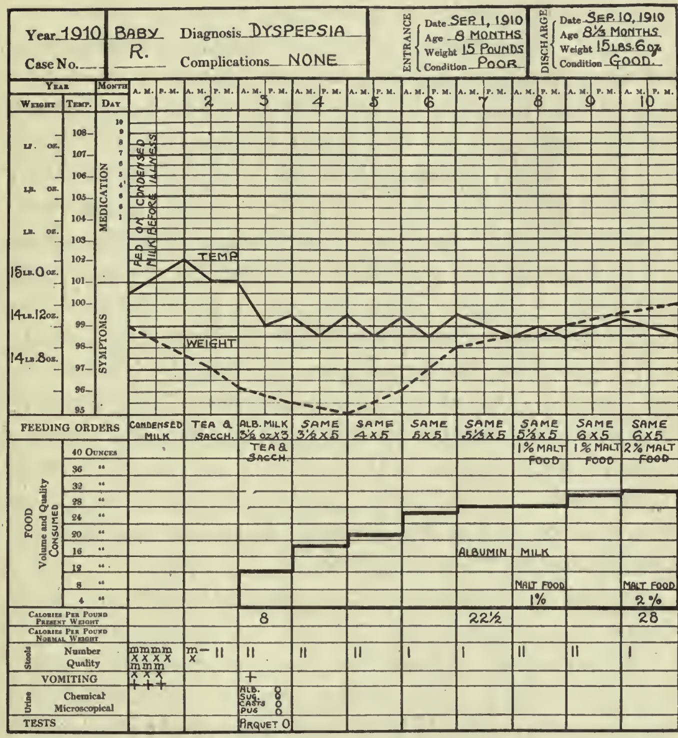

Fig. 10.—Chart showing hospital record of an infant with dyspepsia.

Gastro-intestinal Symptoms. The appetite is poor. The mucous membrane of the mouth is red, and may be the seat of thrush (due to decreased immunity). Vomiting may be present, and usually occurs long after feeding. Volatile fatty acids may be detected in the stomach content by their odor. The abdomen is distended, and peristalsis increased, and is visible or can be heard by auscultation. Restlessness is marked.

Stools. The clinical diagnosis is usually made from the stools. They are increased in frequency, and they also differ from the normal. They are thinner, contain more mucus, and are either watery or hashy. There is abnormal odor, either that of decomposition or that of acid fermentation. The reaction is variable, mostly acid. The color of the stool is often green, this being due to transformation of bilirubin to biliverdin by oxidizing ferments.

The increased peristalsis results in impairment of absorption, which may easily be determined by metabolic experiments, and also estimated by macroscopic, microscopic, and chemical examination of the stools.

Fatty acids appear in the stools in the shape of white or yellowish lumps (milk curd), and, by addition of strong acids and slight warming, fatty acid needles may be crystallized from them.

Neutral fat is present in the form of smaller or larger drops.

If flours are in excess, the stools are frequently paste-like and foamy. By iodine solutions the unchanged starches are stained blue, and the erythrodextrin is stained red.

Of especial interest has been for some time the question whether in stools undigested casein was found. The yellowish lumps, the so-called milk-curds, in the hashy stools, seen even in feeding with boiled milk, have erroneously been regarded as casein curds, which were supposed to escape digestion on account of their being difficult of digestion. Today we know positively that these so-called "casein curds" are composed chiefly of fatty acid salts and bacteria. Only in feeding with raw milk frequently large, tough, bean-like casein curds pass through the intestine without being digested. Even in the presence of true casein curds, however, one must not conclude that they are the primary factors in the pathogenesis of this nutritional disturbance unless we are certain that an excess of raw milk has been fed.

Varieties. First, the acute dyspepsia, which begins with a definite acute onset, usually in infants who have been previously well, and second, a chronic dyspepsia, which begins less acutely, or follows acute attacks, and which recurs even in the presence of a carefully regulated diet. It soon becomes evident that in the latter cases there is a definite lessening of the food tolerance.

Diagnosis. The diagnosis can be made only by a careful consideration of the feeding history and the clinical and functional symptoms.

It is first necessary to differentiate dyspepsia from the milder forms of enteral and parenteral infections. The latter are frequently associated with intestinal irritation. One must remember that the infections, especially in young infants, are frequently associated with a secondary nutritional disturbance, and *vice versâ,* that secondary infections commonly follow in the wake of nutritional disturbances. An infection should be suspected when the temperature remains high after the withdrawal or reduction of the food (especially of the carbohydrates), and when albumin and hyaline casts appear in the urine, and the mucus continues in excess in the stools, presenting the picture of a secondary enterocolitis. If infections are not recognized, there is a great danger of continuing the starvation diet (which has been inaugurated for the treatment of dyspepsia) too long, and thereby reducing the vitality of the infant to the stage of decomposition. It is also of importance to note whether the dyspepsia is primary or an acute exacerbation in the course of a decomposition, as on this differentiation to a great extent depends the prognosis and the therapy. Here, again, a careful history is of vast importance, and one should carefully note the presence of repeated dyspeptic attacks, with recurring fluctuations in weight, the occurrence of previous infection, both enteral and parenteral, as all of these indicate a tendency to decomposition.

Prognosis. In infants previously healthy and with a proper dietetic treatment, the prognosis is good. Repeated attacks should always be seriously considered. Dyspepsia in very young infants is always more serious than in the older and better developed ones.

Treatment. *Human Milk.* The best treatment of all forms of dyspepsia consists of feeding human milk. The younger the infant, the more the indication for human milk. This is especially true of infants under two months of age. In severe cases it may be necessary to place the infant on a starvation diet for six to twelve hours, and then administer the breast milk in restricted amounts.

Artificial Feeding. In artificial feeding the treatment of acute dyspepsia is somewhat different from the treatment of chronic dyspepsia.

Acute Forms. In the acute form, where the child was previously well and its tolerance good, the simple unloading of the intestine may allow it to resume its normal function. The following treatment is recommended:

1. *Starvation or Hunger Diet.* Short (six to twelve hours, rarely longer) starvation, only liquids being administered, tea with saccharin being the best (saccharin, 1 grain [0.065 Gm.] to 1 quart [1000 mils]). They should be given freely, up to amounts of the total fluids needed. This permits the stomach and the intestines to empty themselves, and to assume their normal functions. Laxatives are usually not indicated. If temporary starvation is inaugurated, the intestinal tract soon empties itself of its irritating contents.

2. *Indifferent Diet.* During the second day in young infants, one-third whole milk (best boiled or citrated) plus two-thirds thin oatmeal gruel, without sugar, may be fed, such a diet being low in food value and salts. Buttermilk or skim milk may be used in place of the whole milk in severe cases. The total daily quantity of the milk mixture on the second day should not exceed 6 to 12 ounces, divided into six feedings of 1 to 2 ounces each. To this, 20 to 25 ounces of tea, plus saccharin, may be added, making a total of about 1 quart of fluid for the day. This will usually answer. Further treatment depends on the reaction to the above. Upon this treatment the general condition improves, also the disposition, etc., and the weight loss ceases in two or three days. When this is not the case, decomposition or infection should be suspected.

3. *Sustaining Diet.* Gradually, and as rapidly as possible, the food should be increased, the increase to be made at least every other day, in order to limit the underfeeding to minimum. By the third day the quantity of the milk mixture should be increased, the quality may be left unchanged, giving water or tea to the necessary quantity of fluids between the feedings. Weight increase

should not be expected because of the low sugar content and low caloric value of the diet, but a decrease in weight should always be considered serious. The stools are at first small and contain mucus, later less frequent, and often on milk mixtures without sugar there are fat-soap stools which are a good indication.

4. *Ordinary Diet.* In mild cases, the ordinary milk mixtures proper for the given infant may usually be resumed by the end of a week. In more severe cases, return to a full diet should be slower. In these mixtures, the carbohydrates should be started with 1 per cent. of the whole mixture, and gradually increased to 5 per cent. The carbohydrates most suitable for this purpose are the maltose-dextrin compounds, especially those with a high dextrin content and no potassium carbonate. In older infants cereals in the form of flour ball, barley flour, farina, zwieback, can often be added to advantage, as well as clear broths. At first there is a rapid increase in weight, later on a slower one.

Avoid underfeeding too long, even if the stools look bad, if the temperature and weight curves improve, because of the danger of decomposition. It should be borne in mind, therefore, that it is undesirable to underfeed for a long period, and more especially dangerous to inaugurate starvation repeatedly, or to keep an infant for days on a starvation diet, such as cereal waters or very weak milk mixtures. It is also necessary to know and recognize the stools of an underfed infant (*hunger stool*). This is greenish-brown in color, composed chiefly of mucus, and small in amount, and sometimes frequent. They should not be mistaken for the curd-containing frequent stools of dyspepsia, as the former is an indication for the resumption of food, while the latter indicates starvation.

Fats can be added in place of sugars, but this should be done with care. Codliver oil has given us the best results. It should be given in small quantities at first, beginning with 1 mil twice daily, and increased to 4 mils per dose.

In some infants the above-described treatment is unsuccessful. In one group of these cases the loss of weight is not favorably influenced, while the stools improve; and in a second group the loss continues with continued diarrhea. In these cases there is either infection or they are cases of grave nutritional disturbances on transition to decomposition. It would be a very great mistake to continue starvation longer, with the idea that by giving the digestive tract longer rest, it may still recover. This may kill the child. In these cases treatment as recommended for decomposition or infection must be instituted. Therefore, it is advisable to use routine treatment as described above, and, if not successful, the underfeeding should not be continued under any circumstances, but the treatment for decomposition (described later) or infection (see Infections) should at once be instituted, if human milk is not obtainable.

It is in these cases that Finkelstein's albumin milk is indicated. (See p. 292, for preparation, and p. 236, for method of administration.)

Chronic Cases. In treatment of chronic forms there is no indication for underfeeding. Since here there is no transitory weakness, but a chronic weakness of tolerance, the additional trauma of starvation would have an unfavorable influence. Carbohydrates are to be reduced to the amounts absolutely necessary (about 2 to 3 per cent), and the less easily assimilable carbohydrates are to be replaced by those that are more easily assimilated (maltose-dextrin mixtures). If this does not improve the stools, then nursing on the breast or albumin milk feeding is necessary. If both of the latter are not available, then the quantities of foods should be carefully measured, with the hope that when the child becomes older the tolerance will become physiologically increased, and the condition thereby undergo spontaneous healing.

Medicinal Treatment. This is unnecessary in most cases. For the treatment of irritative conditions which persist even after the dyspepsia proper (loose stools in presence of gain in weight), astringents are of use. Tannigen or tannalbin 1 to 5 grains (0.065 to 0.325 Gm.) four to five times daily will answer, or calcium lactate in doses of 10 to 15 grains (0.65 to 1 Gm.) may be prescribed in a 10 per cent. solution to be added to each milk feeding.

CHAPTER V.

THE STAGE OF DECOMPOSITION.

Synonyms: Marasmus, atrophy, pedatrophy.

The third stage of impaired nutrition in the classification of Finkelstein, called by him *decomposition,* is recognized by him as what has been described in pediatric literature as marasmus or atrophy. The clinical picture may be viewed as the end result of repeated nutritional disturbances or constitutional factors. The past history is of the utmost importance, and a careful search reveals improper diets, with resulting disturbance of nutrition, or a nutritional disturbance following enteral or parenteral infections, each leaving in its wake evidence of impaired nutrition, until after weeks or months we have reached the stage of deep-seated tissue starvation. The chronic infections, such as syphilis and tuberculosis, may also result in a similar picture, but must be differentiated to clear the classification for therapeutic purposes.

During this stage it becomes increasingly difficult for the infant to assimilate a sustaining diet, with resulting extreme loss of weight, and great lack of resistance of the organism to infections and other injurious external influences (heat, cold), this general weakening of the vitality of the infant being due to perverted metabolism, consisting of breaking down of the body substance, and change in the composition of the cells (abnormal katabolism), and of deficient and improper assimilation of the food (abnormal anabolism).

Etiology. Disturbed metabolic balance may be the direct forerunner of decomposition, if the dietetic error is not corrected; likewise all factors leading to dyspepsia and intoxication may also be forerunners of decomposition. At what moment this change takes place we have no means of telling, but we know that deep-seated organic changes are necessary to its development; these changes which produce such an intolerance toward nourishment may have developed previously to the preceding illness, or during its course. Premature infants are especially predisposed, also young infants with previous dietetic errors and diarrheal attacks, also those fed on a one-sided diet, excessive in carbohydrates, especially cereal waters and gruels, as seen in too long continued hunger diet. Especially to the very young does the statement as to cereal waters and gruels apply. All of the preceding reduce the tolerance toward assimilation of a full and normal diet. The tendency to decomposition, and therefore to the narrowing of the nutritional sphere increases with each dyspeptic attack. Czerny's internal hunger, or, as he commonly calls it, "cell hunger," is the cause of decomposition. The above term is used in contradistinction to hunger as usually thought of, which is due to a lack of food to appease the appetite.

Pathogenesis. In the older literature the terms *marasmus and atrophy* were used to describe the clinical picture as presented by this condition. And it was assumed that destructive changes in the intestinal glands following chronic inflammation, with a secondary impairment of the functions of absorption and excretion, were the underlying pathological conditions, which resulted in an inanition. This, however, has been found to be erroneous, since repeatedly the intestine of the atrophic infants was found to be normal.

The great and sudden fluctuations in weight as seen in this condition must in the first place be due to loss of water and salts, while the disintegration of the body substance, including the cells, furnishes only a smaller quota to the loss of weight.

The researches of Czerny on metabolism have thrown considerable light on this condition. The abnormal splitting of sugar and fats contained in the food produces excessive amounts of acids in the intestines, which results in the loss of alkali salts, first, through neutralization of the acids formed in the intestinal tract from the food, and secondly, through salt losses due to excessive intestinal secretion, as seen in this condition. These abnormal processes result in a relative acidosis, an acidosis of enteric origin. And as a result of such, enteral loss of salts and markedly increased NH-excretion takes place, which is evidenced clinically by increase of ammonia in the urine.

To cover these losses, salts deposited in the tissues are in part withdrawn, and finally the cells themselves are destroyed through being deprived of their salt content (mineral hunger). It should be remembered that an abnormal fat metabolism is frequently the essential factor in the etiology of this condition, due to an overstepping of the fat tolerance. And further that fermentative changes in the carbohydrates produce increased acidity of the contents of the intestinal canal, and so enhance the action of fats. While there is usually an excess of protein loss over protein assimilation, the tolerance for proteins is usually less affected. Because of the loss of nitrogenous substances due to a relative excess in excretion of NH, proteins must be utilized in the diet to counteract these losses.

Increased peristalsis in diarrheal conditions results in further inanition, due to the passing of undigested food through the intestinal tract. The "decomposition" of the organs essential to life finally leads to an alteration of the condition of the cells and of their functions, which results in the death of the organism.

Symptoms. The cardinal symptoms of decomposition are intolerance to food and great loss of weight.

1. Lack of ability to assimilate food is pathognomonic of this condition. The paradoxical reaction to food,

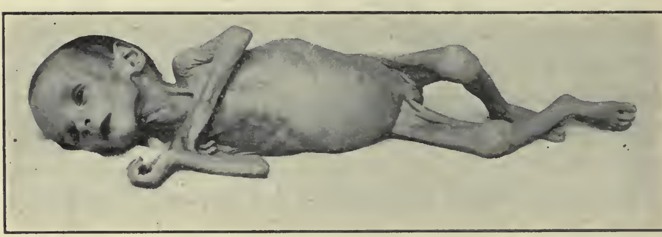

Fig. 11.—Infant with decomposition.

mentioned in the two preceding stages of nutritional disturbances, becomes here a striking and serious phenomenon. Starvation or the institution of the *hunger day* as a therapeutic measure in these infants not infrequently results in an inanition which is fatal to the infant. Again, too rapid increases in the diet are equally serious, and not infrequently precipitate alarming and fatal symptoms. When the condition has progressed to this degree, human milk alone offers hope of recovery.

2. Loss in weight is the second cardinal symptom of decomposition, due, as the name of this condition suggests, to disintegration of the body substance. This may be slight in the beginning, and in the light cases; in the

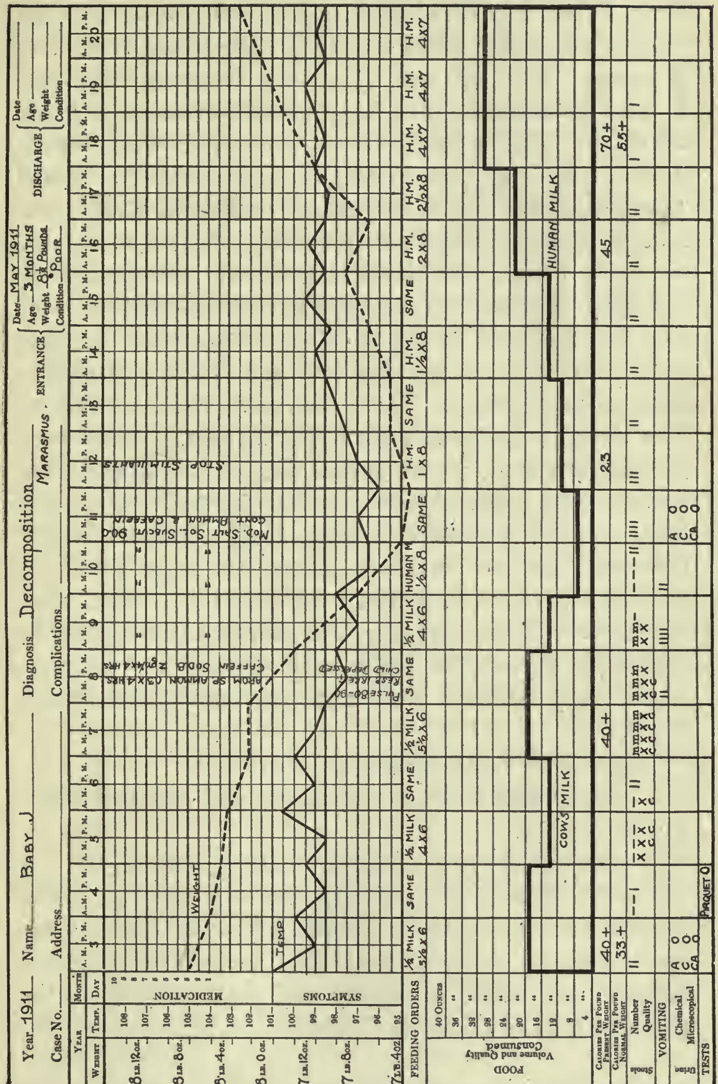

Fig. 12.—Chart showing hospital record of infant with decomposition.

later stages and in severer cases, however, it is often sudden and rapid, and may reach daily losses from 1 to 3 ounces (30 to 100 Gm.), resulting eventually in a picture of marasmus. The baby becomes thin, emaciated, wrinkled, with prominent ribs, covered with tightly drawn skin, and with intercostal spaces deeply marked (skeleton-like). The tissues are soft and flabby, the muscles either relaxed or hypertonic, the abdomen protuberant, usually distended, the color, pale first, later changing to characteristic grayish-white, with more or less cyanotic lips, fingers and toes. The mouth appears large, the cheeks sunken, and the facial expression anxious and serious. These characteristics give the infant the appearance of a wrinkled old man. As has been previously stated, in the earlier stages, these babies are irritable and apparently in constant distress, cry a great deal, and are excessively hungry. In the later stages, however, they are often apathetic, and apparently too weak to perform voluntary movements. When they have reached this stage, they are subject to sinking spells —that is, periods in which their vitality is very low. These may become very alarming, and often result fatally.

3. Vomiting is frequent.

4. The hunger is often very great, and extremely difficult to satisfy.

5. Subnormal temperatures, ranging from 96° to 98° F., with an irregular daily curve is the rule. The temperature can easily be raised to 100° or more by the application of artificial heat (hot water bottles, etc.), and can sink quite as rapidly and alarmingly when the artificial heat is removed.

6. The pulse is often slow and small, and the heart-beats weak, and often only one heart tone is heard at the apex.

7. Respiration becomes rapid, and the expirations prolonged. The breathing becomes irregular, even to the Cheyne-Stokes type.

8. The sensorium is not involved in these infants, and when not too weak they take cognizance of their surroundings, are alert, and sleep but little.

9. The urine usually shows an increased ammonia output. It may contain albumin, but very rarely sugar.

10. The stools are variable, mostly dyspeptic, occasionally diarrheal. In the earlier stages and in periods of remissions they may be quite firm (soap stools), again soft and firm stools may alternate. The hunger stool—small, dark, and containing much mucus—is common, especially in advanced cases, with an inability to take proper diet. Dark-brown, black, and tarry stools indicate usually hemorrhages from ulcers in duodenum (Helmholtz). We therefore learn to recognize the character of the stools as being only of secondary importance in the diagnosis, and also of secondary importance for treatment. We must not be misled into further starvation because of temporary changes in character, even for the worse, of the stool, due to the changes in the diet instituted for therapeutic purposes.

11. These infants are peculiarly susceptible to infections, and even slight infections of the skin, respiratory, gastro-intestinal, and genito-urinary tracts may prove fatal.

12. Edema, cyanosis, and a more or less generalized purpura are not infrequently forerunners of an impending death.

Diagnosis. The diagnosis in severe cases may be made from the clinical picture of the condition, but it is necessary to exclude emaciation due to tuberculosis, syphilis and cachexia caused by other disease, and also by simple inanition, due to prolonged underfeeding. This is to be based on the history and examination of the infant. In lighter cases it is necessary to differentiate especially from disturbed metabolic balance and from simple dyspepsia, since the treatment which improves these conditions may do considerable harm in infants suffering from decomposition. The status præsens is not sufficient for making the diagnosis, since, as previously mentioned, remissions with stationary weight and good stools often occur. In these cases the history is of utmost importance: repeated diarrhea, loss in weight and febrile infections should lead one to suspect decomposition. The positive diagnosis is made upon the reaction of the infant to food. If on somewhat increasing the diet a marked and severe paradoxical reaction appears (diarrhea, loss of weight, and occasionally fever), decomposition should be suspected.

Prognosis. We must remember that while primarily the picture of the disease is a nutritional one, the death is frequently brought about by infection.

The prognosis depends on the following factors: (1) The stage of decomposition. When the loss of weight has reached one-third of the body weight (Quest's figure), then the reparation under any treatment seems to be impossible. (2) The nature of the dietetic treatment, and especially the possibility of feeding with human milk. If one avoids the common errors, even the severe cases may be saved, except when the treatment is started too late. (3) The extent of the lowered immunity. The prognosis should always be guarded.

Improvement is common even in severe cases, but there is a great tendency to sinking spells and collapse. Death in these cases is sometimes remarkably sudden. It usually occurs in one of the following ways: (1) By sudden syncope. (2) By apparent paralysis of the respiratory center. Periods of apnea usually precede the latter. There is no disturbance of consciousness. The face looks gray, and the eyes are staring. The breathing becomes irregular and slow, the heart weakens, the temperature sinks far below normal, cyanosis increases, and breathing gradually stops. Sometimes the heart stops first. Such death may extend over days.

Treatment. Prophylaxis is the key-word to successful treatment. A recognition and proper interpretation of minor nutritional disturbances will avoid the graver conditions.

For a proper conception of the therapeutic needs we must recognize:

1. That we have a chronic condition which is subject to acute catastrophes.

2. That the younger the infant and the greater the preceding dietetic errors, the graver are the consequences of decomposition.

3. That starvation is dangerous.

4. That food is assimilated with difficulty.

5. That the downward weight-curve is likely to drop suddenly with improper feeding and intercurrent infection.

Two essentials are necessary to the successful treatment of the majority of cases of decomposition: (1) avoidance of prolonged starvation, and (2) human milk. It is the misfortune of most of these infants to have their abnormal stools, or more commonly, the hunger stools previously described, interpreted as an indication for starvation, regardless of the fact that the baby is already starving. It has been our experience not only to have seen one day of starvation, but repeated periods of starvation the rule, because of misinterpretation of the significance of the "starvation stools." A single day of starvation is often sufficient to kill an advanced case, and even prolonged underfeeding, below 60 calories per kilogram (the amount required to sustain the body equilibrium), has a very harmful effect. Starvation from without is thus added to inanition from within.

1. *Feeding with Human Milk.* It must be given in moderate quantity, best guarded by drawing off and feeding, as these infants drink too rapidly (always hungry), and do not stand large amounts. About 200 to 300 mils daily is enough to sustain the infants temporarily (60 calories per kilogram is sustaining—Rosenstern). Feed often; ten feedings may be given, one every two hours (10 to 20 mils), weak tea or saccharin water *ad libitum* between feedings. The daily quantity should be increased as rapidly as possible (at least every other day), until not later than after 7 to 10 days about 100 calories (130 to 150 mils) per kilogram are administered. The number of feedings should gradually be decreased as the condition improves, and direct nursing on the breast may be tried later, but the danger of overfeeding must not be overlooked.

Weight may still not improve for some time. This Keller calls *"reparation stage."* Even on feeding with human milk there is a shorter or a longer period of stationary weight (depending on the severity of the case), which, however, is accompanied by improvement of the symptoms. Those who have not had experience in these cases may be inclined to blame the wet-nurse, and advise a change. This, however, is constant in the stage of reparation, in which the body is being reconstructed, without being able to put on weight, this being partially, at least, due to still deficient absorption, and partially also to the fact that the human milk, containing comparatively small quantities of proteins and salts, furnishes only a limited quantity of material for rebuilding of the body. Only after this period the gain in weight begins. This may be shortened by feeding daily 100 mils of boiled buttermilk or skim milk, which is rich in salts and proteins, both of these substances hastening weight increase. This is not to be done until after the third or fourth week of treatment, and with a close observation of the results. It may be fed by mixing with and distributing through the breast feedings.

Carbohydrates should be added with even greater care, adding 4 Gm. at a time to the day's feeding. In older infants a small amount of farina soup or zwieback in tea may be tried later.

The complete recovery is not to be expected sooner than in two to three months. And only then should the return to artificial feeding be thought of. The weaning should be preceded by experimental administration of small quantity of whole cow's milk, as there is a possibility of idiosyncrasy to cow's milk.

2. *Artificial Feeding.* If there is no possibility of feeding an infant suffering from decomposition otherwise than with artificial food mixtures, then the same rules are to be followed as have been given for dyspepsia. In this condition also the first thought should be of boiled buttermilk and skim milk mixtures, with a low percentage of fat, diluted with gruels, and containing a moder-

ate quantity of slowly fermentable carbohydrate, such as maltose-dextrin compounds (see Appendix), fed in small quantities at frequent intervals.

In mild cases feedings of 30 mils (1 ounce) 8 times daily, and in severe cases 10 or 12 feedings of 15 mils (0.5 ounce), may be given in the twenty-four hours. The buttermilk can be replaced by skim milk, if the former is not well taken. Flour ball or dextrinized barley flour can be used in place of ordinary wheat flour to advantage, and maltose-dextrin compounds can be used in place of cane-sugar.

Brady's mixture No. 1 can frequently be used to better advantage in the same quantities (see Appendix, p. 284).

The individual meals should be increased so as to meet the infant's caloric needs as rapidly as the condition allows.

While in simpler forms of nutritional disturbances the intestine recovers within a short time to such an extent that the feeding may be more liberal, in severe decomposition the increase of food is often followed by aggravation of the condition. Administration of farinaceous foods alone is also risky, because of the danger of further inanition. From this it becomes apparent how limited is the outlook for good results in the extreme cases of this condition with artificial feeding, especially when occurring in very young infants.

Recent experience, however, has taught us that the boundaries of curability can be considerably broadened by the use of the albumin milk of Finkelstein. The object of the albumin milk is to limit as much as possible the injurious acid fermentation, which is accomplished by diminution of the percentage of milk-sugar below that contained in cow's milk, by the removal of some of the whey, whereby the tolerance of the intestine for the sugar is improved. By the administration of large amounts of finely divided casein as contained in the albumin milk, alkaline reaction is produced which is antagonistic to acid fermentation. It also contains over 2 per cent. of fat, which can be digested by these infants in all probability because of the small quantity of sugar and salts contained in the albumin milk.

The advantage of the treatment with albumin milk consists in the fact that it is possible to reach sufficient feeding quantities much more rapidly than with most other artificial foods, without the danger of exciting anew the fermentative processes. Thereby the danger of inanition is avoided and reparation is accelerated.

In the *mild* cases of decomposition we start after an interval of six hours on tea, with administration of 300 mils of albumin milk, with an addition of 3 per cent. of maltose-dextrin preparations (milk-sugar is not advisable, and even the cane-sugar is not so reliable), divided into 5 or 6 meals, and with further addition of tea. In the days that follow, without paying any attention to the stools, the quantity of albumin milk is increased, every other day by 100 mils. In the presence of firm stools it is increased even more rapidly, until a daily quantity of 180 to 200 mils per kilogram (3 ounces per pound body weight) is reached. A total daily quantity of 1000 mils of albumin milk is rarely to be exceeded. In typical cases dry fat-soap stools appear after one to two days, this is followed by cessation of weight loss, and reparation proceeds undisturbed.

After the quantity of food necessary to sustain the infant is reached, sugar may be gradually increased from

3 to 5 per cent. Dextrinized starches in the form of flour ball (imperial granum), or dextrinized barley flour in quantities of 1 or 2 per cent. of the mixture, can often be added to advantage to albumin milk before adding sugars.

In *severer grade* of decomposition the intestine is also to be evacuated by a short period of hunger. In spite of the danger of inanition, six, or at most twelve, hours on tea cannot be avoided. This is to be followed by the administration of albumin milk, best with frequent meals (8 to 10), on the first day 200 to 300 mils, and then, as previously advised, rapid increase with gradual diminution of the number of meals and increase in the addition of carbohydrates. If the initial loss in weight does not stop within three to four days, and if the child shows languor and tendency to subnormal temperature, then the addition of carbohydrates must be increased, even in the presence of frequent stools, until the loss stops.

If we proceed in this way, then the number of unsuccessful cases becomes considerably smaller. Experience has shown that in albumin milk therapy often an error is made which frequently leads to failure by underfeeding. It should be remembered that albumin milk has a caloric value of only about 12 to the ounce, and therefore this feeding must be carefully guarded to avoid (1) too slow initial increase, thereby prolonging inanition, (2) omission of carbohydrates or insufficient increase of the same, (3) repeated restriction of the quantity of the food, or withholding carbohydrates when the temperature rises or diarrhea reappears. All these are to be avoided. Only when sudden loss in weight and violent diarrhea set in, should the total quantity of the food be reduced.

After disappearance of these acute symptoms the increase must be made as soon as possible.

In the beginning of the treatment with albumin milk, exacerbations similar to those that occur on feeding with human milk may occur, and these should not lead to starvation. Later, the gain is rapid, provided that sufficient quantities of carbohydrates have been added.

The duration of feeding with albumin milk is about six to eight weeks for the younger infants, and four to six weeks for the older infants. After this time the disease is cured usually to such an extent that ordinary milk mixtures, corresponding to the child's age and weight may well be taken. The change is best made by replacing all the feedings of albumin milk mixtures at one time. This is frequently followed by bad stools for a day or two, which should not lead one to discontinue the new diet. The quantity, however, should not be further increased until they show some improvement.

If a relapse occurs, then it is necessary to return to feeding with albumin milk for some additional time.

One may speak of a complete cure of this nutritional disturbance in an infant only when, after discontinuation of albumin milk and return to the usual milk mixtures, with careful dosage; the development proceeds without any disturbance.

Medicinal Treatment. This is practically limited to stimulation in the presence of collapse and sinking spells, and the favorite stimulant is camphor given intramuscularly in the form of a sterilized camphorated oil (5 to 10 drops every two to four hours). Alcohol is apparently of benefit in severe cases. Five to 15 drops of whisky or brandy every two to four hours. In the severer types transfusion is also indicated.

Artificial heat must be applied in all cases with a decided tendency to low temperatures. This must not be overdone, since the child's temperature can easily be raised above the normal, and act as unfavorably as subnormal temperature.

CHAPTER VI.

THE STAGE OF ALIMENTARY INTOXICATION.

Synonyms. Gastro-enteric intoxication (Holt), catarrhal enteritis, cholera infantum, summer diarrhea.

Definition. This is not a disease, but a general toxic state, characterized by a symptom-complex in which diarrhea and irritability of the central nervous system are the most characteristic signs of the toxemia.

The graver the preceding nutritional disturbances, *i.e.*, the closer the infant approaches the stage of decomposition, the more readily does the stage of intoxication develop. *Collapse and nervous symptoms outweigh the intestinal symptoms.*

Etiology. All factors which cause nutritional disturbances can be active factors in the causation of intoxication. Although frequently a primary food disturbance, it is more commonly seen as a food disturbance secondary to some other factor. Among the most important of these are:

1. *Food.*

   (*a*) Combination of food elements which individually would be insufficient to cause a disturbance.

   (*b*) Infected food—that is, spoiled milk, not commonly due to the bacteria themselves, but to their activity on the fats and sugars, and the formation of toxic bodies (Czerny and Keller).

2. *Infections.* They are not due to a single factor. We must believe that the infections injure the intestinal

wall and other digestive organs. From this point the pathogenesis is the same as in alimentary intoxication. The toxic influences of different infections are as different as are the infections.

(*a*) Gastro-intestinal infections (enteral infection). (See chapter IX.)

(*b*) Systemic infection, as otitis, cystitis, pharyngitis, etc. (parenteral infection). Intoxication is frequently seen following in the wake of or occurring during infections due to the disturbances in the digestive functions. (See chapter IX.)

3. *Heat.* This can cause a chain of symptoms resembling intoxication. As to the exact cause there has been much speculation, and it is not yet satisfactorily settled. We cannot overlook the fact that in many cases a chain of symptoms resembling intoxication is seen, seemingly due to bacterial action on the milk, and the subsequent production of toxic bodies.

These facts are established: that infants are greatly depressed and debilitated by heat, and therefore can stand less food in the hot months. It is also true that less food is required during the summer months to nourish an infant, and this should be taken advantage of as a prophylactic therapeutic measure. Unfortunately, this is not heeded in many cases, because the child is more thirsty, and, its food being liquid, quenches its thirst, and is therefore given in excessive amounts; and secondly, because the cry and discomfort due to the same overfeeding and heat are interpreted as hunger. It should therefore be the duty of the physician to warn against excessive feeding during the hot summer months; that these latter are factors is evidenced by the fact of their prevalence among the poor and ignorant. Summing up the situation, we can state with positiveness that all depends upon the individual resistance; a more severe irritant is necessary in those suffering with disturbed metabolic balance and dyspepsia than in the atrophic infants to develop the stage of intoxication.

To recapitulate: to develop intoxication there must be a pre-existing nutritional disturbance or an injured intestinal epithelium. Enteric and systemic infections, as well as heat, predispose to intoxication through their action on the cells of the digestive apparatus of the intestinal and secretory glands, and general systemic effect. The resemblance of these cases to an infection naturally leads to the belief that they are due either to infection of the intestinal mucous membrane or to the absorption of bacterial toxins from spoiled milk. While infections or toxins may cause a similar picture, in a large group of cases they will not explain the clinical findings—first, because the symptoms disappear upon withdrawal of the food; secondly, they may appear during the feeding of aseptic milk as well as septic, and that no pathological findings are found that could explain the symptoms. Again, increases of food above the child's tolerance will cause relapses, and food withdrawal will again cause a rapid improvement.

Pathogenesis. Several factors, either individually or together, can cause the group of symptoms characteristic of alimentary intoxication.

1. The symptoms may be due to the toxicity following absorption of imperfectly elaborated products of the intermediary metabolism. These are the type of cases described by Finkelstein in his "Food Injuries," and represent the fourth stage in the progressive intolerance for

food. The less the infant's tolerance, *i.e.,* the closer it approaches the stage of decomposition, the smaller the amount of food necessary to produce an intoxication (Finkelstein). The precipitating factors are the same as in dyspepsia—that is, the sugar and whey (lactose and salts) content in the food—but here we have a more severe picture. The alimentary glycosuria, which frequently occurs, is evidence of a disturbance in the carbohydrate metabolism. Sugars of the type ingested may be seen in the urine long before the end of the proper assimilation period. This ceases when the sugar is withdrawn from the diet. Fat can also produce toxic symptoms, but this can in all probability occur only after the sugar has acted harmfully, or when the infant is in or approaching the stage of decomposition, or after a severe infection has seriously affected the infant's metabolism. This in turn, together with the hunger and loss of alkalies due to vomiting and diarrheal stools, may bring about an injury to fat metabolism which may be evidenced as an acidosis. Meyer found fat absorption reduced from 97 to 60 per cent. This improves early in convalescence. Splitting of fats is bad, and we get an acidosis with the presence of acetone and aceto-acetic acid, butyric acid, etc., in the urine (Rosenstern). When this stage is reached, there is also another probability—that of interference with protein metabolism; but whether or not this has any effect upon the picture rendered by intoxication is open to question. It is questionable whether the salt loss is the primary cause of the water loss, or whether the loss of water by the system has its own pathogenesis. Indeed, it would require a great salt loss to account for the great loss of water, and it is quite possible that a toxic influence results in a disturbance of the water-binding property. The great water loss also causes accumulation of toxic products and products of metabolism in concentrated solutions.

In such a general failure of metabolism, we have to assume a severe damage of the corresponding organs and cells. We have, therefore, when the picture is complete, an insufficiency of all the functions of the intermediary metabolism (*metabolic bankruptcy*—Finkelstein).

2. The symptoms may be due to a *relative acidosis* dependent upon an excessive loss of bases, more especially sodium, by way of the alimentary tract, through vomiting and the diarrheal stools. This is evidenced clinically by the increased ammonia content of the urine. From 40 to 50 per cent. of nitrogenous compounds of the urine do not appear as urea, but as ammonia, the ammonia being used to unite with the acids which are in relative excess in the blood. Howland and Merriet found in their investigations of toxic diarrheas that not alone was the acidity of the blood increased, but that there was a positive evidence of acidosis, as shown by the diminution of carbon dioxide tension of the alveolar air. They also found an increased tolerance for alkalies in these infants, in which they resemble other forms of acidosis.

3. The type secondary to the enteral and parenteral infections. In this group, two further factors are of importance—first, that due to bacterial invasion in the infections; and second, the danger of absorption of the toxic products of bacterial fermentation of food in the intestinal tract.

Even in the infective types, the several factors, absorption of toxic products of the intermediary metabolism, the relative acidosis due to alkali losses through the stools, and, lastly, the absorption of toxic products from the intestinal canal, may all be constituting causes.

4. The large group of cases seen during the hot summer months are probably due to a combination of factors, —systemic depression, spoiled milk and bacterial invasion.

We have, therefore, a clinical picture dominated by nervous and intestinal symptoms which may be caused by a variety of factors. The manifestations may be the end result in the cause of chronic nutritional disturbances, with a steady tendency toward metabolic bankruptcy, or, as in the case of the third and fourth groups, the effect may acutely follow the absorption of products of bacterial fermentation from the intestinal tract in infants often previously strong and healthy. In all of them a secondary relative acidosis due to salt losses through vomiting and diarrhea is a serious complication. Again, it may be quite impossible to decide in many cases whether the products of intermediary metabolism, the secondary relative acidosis, or the toxic products of bacteriological fermentation are the most important factor in the causation of the clinical manifestations on the part of the nervous system.

Symptoms. 1. *Fever.* A rise in temperature is the first symptom of an alimentary intoxication. It may be slight, or it may go up to 104° or even 106° F. The height of the temperature is not always a direct indication of the severity; in fact the several types associated with decomposition may have a low temperature. If the case be one of true intoxication, prompt withdrawal of the food is usually as quickly followed by a lower temperature. However, if the offending food is continued, we soon have other symptoms suddenly and to an alarming degree.

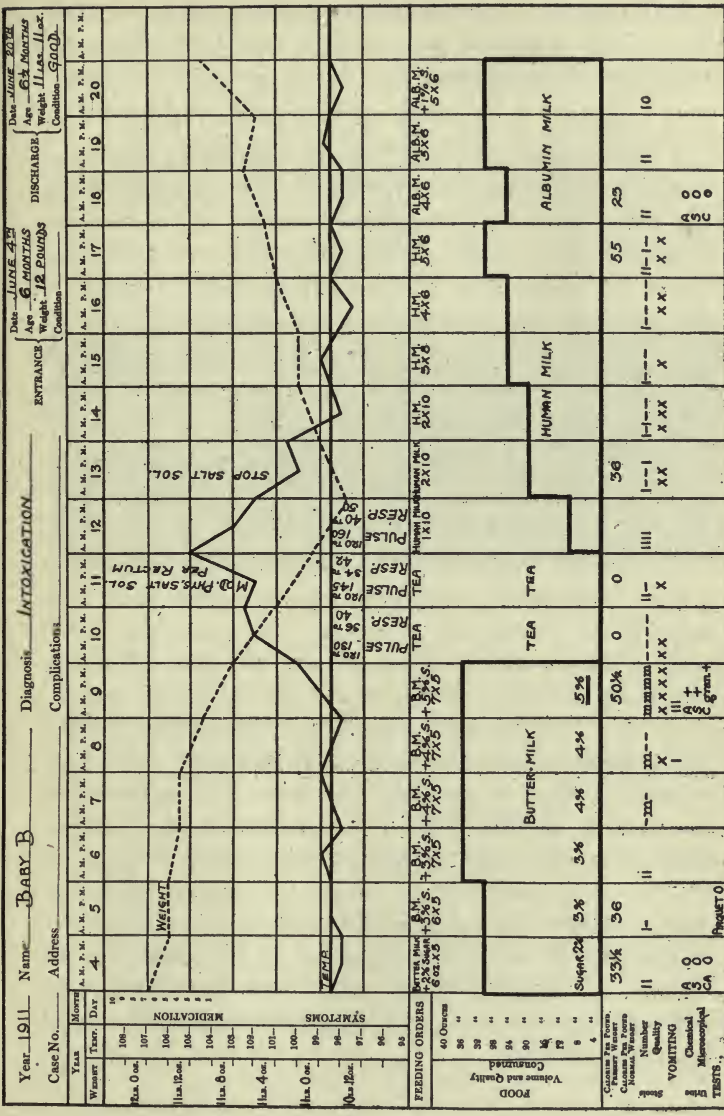

Fig. 13.—Chart showing hospital record of an infant with intoxication.

2. Rapid *loss in weight,* even 1 to 2 pounds in a few days. This is mainly due to loss of water. The skin becomes dry and inelastic.

3. *Vomiting* is frequent, and may contain blood.

4. The *stools* are liquid, usually numerous, and contain mucus, and occasionally blood. In the severest cases —cholera infantum—the stools assume a rice-water appearance, move almost continuously, and are often associated with tenesmus, and not infrequently prolapse of the rectum. Exceptionally, an obstipation is seen in place of the diarrhea, and when this is associated with vomiting and abdominal distension one cannot help but think of intestinal obstruction.

5. *Collapse.* The skin is gray in hue, and becomes wrinkled. The eyes are sunken, with distant stare, and the nose assumes a pinched appearance.

6. *Nervous symptoms and psychic disturbances are usually pronounced,* and often lead to a confusion with meningitis. The infant is restless; the sensorium is disturbed, with an occasional cry as if in pain; the hydrocephaloid state may be present, with strabism, convulsions, etc. Before these more severe symptoms develop, the child appears apathetic, drowsy, and dopy. The face assumes a fixed expression, and there is a tendency on the part of the infant to lie constantly in one position, and when the child moves its extremities it does so slowly, as if too tired or weak to change its position. The arms are not infrequently flexed in an attitude resembling that of a prize fighter. If the condition increases in severity, stupor and coma, associated with twitchings, convulsions, strabismus, and other meningeal symptoms, ensue.

7. Typical respirations (deep, rapid, without pause), described as toxic respirations. The respiratory manifestations may vary from a slight increase in number and depth to a marked dyspnea.

8. Glycosuria is a frequent finding in the type due to "food injury," and the sugar is of the same variety as that in food; thus, milk-sugar leads to lactosuria and galactosuria. This glycosuria, which is of alimentary origin, disappears with the withdrawal of the food. The

Fig. 14.—Infant with intoxication.

phenylhydrazin test is the most reliable to make, as the copper sulphate tests require long boiling with lactose, etc., and the reaction may be overlooked.

9. The urine contains albumin and casts. The amount of urine is small, even to anuria.

10. Leukocytosis is present up to 30,000.

11. The heart action is weak, and the pulse small and irregular.

12. Sclerema is constantly seen in the severer types—a very bad sign—due to a coagulation of tissue fluids of an unknown nature (Czerny and Keller).

13. Enlargement of the liver accompanies the severe types.

Pathology. In the small intestine there is usually no marked change. Hyperemia of the mucous membrane and enlarged follicles, especially Peyer's patches, are usually present. The liver shows a hyperemia, cloudy swelling, and fatty degeneration (probably causing hepatic insufficiency).

Diagnosis. The diagnosis is based on the above symptoms, and improvement on withdrawal of food. The most characteristic and striking symptoms are those of the nervous system resulting in stupor, pauseless respirations, and a toxic appearance. These are associated with diarrhea, vomiting and a rapid loss in weight. The history of preceding nutritional disturbances and infections are of great importance in diagnosis.

Prognosis. This depends much on reaction to hunger diet, as very severe symptoms disappear often in twenty-four hours of starvation in the "food injuries." If the same do not disappear in this time in this class of cases, in the absence of infection, the prognosis is bad. Infections add to severity.

Treatment. 1. Removal of all food for twelve to twenty-four hours, with sufficient water administration.

2. In severe types, subcutaneous salt infusions twice daily, 100 to 200 mils. Ringer's solution may be used to advantage for this purpose.

	Gm. or mil
NaCl	7.5
KCl	0.1
CaCl	0.2
Water	1000.0

The water used in making this solution should be redistilled shortly before using.

If the infant presents evidence of acidosis, sodium bicarbonate and dextrose may be added to the Ringer's solution, and administered intravenously in young infants through the longitudinal sinus, and in older infants into the anterior jugular or median basilic vein.

About 4 Gm. (60 gr.) of sodium bicarbonate and 6 Gm. (90 gr.) of dextrose may be added to 120 mils (4 ounces) of saline solution, and repeated in four to six hours if indicated.

It should be remembered that intravenous administration of large amounts of sodium bicarbonate may result in collapse.

Pure dextrose is essential (Kahlbaum's is a good product). If dextrose appears in the urine, the administration should be stopped.

3. Salines per rectum, best administered by the drop method. Thirty drops per minute for four hours is 450 mils. One-half strength of Ringer's solution may be used. Sodium bicarbonate, 5.0 Gm. (75 gr.) may be added to every 500 mils of the solution (1 per cent.).

4. One lavage, if food has been given shortly before, or if vomiting is severe.

5. Avoid all laxatives, as the bowels empty themselves, and any further purgation increases the loss of salts and water, and increases the tendency to development of an acidosis.

6. Analeptics. Give a mustard bath in case of collapse. Reddening of the skin is a good sign.

7. Antipyretics. Use tepid packs, and leave the infant undressed. Ice-cap to head is useful, but should not be applied directly to the head, because of the thinness of the skull in young infants.

8. Stimulants. In collapse, warm packs or baths are indicated. Caffein sodium benzoate, 0.006 Gm. to 0.030 Gm. (0.1 to 0.5 gr.) four or five times daily; camphor-

ated oil in 1-mil doses every two hours hypodermically if indicated; epinephrin solution, 0.5 mil (1 to 1000), subcutaneously or intravenously.

9. Sedatives for convulsions. Sodium bromide 0.2 Gm. to 0.3 Gm. (3 to 5 gr.) repeated in three to four hours; veronal, 0.05 Gm. Chloral hydrate is best avoided.

10. Opium may be indicated when the diarrhea remains uncontrolled by other methods. Paregoric in suitable doses per mouth, or the tincture per rectum may be used with care.

11. An electric fan is a most valuable addition to our therapeutic measures in summer.

12. Lumbar puncture may be indicated in the presence of increased intracranial pressure, and for diagnostic purposes.

13. Diet. *Hunger diet* should be employed rarely longer than twenty-four hours. Occasional administration of dilute saline solutions ($NaCl$ 5, $NaHCO_3$ 5, water 1000) per mouth, or thin gruels may soon be used with care to supplement an occasional feeding. When infant is stuporous, water should be administered by gavage at regular intervals of about three to four hours.

In cases of food intoxication, twenty-four hours on a hunger diet causes striking changes. The child looks bright, smiles, and to all appearances looks convalescing, notwithstanding a usual loss of weight. The stools also become less frequent, and although small and containing mucus (hunger stools), they cause less irritation of the buttocks and little loss of water. The improvement is no less striking than that seen in the crisis of pneumonia.

Human Milk. Human milk is by all means the best food. Feed often, and in small amounts, ten times daily, 5 mils from bottle or spoon. The infant may also be placed directly at breast for one- or two- minute periods in less severe cases. Increase when the temperature, etc., do not react to food, and then not more than 50 to 100 mils daily increase at first. After several days, if the infant shows no evidence of relapse, it is again placed unrestrictedly on the breast. If this is done too soon, reintoxication occurs. A too prolonged starvation adds the danger of inanition.

A sustaining diet should be reached in eight to ten days (32 calories per pound), after which the child can be put on the breast five times daily. Weigh infant before and after feeding, if placed at the breast. If the elevation of temperature returns, except in the presence of infection, cut down the food. The gain in weight is very slow in the stage of repair on human milk, due to the low protein and salt content.

Cow's Milk. For the first few days after the hunger day, a food low in fat and sugar should be fed, because of the lowered tolerance. One-half skim milk or buttermilk, boiled or citrated without sugar, will answer, but should be fed in small quantities, 10 times 5 mils daily, then 10 times 10 mils. On this low diet weight loss and temperature will usually stop. There is, however, again great danger from underfeeding too long, so that these infants offer every indication for our best judgment. At all times plenty of indifferent fluids should be administered between feedings. After ten to fourteen days, 32 calories per pound may be fed. Less rapid increase than in human milk feeding should be the rule. Older infants can be given gruels in their milk. Recurrence of dyspepsia is an indication for return to indifferent foods. With a second recurrence breast milk is absolutely indicated.

Return to carbohydrates should be made with great care, adding 1 per cent. to the food mixture, and increasing to 5 per cent. with continued improvements. The maltose-dextrin compounds are best for this purpose.

Albumin milk is indicated in this condition, and the following is a good working rule for its use in these cases: First day, tea. Second day, 10 times 5 mils albumin milk with tea *ad libitum*. Increase 50 mils daily until stools are good; then further increase 100 mils daily until 180 to 200 mils are given for each kilogram of body weight (3 ounces per pound). After the stools are firm, add sugar to the food, and increase gradually to 4 per cent. Dextrin-maltose compounds are best. In intoxication we have obtained better results by at first feeding albumin milk without sugar addition, but containing 1 per cent. of flour (flour ball). After six to eight weeks an ordinary milk mixture may be fed. Feedings can now be reduced to five or six daily. Never feed over 1000 mils a day of albumin milk. Before this amount can be digested we have usually reached the point where sugar can be added to meet the caloric needs of the infant.

CHAPTER VII.

MIXED FORMS OF NUTRITIONAL DISTURBANCES.

Disturbed metabolic balance is frequently associated with dyspeptic symptoms. Again, these may show signs of intoxication. Decomposition is the form most subject to complication.

Treatment. Disturbed metabolic balance with dyspeptic symptoms is to be treated as dyspepsia, by reducing the diet. In dyspeptics with signs of intoxication employ hunger diet, etc.

Decomposition complicated by intoxication is the severest combination, but can be recognized, if careful consideration is given to the history and to the infant's general condition. The greatest danger lies in the fact that in the former we must nourish, in the latter starve. With only a short hunger period (six hours) either human or albumin milk should be given in small quantities, 10 times 5 mils, and increased by 50 mils daily under control of the clinical symptoms. After 8 to 10 days of the above, the infant can usually be put to the breast five times daily. The weight may remain stationary, and one must judge by the stools and general condition as to the addition of further foods. With albumin milk, after three to four days, the weight becomes stationary, and the stools of a fat-soap character; then gradually some malt-sugar may be added.

In nutritional disturbances associated with an infection an early diagnosis is most important, otherwise there is the danger of carrying the underfeeding to the point of lowering the resistance of the child beyond repair.

CHAPTER VIII.

NUTRITIONAL DISTURBANCES DUE TO INSUFFICIENT FOOD.

THIS group of cases may be divided into two classes: (1) Quantitative inanition, (2) qualitative inanition.

1. **Quantitative Inanition.** The cases of this class include those infants receiving a diet containing a proper proportion of the necessary food ingredients, but of insufficient caloric value. (Too little of a proper food.) These must again be divided into two groups:

(*a*) Normal infants quantitatively underfed.

In breast-fed infants this group is more common than in artificially fed. And while in the artificially fed such cases are occasionally seen, this is a far less frequent condition than overfeeding. Because in the normal infant hunger is manifested by crying, restlessness, loss of weight and associated constipation, which fortunately in most instances leads to a proper interpretation, resulting in increase of the diet.

(*b*) Infants suffering from nutritional disturbances, quantitatively underfed.

These cases are the ones which so frequently suffer from quantitative inanition, due to the fact that the fever, vomiting, and diarrhea offer every indication for a reduction in diet, or a starvation diet. While this leads to an improvement in the general symptoms, the remaining hunger stool, because of its greenish-brown color and excess of mucus, is not uncommonly interpreted as a diarrheal stool, leading to prolonged starvation, and not infrequently repeated catharsis.

The similarity of the grave hunger conditions following repeated starvation to decomposition is very striking. This is easy to understand, because the symptoms of decomposition are after all due to a condition of inanition caused by deficient absorption of food, and by loss of the body substance. In the beginning, and for a longer time thereafter, the inanition differs from decomposition in the reaction to the increase of the food, which in simple inanition is followed by gain in weight, in decomposition frequently by loss of weight. Finally, however, even in the child suffering from simple inanition the weakening of the organism reaches the stage in which there is a decrease of tolerance to food.

Treatment. *Prophylaxis.* Repeated hunger days and long-continued underfeeding should be instituted only upon definite indications, the sudden decrease in the food leading regularly to weight loss and lowered food tolerance.

An initial cathartic is frequently indicated, while repeated catharsis is harmful.

The diet should be as rapidly increased as the infant's condition will tolerate. It should be carefully selected to meet the requirements of the individual infant.

While in mild cases a properly selected diet leads to rapid recovery and gain in weight, in the severe cases bordering on decomposition, we not infrequently see a paradoxical reaction to food, necessitating feeding as described under the chapter on Decomposition.

In every case the infant's tolerance to food should be carefully studied, and increases made only as tolerance permits.

Hunger stools are rapidly replaced by those of normal consistency in the presence of a proper diet.

2. **Qualitative Inanition.** As qualitative inanition are designated those forms of nutritional disturbances which are due to the lack or insufficiency of one or more indispensable food substances or constituents of the food. The qualitative inanition is very frequently associated with quantitative inanition.

Flour Injury. From among these conditions of inanition the most frequent in the infant is the flour injury (Mehlnährschaden—Czerny and Keller).

Etiology. The condition follows feeding with a diet composed largely of cereals or cereal waters, as is frequently seen when these are used to replace milk mixtures which have been poorly taken (dyspepsia, etc.). It is therefore due to continued feeding of flour gruels, either without milk or a diet too low in milk content. Whether simple flour or baby foods, dextrinized or not are used, the result is the same. Although the flour in its digestion is changed to sugar, the effects are not those of excessive sugar diet (acute), but only leads to acute symptoms after the organism has been generally impaired by the long use of the one-sided diet.

Pathogenesis and Metabolism. The disturbance of the organism which develops on one-sided flour feeding is to be regarded as qualitative inanition, being due to the lack of important tissue-building substances (fat, proteins, salts), and the resulting improper formation of the body tissues.

Steinitz and Weigert found in animals that a flour diet led to an abnormal chemical composition of the organism. The body became richer in water and fat than normal, and this excess of water reduces the natural immunity. The œdema indicates a disturbance in the salt balance between the tissues and body fluids.

In many cases, also, the caloric intake may be insufficient, so that quantitative inanition complicates the picture. The accumulation of large quantities of water which occurs when large quantities of flour are fed in presence of salts results in fluctuations in weight.

Rapidity of development depends on the following factors:

1. Age. The younger the child, the quicker the effects.

2. The more the flour outweighs the other ingredients of the diet.

Symptoms. They may assume any form of nutritional disturbances. In many cases apparent symptoms of disease are lacking for a long time in spite of the improper diet. The infant may even apparently thrive well, since (due to the great water-binding property of carbohydrates) considerable gains in weight may occur. The appearance of the child is good, and fat cushion abundant. Even at this time, however, frequently some anomalies are observed: the musculature may be slightly hypertonic, the appearance may be pasty, suggesting a water-soaked sponge. Not infrequently by careful examination nervous irritability (latent tetany) may be detected. This is followed by development of grave symptoms of typical flour injury, which may assume variable appearance, according to whether the flour is given alone or combined with some other food.

Flour has the property of causing the body to take on weight by water absorption. This is especially true if the infant was previously healthy, and may be misleading. In infants suffering from nutritional disturbances the picture develops more rapidly, especially upon inauguration of repeated starvation diet. Finally, however, both these groups of infants present the picture of an *inanition*—that is, the *atrophic stadium,* which cannot be distinguished from a *decomposition* clinically. They are subject to rapid weight and water losses, showing the loose binding of the water in the tissues.

Œdema may complicate the picture, especially where the flour is given in a salt-rich diet as bouillon, milk, etc., and the œdema may resemble that of a nephritic patient (urine is usually negative).

The *natural immunity* in these hydremic conditions is greatly reduced, and the children are subject to furunculosis, otitis, and infections of the respiratory and digestive tracts, all of which give a bad prognosis.

Hypertonia is very common, with a characteristic muscular rigidity, resulting in stiffening of extremities, opisthotonos, etc., and it is often difficult to differentiate them from cases of spastic cerebral paralysis and chronic tetany, from which latter these infants often suffer. The history of nerve irritability must be used as a point of differentiation.

Hypertonic form has also been described, the chief symptom of which is the rigidity of the muscles. This hypertonicity may occasionally assume such proportions that the limbs and the entire body may become rigid. But this condition is not exclusively caused by flour injury, but may be seen also in other nutritional disturbances.

Stools. Often the stools are good for a long time, but sooner or later in all cases acute intestinal symptoms develop. More characteristic, after continued feeding on a one-sided flour diet are soft, mushy, loose stools, which are frequent, and vary in color from brown to yellow. A further characteristic is a tendency to fermentation, with the formation of acids and gas, which tend to irritate the buttocks. The small, dark-brown stools, composed mainly of mucus (hunger stools), are not infrequently seen, and are of especial significance, because they are often misinterpreted as dyspeptic stools.

Diagnosis. The feeding history is of the utmost importance. Hypertonia and œdema should lead to suspicion. Presence of excessive fermentation or of "hunger stool."

Prognosis. The younger the infant and the longer the unsuitable diet has been continued, the worse is the prognosis. The high mortality in this condition is due not so much to the nutritional disturbance itself, but more so to unavoidably complicating infections. Tetanies and convulsions due to them are also grave complications.

Prophylaxis. The development of a primary flour injury is prevented by ordering proper diet. In using the flour diet for therapeutic purposes in the treatment of dyspepsia, especially when repeated starvation is inaugurated, the danger of development of the flour injury must be kept in mind, and the one-sided diet must not be continued longer than several days.

Treatment. 1. *Human Milk.* In young infants and also in all severe cases, feeding with human milk offers the best hope for the cure of the condition. It is absolutely indicated (1) before the third month, (2) in evidence of decomposition.

Begin with 200 to 300 mils daily, as in decomposition, and continue, even with weight loss and development of dyspeptic symptoms. Increase the amount steadily. Even with human milk the course will be slow, if the condition is well advanced.

2. *Artificial Feeding.* One-half to two-thirds skim or whole milk plus water in feedings of 10 times 10 mils

with water or tea *ad libitum.* Continue, even with weight loss, which is the rule, unless the stools are dyspeptic. It may often be of advantage to make the loss slower by addition of some flour or maltose-dextrin preparations to the milk mixture. Albumin milk and buttermilk mixtures are often taken to better advantage than whole milk mixtures. If they fail, human milk must be given.

If stools retain fat-soap character after 10 to 14 days, the diet may be more rapidly increased.

Course is often interrupted by weight drops and infections.

In very severe cases in which symptoms of decomposition are present, same treatment as in decomposition should be instituted.

CHAPTER IX.

INFECTION AND NUTRITION.

THE intimate relation between infection and nutrition may be made clear by considering the subject under three headings:

1. The susceptibility to infections as influenced by previous diet and the state of nutrition.
2. The course of infections as affected by diet and the state of nutrition.
3. The influence of infection upon nutritional processes.
   (*a*) Parenteral infections.
   (*b*) Enteral infections.

1. Susceptibility Influenced by Nutrition.

The previous diet and the state of nutrition being the same, there are marked individual differences in the susceptibility to infection. Among the breast-fed infants there are on one hand infants who remain free from any infection, even under very unfavorable external conditions, while on the other hand there are breast-fed infants who under favorable conditions often contract an infection. This points to congenital differences based on the difference in the *constitution* of the individual. As a rule, the lowering of immunity is not the only sign of inferior constitution in these infants, but they show a number of other symptoms of a constitutional anomaly, such as exudative and neuropathic diathesis. In this group of infants the susceptibility to infection becomes even more striking when they are put on artificial feeding, and especially when the diet is improper. In infants with constitutional anomalies one is justified in thinking of an abnormal composition of the tissues and of the body fluids, both the latter factors in themselves leading to a lowering of immunity.

The natural immunity of the healthy breast-fed infant affords the best example of the importance of the *diet* in the establishment of resistance to infection.

In the artificially fed infants the increased susceptibility to infection is usually based on nutritional disturbances, which, however, may be so slight as to escape recognition. However, when a careful study is made of the feeding history the cause can usually be demonstrated in a poorly balanced diet, more commonly one excessive in carbohydrates and fats, which result in an abnormal composition of the tissues (see Nutritional Disturbances). Those modes of feeding which cause normal tissue chemistry diminish susceptibility, while every form of feeding which unfavorably influences metabolism increases susceptibility to infection.

In the artificially fed infants these facts offer valuable therapeutic suggestions, and should lead one to avoid overfeeding as a whole as well as of the individual constituents of the diet, and the early administration of the mixed diet.

The susceptibility to infection is increased by every nutritional disturbance. This applies to the simple and seemingly harmless digestive disturbances, as well as to the more severe forms (decomposition, intoxication).

2. Course of Infections Influenced by Nutrition.

The course of the infection is essentially influenced by constitution, age, hygienic conditions, mode of feeding, and the state of nutrition. The premature and the very young react poorly to infections. Gastro-intestinal, pulmonary and septic infections of the newborn have usually an unfavorable course, especially in the artificially fed infants. Infants suffering from constitutional anomalies are less likely to react favorably than normal, healthy infants. In all infants suffering from exudative or neuropathic diathesis even slight infections should be given serious consideration.

Nutritional disturbances have a direct influence on the prognosis of all forms of infections. This is more especially true of the infections of the respiratory passages, in which a simple rhinitis or pharyngitis may readily be complicated by pneumonia and severe gastro-intestinal complications, but also true of the simple skin infections, which may rapidly take a serious course resulting in sepsis.

The institution of a proper diet is of primary importance in all cases of infections.

Feeding with human milk is the treatment of choice. If this is not obtainable, and it is necessary to feed artificial food mixtures, they must of necessity be well balanced, and excesses of carbohydrates are to be avoided. Whenever possible, a mixed diet should be instituted.

3. Infection Influencing Nutrition.

Infection may produce any form of nutritional disturbance, from the slightest forms to the most severe forms of decomposition and intoxication. One may almost say that, for the production of nutritional disturbances, infections are to be ranked as of equal importance with dietetic errors.

Although the course of alimentary nutritional disturbances is very similar to that of nutritional disturbances due to infection, still there are important differences that must be kept constantly in mind in order to avoid failures in the treatment. The following table briefly summarizes the most important differences between the two forms of nutritional disturbances:

Nutritional Disturbances due to Alimentation.	Nutritional Disturbances due to Infection.
History of dietetic errors, especially high sugar diet.	Acute disturbances not so much dependent on the nature of the diet.
Appearance of intoxication only on a diet rich in whey and sugar.	Intoxication occurs also on diet low in whey and sugar.
Disintoxication of toxic states (fever, nervous symptoms, etc.) by withdrawal of food.	Toxic states continue or even become worse in spite of withdrawal of food.
Improvement in general condition, and especially of diarrhea, on correction of the diet, especially by reduction of whey and sugar component part.	Persistence of diarrhea after similar change of diet, at least in a number of cases.
Progressive narrowing of food tolerance in untreated cases.	Spontaneous increase of tolerance without special dietetic treatment after the infection passes over (in majority of cases, not always).

(A) Parenteral Infections.

Etiology. It has already been pointed out with what great frequency infants and children suffering from nutritional disturbances are subject to secondary infection. The most frequent of these are those of the skin, respiratory, gastro-intestinal, and genito-urinary tracts, ears and general septic infections.

In contradistinction to this, infections, such as "colds," tonsillitis, pneumonia, otitis, cystitis, pyelitis, which are accompanied by lowered food tolerance, very frequently result in secondary nutritional disturbances. They are likely to run a more severe course than the primary nutritional disturbances.

The common occurrence of the *"summer diarrheas"* leads us to search for a relationship between heat and the nutritional disturbances as seen in summer. This relationship has already been discussed under the chapter on Intoxication. However, it may be well to briefly enumerate the factors which are important in the causation of these nutritional disturbances. High temperatures cause systemic depression, and directly influence all of the body functions. Less food is required in hot weather, and therefore the previous diet may be considered excessive in many instances. Bacterial action on the milk, and the subsequent production of toxic bodies, is a factor of primary importance. An excessive retention of heat by overdressing during the summer months has been proven to be a contributing factor by McClure and Sauer.*

A study of the cases of diarrheas in the wards of Sarah Morris Hospital by Gerstley and Day during the course of two summers showed that most of our intestinal cases were secondary to parenteral infections, and not primary intestinal infections, as described by Kendall and Day in their investigations of the Boston epidemics. This could in greater part at least be accounted for by the fact that all of the milk fed to our infants was either pasteurized or boiled, while in the eastern cities considerable raw milk was fed.

* Sauer, Am. Jour. Dis. Child., 1915, ix, 490.

Symptoms. By careful clinical observation and experimental investigation L. F. Meyer has shown that infection may produce the following changes:

1. Diminution in the gain in weight without any acute symptoms on the part of the gastro-intestinal canal during or after the infection.

2. Loss of weight and changes in the stools corresponding to the acute nutritional disturbances.

(*a*) Acute disturbances of the nature of dyspepsia beginning with the infection and disappearing after the infection has been overcome.

(*b*) Acute disturbances which begin with the infection, but remain even after the infection is overcome, under certain conditions for weeks (chronic dyspepsia).

(*c*) Grave nutritional disturbances beginning with the infection, but soon becoming the most prominent in the clinical picture, with or without toxic symptoms (intoxication, decomposition).

Diagnosis. Alimentary intoxication is usually easily recognized by the nervous symptoms, toxic expression, pauseless respiration, and marked drops in the weight curve. In intoxication, temporary complete withdrawal of food in the absence of severe infection results in disintoxication. This is known as *therapeutic dietetic test.* In parenteral infections this is not the case, and starvation only leads to further reduction of resisting power, and therefore should not be long continued.

It is necessary to avoid the mistake of overestimating the intestinal condition for which in many cases the physician is called, and thereby failure to recognize the

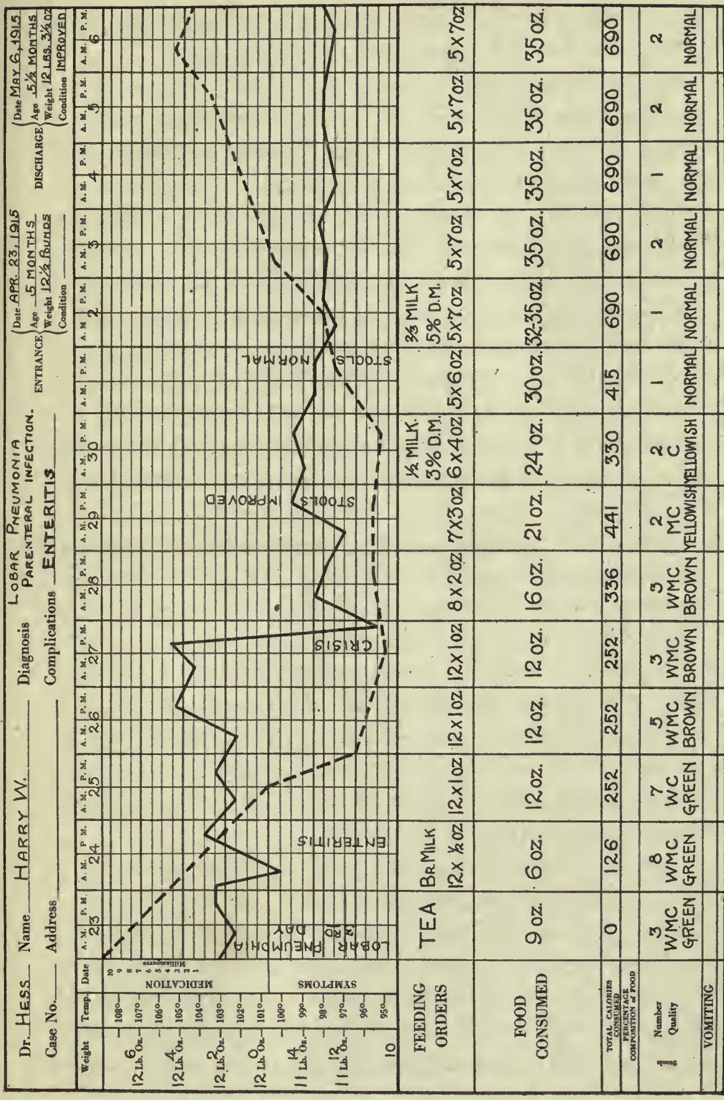

Fig. 15.—Chart showing hospital record of an infant with parenteral infection complicated by enteritis.

underlying infection, such as "cold," bronchitis, pneumonia, pyelitis, etc., as a fundamental factor.

Treatment. For treatment practically the most important characteristic of nutritional disturbances due to infection is the spontaneous rise of food tolerance after the cure of the infection.

The primary infection calls for foremost consideration, and its treatment must necessarily vary according to its nature. The intestinal condition, on the other hand, if mild in nature, frequently calls for little treatment in these infants, more especially because in the presence of fever there is a tendency to reduce the intake of food, which in itself is sufficient to correct the intestinal disturbance. Further, with the improvement of the infection the appetite returns, and the infant will demand increased food.

Where it is possible to keep up the baby's nutrition by the proper administration of food during the course of an infection, such children may be subject to little or no weight loss. In more serious cases the food must be reduced both qualitatively and quantitatively, more especially the sugars and the fats. However, in order to avoid catastrophes, long-continued underfeeding or starvation must of necessity be avoided, since this treatment, causing insufficient nutrition of the body-cells, would decrease the resistance of the infant.

The safest plan is to administer in place of carbohydrate- and whey-rich mixtures, which, as has often been pointed out, easily lead to acute digestive disturbances, mixtures high in proteins and low in sugar and whey. Human milk, albumin milk, and skim and buttermilk mixtures, with small amount of sugar only are to be used. In grave nutritional disturbances, with sudden losses of weight and toxic symptoms, complete withdrawal of food cannot be avoided.

In young and weak infants, as previously stated, breast milk may be imperative. In older infants, and those less severely infected, albumin milk, with 2 or 3 per cent. of sugar addition, or buttermilk and skim milk mixtures are frequently well taken. In all cases inanition must be avoided by keeping the child on a sustaining diet of 70 calories per kilogram, or an amount above this.

The type of infants who have been improperly fed, more especially those who have been raised on condensed milk or other foods containing a minimum of fat and protein, but an excess of carbohydrates, offer greater difficulties, because they possess a limited immunity to all forms of infection, beside reacting poorly to changes in their diet during illness. They also react very poorly to starvation, rapidly passing into a state of decomposition. The treatment in these cases should follow that outlined for milder forms of decomposition.

To repeat, under all circumstances food should be restricted as little as possible.

The two most important symptoms calling for treatment in the course of parenteral infections are (1) vomiting and (2) refusal of food.

If temporary reduction in food does not relieve vomiting, it may be necessary to resort to gastric lavage which is best performed with 1 per cent. sodium bicarbonate solution, allowing 2 or 3 ounces of the solution to remain in the stomach, with the administration of slightly sweetened tea or cereal waters *ad libitum,* as retained. Prolonged starvation must be avoided.

We have found chymogen milk fed in small quantities at two- to three- hour intervals especially suitable for these cases. This is probably due to the fact that the casein is precipitated in a flocculent form.

Refusal of food which is commonly experienced in these infants calls for catheter feeding (see chapter on Premature Infants).

(B) Enteral Infections.

Etiology. Besides the alimentary nutritional disturbances proper, there are in childhood, and especially in infancy, numerous diseases that have to be regarded as true infections of the digestive canal, due to invasion of pathogenic bacteria, or increased and changed activity of the bacteria normally present. In many cases infective material is introduced by food, and especially by the milk, in which the micro-organisms are present, being derived from the diseased cattle that furnishes the milk (Streptococcus from inflamed udders, Bacillus coli from feces) or bacteria pathogenic for the human may find their way into the milk in transportation from the place of production to the place of consumption. Besides this, water or contaminated foods other than milk may be the medium through which infection takes place.

There are numerous cases of transmission by contact. These are most commonly seen in the epidemic appearance of gastro-enteritis in institutions for small children and infants. A small, but typical epidemic is reported by Smillie* who has observed it during his study of epidemiology of bacillary dysentery. Four babies developed bacillary dysentery in the wards of the hospital, each of them having been admitted with quite a different diagnosis, and their stools having been negative on admis-

* Smillie, Am. Jour. Dis. Child., 1917, xiii, 337.

sion. Each developed the disease seven to ten days after admission, and in no instance did the infant come from an infected home or neighborhood.

The environment of the infant, and especially lack of proper cleanliness generally, and in preparation of food especially, are very important factors, which make the enteral infection possible.

Parenteral infections are often followed by enteral infections, and this is especially true of infections of the respiratory tract which often lead to enteral infections producing what has been called "bronchoenterocatarrh."

The most important clinical condition among the enteral infections is inflammation of the intestinal mucosa (enteritis), brought about by a variety of bacteria, and accompanied by slimy, purulent, and bloody evacuations and tenesmus. The causative bacteria may be Streptococci, Bacillus typhosus, B. paratyphosus, B. coli, B. dysenteriæ, B. pyocyaneus, B. aërogenes capsulatus (gas bacillus), and B. lactis aërogenes.

Kendall and Day, making a careful study of the epidemics of summer diarrhea in Boston, found that during the year 1910 the epidemic was mainly due to dysentery bacillus, fully 75 per cent. of 52 cases being due to these organisms. Streptococci were also present in about 60 per cent. of the dysentery cases, probably as secondary or terminal invaders. The summer of 1911 was noteworthy as a "streptococcus" year; 54 per cent. of 146 cases studied harbored large numbers of these organisms. The year of 1912 was a "gas bacillus" year, these organisms appearing in unusually large numbers in 39 per cent. of 135 cases examined. Each of the above types was found each year, but the striking feature is the shifting of the dominant organism from year to year. Kendall concludes that, bacteriologically considered, these cases are of varied etiology, caused by organisms of very unlike characteristics.

In contrast to this, Gerstley and Day studied the summer diarrheas at the Sarah Morris Hospital for Children (Chicago) during the course of two summers, and found that most of them were secondary to parenteral infections (see p. 249). Day worked both in Boston and Chicago cases, and therefore the error could not have been one of technic. The difference was probably due to use of boiled milk in Chicago, and unboiled milk in the East.

Pathology. To the invasion of pathogenic bacteria the digestive canal reacts by inflammation of the intestines (enteritis). The large intestine is always more affected, while in the small intestine the pathological process, as a rule, is limited to its lower portion. However, in cases secondary to infections of the nose and throat, even the gastric mucosa may be involved. Mesenteric lymph-glands are swollen. In some cases the bacteria invade the deeper organs also, and may be cultivated from the spleen and the gall-bladder. Liver and kidneys show degenerative changes in severe cases, probably due to the action of toxins. Occasionally other organs may secondarily become affected (otitis, pneumonia).

The inflammation of the intestines may reach any degree of severity, and is dependent to some extent at least upon the causative organism, being, as a rule, most marked in cases in which dysentery, typhoid, and streptococcic organisms are excitants of the pathological process.

It may be a hyperæmia and swelling associated with exudation of excessive amount of mucus and occasionally of blood, producing a picture of catarrhal gastro-enteritis marked by mucus, mucopurulent, and occasionally also slightly bloody diarrheal stools. These cases are caused by a variety of bacteria, and they are often secondary to infections of the respiratory tract, the same micro-organisms being causative in both instances. We have frequently seen such a clinical picture associated with severe vomiting, and a secondary acidosis following in the course of a streptococcus sore throat.

Intense swelling of Peyer's patches in the small intestine is seen in typhoid infection. Sloughing and ulcer formation is far less frequent than in the adults.

In paratyphoid infections, while infiltration of Peyer's patches and solitary follicles are usually present, deep ulceration is lacking, as a rule.

In infection with dysentery bacilli, the large intestine is especially affected, being the seat of sero-hemorrhagic and hemorrhagico-purulent inflammation, with marked tendency to formation of ulcers throughout a large part of the large intestine, and less frequently the lower ileum.

Again, we may see marked intestinal pathology, as evidenced by deep-seated ulcerations and infiltrations of mucosa and secondary inflammation of the submucous and muscular layer of the intestinal wall, which condition is usually spoken of as ulcerative follicular colitis, and this may be complicated by formation of a pseudomembrane in various areas throughout the large intestine, which condition has been described as a membranous colitis. In many of these cases it is difficult to determine the exact bacteriological factor, because of the presence of secondary organisms. Most of these cases are either subacute or seen as secondary involvement in infants who have suffered from repeated nutritional disturbances.

On the whole, in those cases of inflammation of the intestinal tract due to bacterial infection and presenting serious pathological changes, the most marked changes are found in the lower three feet of the small intestine and in the large intestine. While there is very frequently a disparity between the severity of the clinical symptoms and the pathological changes seen *post-mortem* in that not infrequently severe symptoms are associated with little pathology, on the other hand marked pathological changes are almost invariably associated with a severe clinical picture.

Symptoms. The symptoms vary with the individual excitant of the disease, and thus also to a certain extent with the pathology, but, in general, the symptoms are so variable and with very few exceptions so little characteristic for the particular excitant that the etiological and pathological grouping of clinical pictures is impractical. It seems much better to differentiate the various forms from the clinical point of view.

Diarrhea with slimy or purulent evacuations, often with blood, accompanied by abdominal pain, tenesmus and fever, are the most characteristic and the most constant symptoms of enteral infections.

The *onset* and *progress* of enteral infections, as a rule, are sudden and rapid, and in this way they markedly differ from alimentary nutritional disturbances in which prodromes consisting of milder symptoms are often present, and the progress is gradual. In enteral infections the stormy course may result in rapid production of a very severe picture of general prostration, and even an early fatal outcome.

Diarrhea is so constant that these cases have been designated as "infectious diarrhea," and yet it should be remembered that typhoid and paratyphoid infections in young individuals may be associated with any degree of constipation early in the disease. The stools are, as a rule, frequent, often one every hour, and there are also cases in which the bowels seem to move almost continuously. The number of stools varies also, according to the seat of the most severe inflammation, and they are more numerous when the large intestine is chiefly affected.

Loss of weight, often sudden and marked, is always present, and is due to many evacuations, and also to accompanying nutritional disturbance.

Stools. The macroscopical appearance of individual stools varies not only with the etiological factor, but is also dependent to a great extent upon the reaction to food, and upon the intestinal pathology, and is therefore of little value in the etiological diagnosis of enteral infections. The size of the stools is indirectly proportional to their number. In the beginning they appear to be of normal composition, but sooner or later they are composed chiefly of mucus and blood, and occasionally pus may be seen, even by the unaided eye. Portions of the intestinal mucous membrane are seen in severe cases at the time of sloughing and ulceration. The odor of the stool varies with its composition, and thus with the progress of the disease. In the beginning the odor is that of the normal stool; later stools, composed of mucus and blood, are almost odorless; and those containing large quantities of sloughs have often a putrefactive odor. The reaction of the stools varies also with their composition, being mostly alkaline. In exceptional cases the stools may not be considerably increased in number, and may contain neither mucus, nor blood, nor pus.

Abdominal pain and *tenesmus,* due to irritation by the bacteria and their products, and also due to the abnormal intestinal contents, and to increased peristalsis, and sometimes to distention, appear very early in the disease, often being the first symptoms. Although being severe usually, they vary from a slight discomfort to excruciating pain, which keeps the child constantly awake, and, causing exhaustion, adds to the severity of the case. Abdominal distention is intermittent, the abdomen being usually sunken. Abdominal tenderness is not frequent. Anorexia is almost always present, while vomiting is more commonly seen early.

Fever is always present in enteral infections, and varies with the severity of the infection and the pathology. More often it is not extreme after the first exacerbations. It persists throughout the disease.

Leucocytosis and oliguria are usually present.

Enteral infections are always associated with *nutritional disturbances,* since the infection affects an organ chiefly concerned in nutritional processes. And nutritional disturbances, again, produce symptoms of their own.

The *course* of enteral infections varies considerably, being dependent chiefly upon the nature of the organism and the stage of nutritional disturbance that develops, and also on the nature of complications. Some cases may be so mild as to resemble subacute dyspepsia, and only inability to influence the fever by the diet may point to their true nature. On the other hand, however, severe toxic conditions occur, being due either to sepsis or to a nutritional disturbance which develops secondarily to infection. The duration of the disease varies from a few days to several weeks.

Complications. The great danger of the infections of the gastro-intestinal tract lies in their tendency to complications, at the head of which stand nephritis and pneumonia. Other complications are cysto-pyelitis and various pyodermatoses, and other pus infections and general pyæmia or septicæmia, which start either from the skin or from the diseased intestines.

More important than this is the association of infectious diseases of the intestines with secondary nutritional disturbances. It is easy to understand that in severely diseased intestines the normal digestion of food is made especially difficult, and thus acid decomposition easily occurs, which in turn leads to dyspepsia, and in the wake of these even the alimentary decomposition and alimentary intoxication may be implanted upon the original disease. The inanition caused by the flour injuries (Mehlnährschaden) may in some cases reach disastrous gravity. There can be no doubt that the majority of the cases resulting in decomposition are not due to the infection alone, but also to the inanition and other forms of secondary nutritional disturbances, and it is probable that even a part of the severe ulcerative forms and various complications develop on the same foundation. The underfeeding alone gradually decreases the general power of resistance of the body; it weakens also the antibacterial functions, and thus the local or general infection may spread unimpeded.

Diagnosis. In making a diagnosis it is necessary to differentiate the enteral infections not only from (1) alimentary nutritional disturbances, but also from (2) nutritional disturbances caused by parenteral infections. (3) Diagnosis of the causative organism or group of organisms is also of great importance for the treatment.

(4) Enteral infections are always complicated by nutritional disturbances, and it is of great importance to recognize the degree (dyspepsia, intoxication, decomposition) to which the infant is affected.

In practice it is often difficult to differentiate clinically the gastro-intestinal infection from other forms of alimentary disturbances, because neither bloody and purulent stools nor the finding of pathogenic bacteria in the stools in itself is sufficient for the diagnosis of enteral infection, except possibly in the presence of typhoid, paratyphoid, and dysentery bacilli.

An easily applicable method of differentiation is the test for the *reaction to starvation and feeding.* Fever continuing after withdrawal of food speaks for infectious etiology. Inability to influence the symptoms by diet is to be interpreted in the same sense.

History is of considerable importance in making a differential diagnosis. The acute infectious diarrhea starts usually suddenly in a previously well baby, and prostrates it at once, while the alimentary nutritional disturbance comes on gradually. In the latter we get a history of improper feeding, of previous nutritional disturbance, of parenteral infection. It is more gradually progressive.

The differentiation between the enteral and the parenteral infections is somewhat more difficult, and is to be made chiefly by exclusion of the parenteral infection by careful physical examination of the patient. The bloody, purulent stools are usually absent in the cases secondary to parenteral infection.

The diagnosis of the causative organism is to be made by proper bacteriological examination and culture of the stools, and by agglutination reaction. Kendall states that frequently it is very difficult to determine the organism causing the disease, and therefore he has attempted to classify the causative organisms into two groups with a special reference to treatment.* He divides them into two large groups: (1) the various forms of dysentery bacillus and all other organisms except the gas bacillus; (2) the gas bacillus and the allied organisms.

While this classification of organisms for treatment theoretically offered great advantages, in our own clinical work we have not experienced the encouraging clinical results which might be expected, and have instituted a general course of treatment based more directly on the severity of the infection and the symptoms as presented by the cases at hand.

Stool cultures should be made according to the method of Kendall for gas bacillus. This method is so simple that it may be performed even outside of a well equipped laboratory. Small portion of the stool is added to a test-tube of milk. The test-tube is then heated on the water-bath, and left in the boiling water for three minutes. By this procedure all the bacteria in the stool that are not in stage of spores, are killed, and the bacteria develop unrestrained from the spores subsequently. Gas bacillus, being sporogenous, survives the boiling. The test-tube is finally incubated at a body temperature for about twenty-four hours. In the presence of the gas bacillus a large part of the casein is dissolved, but the remaining casein is filled with holes, as if shot to pieces, and somewhat pinkish in color. The odor reminds one of rancid butter, and is due to formation of butyric acid. The true reaction may be easily differentiated from the pseudo-reactions, in which some liquefaction of casein also oc-

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* Kendall and Smith: Bost. Med. and Surg. Jour., 1910, clxiii, 578.

curs, but in which the shotted appearance of the residual casein and the odor of butyric acid are absent.

Differential studies for typhoid, paratyphoid, and dysentery bacilli on endomedium and Russell's double sugar medium, and by further fermentation tests, are indicated in the presence of epidemic or severe endemic cases.

While agglutination reactions are uncertain in very young infants, because of the slight tendency to the formation of agglutinins, in older infants and children it is of very considerable value, as demonstrated by the study of agglutinins by the author at Cook County and Sarah Morris Hospitals during the year 1914. In a series of 30 cases studied in which agglutinations were made for typhoid, paratyphoid (alpha, beta, and Morgan), dysentery (Shiga and Flexner), and colon bacilli, the following organisms were demonstrated: typhoid, 2; paratyphoid (Morgan), 1; dysentery, 2. All of these cases yielded the respective organisms in large numbers from their stool cultures. This method of examination is easily carried out in a well regulated laboratory, and is worthy of further consideration in the presence of an epidemic of enteritis or isolated cases of severe enteral infection.

The stage of the nutritional disturbance is best diagnosed by the reaction of the temperature and toxic symptoms to complete withdrawal of food, and presence or absence of paradoxical reaction. (See also Dyspepsia, p. 201; Decomposition, p. 214; Intoxication, p. 232.) Starvation in the presence of infection must always be recognized as a dangerous procedure.

Prognosis. The prognosis of enteritis is, in general favorable. Death is almost always due to complications with septic affections or nutritional disturbances.

In infants and younger children the prognosis depends essentially upon the ability of the physician to apply the proper dietetic methods suitable for the particular case. If he succeeds—and this is at present possible in very many cases—to avoid graver secondary nutritional disturbances, then he will be able to save a surprisingly large percentage of cases; if he is unsuccessful in this direction, then his results will be unsatisfactory.

Treatment. Prophylaxis. In etiology of enteral infections several facts based on bacteriological studies and clinical observations stand out so prominently that the methods of prophylaxis must be based upon them in order to be successful.

1. In the great majority of cases the infection is introduced with the food. Whenever intestinal infection occurs in a breast-fed infant in a private home, the first thought should be that the infant was probably getting other food besides mother's milk, and only after exclusion of this probability the causes should be looked for in the environment of the infant, especially the cleanliness of the mother and the general hygiene of the home. In artificially fed infants the prophylaxis of enteral infections consists of obtaining pure and wholesome milk, keeping it clean, boiling when in doubt, and careful preparation of proper mixtures.

2. In many cases the infection occurs by contact, especially in institutions. Isolation of severe cases of intestinal infection is therefore essential, and isolation of all suspicious cases advisable, especially in institutions.

3. The environment of the infant, and especially lack of proper cleanliness generally, and in preparation of foods especially, are very frequently predisposing and accessory factors. The methods instituted to counteract

these influences must, of course, be adapted to the individual case.

4. Parenteral infections are often followed by enteral infections. Proper treatment of parenteral infection, special attention to the diet and general hygiene, are the keynote of prophylaxis in these cases, the possibility of secondary enteral infection being constantly kept in mind.

5. Alimentary nutritional disturbances increase susceptibility to any form of infection, and especially to enteral infection, and the prophylaxis of secondary enteral infections coincides practically with the prevention and proper treatment of these nutritional disturbances. (See also "Susceptibility Influenced by Nutrition," p. 245.)

Initial. The object of the initial treatment is to decrease as much as possible the number of bacteria present in the intestine, and the removal of irritating intestinal contents. Intestinal disinfection by drugs is impossible; and the cleansing of the intestines by the administration of large quantities of inert fluids, enemata, and possibly an initial laxative, is the best that can be done in this direction.

Castor oil, which is usually taken plain without any difficulty by infants, in doses of 1 to 2 teaspoonfuls, is the best laxative for these cases, since it causes very little intestinal irritation. Only in cases where it is vomited, we should resort to magma magnesiæ ($\frac{1}{2}$ to 4 teaspoonfuls), or to calomel, 0.06 gram (1 gr.), given in doses of 0.015 gram ($\frac{1}{4}$ gr.) every half an hour until four doses are given. Calomel is administered with sodium bicarbonate. The calomel can be followed to advantage with 1 or 2 teaspoonfuls of magma magnesiæ.

An enema of physiological saline (1 teaspoonful of salt to 1 pint of water) is useful.

All food should be stopped for from six to twelve hours. It is not desirable, as a rule, to withhold the food longer than this time.

Water should be given freely during the starvation period, and in quantities that are at least equal to the past total intake of fluids. The water may be given either warm or cool, or in the form of weak tea. Saccharin may be used to sweeten it, using 0.01 gram ($\frac{1}{6}$ gr.) of saccharin to 8 ounces of water, if desired. In presence of marked anorexia or refusal of fluid on the part of the infant, the water or tea must be administered by catheter. In persistent vomiting frequent resort to gastric lavage with 1 per cent. sodium bicarbonate solution will relieve vomiting, and be followed by retention of fluids given by mouth. When the latter does not relieve the vomiting, physiological saline solution or Ringer's solution must be given either by rectum or subcutaneously.

Medicinal Treatment. *Abdominal pain* and *tenesmus* are often so severe that they require a special treatment. Moist heat in the form of compresses, hot water bottles or electric pads should be given preference, and only in cases in which they do not afford relief recourse should be had to opium or morphine. Tincture of opium in doses of 3 to 5 drops may be given in 10 per cent. starch solution by the rectum, or 0.01 to 0.03 gram ($\frac{1}{6}$ to $\frac{1}{2}$ gr.) of pulvis ipecacuanhæ et opii (Dover's powder) (beware of vomiting), or 5 to 20 drops of tinctura opii camphorata (paregoric) by mouth. In some cases 1 or 2 doses of morphine may be preferable, since it decreases the peristalsis less markedly than opium; the dangers of its administration to infants must be remembered, and the dosage must be minimal (0.0003 to 0.001 gram—$\frac{1}{200}$ to $\frac{1}{60}$ gr.).

Stimulants are indicated in some cases of extreme exhaustion, and in cases of sudden collapse. In the absence of hyperexcitability of the nervous system, strychnin is the most generally useful stimulant. It is given in doses of 0.00005 to 0.0003 gram ($\frac{1}{1000}$ to $\frac{1}{200}$ gr.). Caffein in the form of caffein sodium benzoate, or citrated caffein, are of value, and are given in doses of 0.01 to 0.03 gram ($\frac{1}{6}$ to $\frac{1}{2}$ gr.). Camphor 0.05 to 0.10 gram (1 to 2 gr.) dissolved in sterile oil may be injected subcutaneously in emergency.

Special symptoms and conditions arising during the course of the disease, as are high fever, excessive vomiting, symptoms of nervous excitation, or extreme depression, are to be treated as detailed under Intoxication (p. 232).

Injections of silver nitrate are of value in some cases where blood and pus persist in the stool even after the subsidence of acute symptoms, and especially in dysentery. Before an injection is given, the colon should be irrigated first with sterile water (not saline). One per cent. silver nitrate solution is then injected in a suitable quantity. If it causes any pain or irritation, it should be washed out with saline solution. It should not be repeated more often than once a day, and if three injections do not result in marked improvement it is better to discontinue them.

Dietetic Treatment. *Human Milk.* The ideal treatment for all cases of intestinal infections would most naturally be best accomplished by feeding with human milk, and whenever obtainable, more especially in the severe types, it is by all means the diet of choice. Feeding with human milk, especially in young infants, produces very good results, because it retards the complicating nutritional disturbance, and thus favors healing.

Artificial Feeding. From the great number of food mixtures that have been advised for enteral infections, we may judge as to the lack of any specific action. It is probable that success may be obtained with any feeding which prevents the aggravation of nutritional disturbance, and favorably influences the nutritional disturbance which may exist. Feeding with albumin milk, skim and buttermilk, and cereal mixtures and whey-cereal mixture (Frank) offer the least risk.

Prolonged starvation by insufficient diet or by refusal on the part of the infant to take the prescribed diet is always disastrous, and must be avoided. After six, or at the most twelve, hours on the tea diet the infant is placed on cereal water (barley, rice, or flour ball), using 1 tablespoonful of the flour to a pint of water in young infants, and 2 tablespoonfuls to the pint of water in infants over 1 year. After twenty-four to forty-eight hours on the above diet an ounce of clear chicken or lamb broth can be added to the above cereal waters, seasoning with a small amount of salt. If the child will take the food, it may be given in the same quantities to which the child has been accustomed, or smaller quantities at more frequent intervals.

By far the best results obtained in our private and hospital work have been by instituting feeding with albumin milk of Finkelstein after the first twenty-four hours on an inert diet. The value of the albumin milk may be explained by the fact that it is easily digestible, containing moderate quantities of fat and sugar and finely divided casein, which is easily digested in this form. The rules to be followed in the feeding with albumin milk are described under Decomposition. This diet is also to be recommended in home practice, wherever it is possible to obtain it, either from a neighboring hospital or by instruction of the nurse or of the mother. Feeding with albumin milk should be begun after twenty-four hours on the tea and cereal water diet. Sufficient quantity of inert fluid, either in the form of water, tea, or cereal water should be given with or between the small feedings of albumin milk. One of the gravest dangers in the severe infections is that the infants are likely to take too little rather than too large quantities, and are especially prone to vomit when the food is forced upon them.

Boiled skim buttermilk or skim milk with starch or flour ball added (1 tablespoonful to the pint) may be used as substitute, if albumin milk cannot be obtained. They are, however, not so efficacious. They should be fed in small quantities, as recommended for albumin milk.

Chymogen milk (either made from the whole milk, or in severe types from skim milk), either diluted or in small quantities, if given full strength, is frequently retained when the stomach is very irritable, and where the child objects to the less palatable albumin milk and buttermilk mixtures.

The whey-cereal mixture therapy of Frank deserves a special mention. It is administered as follows:

1st day: Initial starvation period on tea for not longer than twelve hours.

2d day: Feed five times 50 grams whey and 50 grams cereal gruel prepared from crushed grain.

3d day: Increase to 60 grams whey and 60 grams cereal gruel.

4th day: 75 grams whey and 75 grams gruel.

5th to 8th day: Not later than on the fifth to eighth day of treatment replace a tablespoonful of whey by tablespoonful of milk. Increases of milk to be guided by the infant's progress and needs.

9th to 11th day: Increase the addition of milk gradually.

12th to 14th day: Even in the grave case 400 grams of milk and 400 grams of cereal gruels and 200 grams of meat broth must be given, and not later than in this time the broth is to be prepared with strained rice or farina. In infants over 1 year, beginning with the tenth day, finely scraped beef may be added.

A careful record should be kept of the exact amount of milk and other fluids taken in each twenty-four hours, and, where possible, the child should be weighed daily to ascertain the loss in weight.

The dietetic therapy has never such a prompt result as in alimentary nutritional disturbances. Even in favorable cases the disease (purulent and bloody stools, fever) continues for one week; in unfavorable cases, several weeks. Strict adherence to the food régime once instituted is desirable. In these cases no greater mistake could be made than to change diet with introduction of repeated hunger days, or to remain on small quantities of food. Thus, an infant suffering from infection succumbs often not to the infection, not to the nutritional disturbance, but to inanition.

Diet in Convalescence. The problem of nutrition offers great difficulties, even after the subsidence of the fever, and following the improvement in the number and character of the stools, as it is frequently necessary to keep the infant on a restricted diet for from one to three weeks. Only rarely it is possible to feed sufficient caloric units for the maintenance of weight during the first and the second weeks of the illness. Where possible, the albumin milk, buttermilk, skim milk, and chymogen milk and cereal gruels should be gradually increased, and these increases in quantity should be maintained even in the presence of moderately bad stools if vomiting is absent, unless one becomes convinced that one or the other of the food elements is absolutely detrimental to the infant's welfare.

It is our desire to impress that possibly the gravest danger to the infant during the period of convalescence is that of underfeeding. Upon the return to milk mixture small quantities of boiled milk, low in fat (albumin milk, buttermilk, skim milk) should at first be used. This may be accomplished by adding it to the cereal gruels. During this stage beef juice broths, egg albumin, coddled egg (prepared as for typhoid fever patients), zwieback crumbs, pap, custards, and junket may be added. Under conditions where ideal milk and milk preparations cannot be obtained, we have found that not infrequently the better brand of evaporated milk, as obtained on the open market, are useful, when properly diluted. The use of condensed milk should be avoided.

The obstinate constipation which is sometimes seen during convalescence should be treated with the utmost conservatism along the lines as laid down for constipation. The infant should have at least one evacuation of the bowels daily. A saline enema is usually sufficient to produce this result.

Appendix.

PROPRIETARY BABY FOODS.

It should be borne in mind that the average daily cost of many of the proprietary baby foods is in excess of twenty-five cents.

For practical purposes the baby foods may be classed as follows:

GROUP I. Prepared from cow's milk.

1. Condensed milk without added sugar.
2. Condensed milk with added sugar (Borden's Eagle Brand) (F., 8.85; P., 7.34; milk-sugar, 11.61; cane-sugar, 42.9; ash, 1.77; water, 27.53).
3. Evaporated milk (St. Charles) (F., 9.0; P., 7.82; milk-sugar, 11.19; ash, 1.71; water, 69.91).
4. Peerless Brand unsweetened evaporated milk (F., 9.27; P., 7.28; milk-sugar, 9.99; ash, 1.51; water, 71.82).
5. Carnation Brand.
6. Lacta Præparata (powder).
7. Mammala (powder) (F., 12.12; P., 24.35; milk-sugar, 55.34; ash, 5; moisture, 3.19).
8. Honor Brand powdered milk (F., 12.0; P., 34.0; milk-sugar, 44.0; ash, 7.0; moisture, 3.0).
9. Merrill-Soule powdered modified milk (F., 18.0; casein, 8.6; albumin, 7.5; milk-sugar, 57.8; ash, 7.3; moisture, 1.2). Calories, 133 per ounce. To be used 1 part food to from 4 to 10 parts of water.

Group II. Foods prepared from dried cow's milk and modified cereals. To be diluted with water only.

(A) Containing much unchanged starch.

1. Nestlé's Food (milk-sugar, 7.4; maltose, 15.6; cane-sugar, 24.77; starch, 17.31; protein, 10.92; dextrin, 13.51; fat, 5.63; ash, 1.49; water, 3.37).
2. Anglo-Swiss.

(B) Starch largely converted into soluble carbohydrates, such as maltose and dextrin.

1. Horlick's Malted Milk (F., 8.5; P., 16.3; maltose and dextrin, 18.80; lactose, 49.15; ash, 3.8; water, 3.0).
2. Allenberry's I and II. (No. I, F., 17.2; P., 10.6; maltose, 14.0; dextrin, 10.0; lactose, 42.0; ash, 3.0.) (No. II, F., 15.88; P., 9.90; maltose, 20.0; lactose, 36.0; dextrin, 13.0; salts, 3.71.)

Group III. Foods prepared from modified cereals to be used with fresh cow's milk.

(A) Starch unchanged.

1. Flours of barley, wheat, rice, corn, oats, soy beans, etc. (Barley flour, 1 level tablespoonful (98 grains) to 12 ounces water equals 1.27 starch or 1.8 calories per ounce.)
2. Arrowroot.

(B) Starch partially dextrinized.

1. Robinson's patent barley flour.
2. Imperial Granum (F., 1.4; P. 14.0; carbohydrates (sol.), 1.8; carbohydrates (insol.), 73.5; ash, 0.39; water, 9.0).

3. Eskay's Food (contains a small amount of egg albumin) (F., 1.0; P., 6.7; carbohydrates (insol.), 21.21; carbohydrates (sol.), 67.81; ash, 1.3).
4. Denno's Baby Food (F., 1.79; P., 11.0; cane-sugar, 15.2; starch, 64.6; ash, 1.12; water, 6.2).
5. Allenberry's No. III (malted) (F., 1.05; P., 10.23; carbohydrates (sol.), 25.00; maltose, 16.5; dextrin, 8.5; carbohydrates (insol.), 60.01; ash, 0.60).

(C) Starch completely changed to dextrin and maltose:

1. Borcherdt's Dri-Malt Soup Extract (maltose, 71.10; dextrin, 13.50; protein, 8.66; ash, 2.94; moisture, 3.80). Calories per ounce by weight equals 110. It is a laxative, and is easily digested because of the high maltose and potassium carbonate (1.1 per cent.) contents.
2. Borcherdt's Malt Soup Extract (protein, 6.40; maltose, 57.57; dextrin, 11.70; ash, 2.54; moisture, 21.79). It contains 1.1 per cent. potassium carbonate.
3. Borcherdt's Dri-Malt Soup Extract with Wheat Flour. Semi-liquid malt soup extract, to which gelatinized wheat flour has been added, and the whole dried. One ounce equals 110 calories.
4. Borcherdt's Malt Sugar (dry) (maltose, 87 per cent.; dextrin, 5 per cent.). The following table will give a comparative idea of the relative value by weight and measure of Borcherdt's liquid and dri-malt soup extracts:

16 Fluid oz. equal 19.5 oz. dry malt powder by measure.
1 Fluid oz. equals 1.2 oz. dry malt powder by measure.
1 oz. of liquid by weight equals 0.83 oz. of powder.
1 Fluid oz. represents 90 calories.
1 Ounce of powder by weight represents 110 calories.

5. Horlick's Malt Food (contains no milk) (F., 1.4; P., 12.06; maltose, 17.86; salts, 2.6). Calories, 109.29.
6. Mellin's Food (F., 0.16; P., 10.35; maltose, 58.88; dextrin, 20.69; carbohydrates (sol.), 79.57; salts, 4.3; water, 5.6). Calories, 91.43.
7. Dextri-maltose (Mead's No. 1) (maltose, 52; dextrin, 41; water, 5; sodium chloride, 2). No. 2 (maltose, 53; dextrin, 42; water, 5). No. 3 (maltose, 52; dextrin, 41; water, 5; potassium carbonate, 2).
8. Nahrzucker (Sohxlet) (F., 0.03; P., 0.13; maltose, 41.0; dextrin, 53.3; ash, 1.7; water, 2).

Group IV. Foods prepared from casein.
1. Larosan (casein plus calcium).
2. Nutrol (sodium compound of casein).
3. Plasmon (from casein by action of CO_2 and $NaHCO_3$).

Group V. Diastatic ferments.
1. Diastoid (Horlick's, powder).
2. Diazyme (Fairchild, liquid), a good product.

Group VI. Peptonizing powders.
1. Peptogenic milk powder (Fairchild's).
2. Pepsin.

Group VII. Rennet powders (precipitating curd in a finely divided form).
1. Chymogen (rennin and milk-sugar).
2. Pegnin (rennin).

It will be noticed that there are two great classes of proprietary infant foods:

The First. (Groups I, II). Those containing cow's milk.

Sweetened Condensed Milks. These are advertised as complete infant foods. All of them are quite similar in composition. All contain large amounts of cane-sugar. It is impossible to make, by simply adding water, a properly balanced food for an infant's continuous diet. A dilution to give a rational amount of proteins and fats has a large excess of sugars, and one to contain any amount under 7 per cent. total sugar would be so weak in both protein and fat that the baby's proper growth would be very seriously interfered with.

Eagle Brand condensed milk contains: fat, 8.85; proteins, 7.34; milk-sugar, 11.61; cane-sugar, 42.90; ash, 1.77; water, 27.5.

TABLE.

A Well-known Condensed Milk, Showing the Content of Various Dilutions. Fats and Proteins Deficient.

	Full strength Per cent.	6 parts water Per cent.	12 parts water Per cent.	18 parts water Per cent.
Fat	6.94	.99	.53	.36
Proteid	8.43	1.2	.65	.44
Cane-sugar ...	50.69	7.23	3.90	2.67
Salts	1.39	.17	.10	.07
Water	31.30	90.49	94.80	96.46

The Unsweetened Evaporated Milks. They were made by heating the milk to 200° F., and then transferring it to vacuum pans, where it is maintained at a temperature of 125° F., until sufficient water is evaporated to bring the product to the required condensation. In most products this milk is about double strength.

The sugar content not being in excess, these milks can be so diluted that a reasonable amount of fat and protein can be obtained, with, however, a considerable deficiency in sugar; this relatively low amount of carbohydrate can then be made up by adding sugar (cane or maltose-dextrin compounds), much the same as is done with cow's milk. Where it is impossible to obtain clean, fresh milk, evaporated milk can be used with good success as a temporary diet in traveling, etc. A fresh can should be opened daily. It can be diluted with three to six or more parts of water, or cereal water and sugar in some form as indicated; however, the carbohydrates contained in the formula should rarely exceed 7 per cent. One part of milk to two parts of diluent plus carbohydrates is the strongest formula in which it is ever necessary to feed infants, as this equals the strength of whole milk with carbohydrate added.

Occasionally, infants with a very weak digestion will thrive on the evaporated milk where all other methods fail, if the food is started in high dilution, the quantity being increased as the infant shows improved capacity.

Because of the repeated heating and the low salt content, the food necessarily loses some of its vital requirements, and an early attempt to change to fresh milk should be made in order to avoid constitutional disorders as rachitis, scurvy, etc. The tendency to become very fat on this class of foods is proverbial, but this is not usually associated with high resistance or immunity to infections, and these infants succumb rapidly to the respiratory and intestinal infections. Unless the mother is forewarned, it is often with reluctance that she can be made to foresee the necessity of taking her baby off the food which agrees with it, and experiment with a new and occasionally uncertain formula.

The Powdered Milk Foods. Mammala, Honor Brand, and Merrill-Soule Brand are fresh milk dried. In the two former, part of the cream has been removed. All have some lactose added. They find their most important indication as an occasional substitute feeding in breast-fed infants—first, for the mother's convenience, to allow her recreation; secondly, where the milk of the mother is insufficient, and one or two regular feedings are indicated temporarily until a formula of fresh milk is advisable, or while traveling, when the milk supply is uncertain; and thirdly, those containing large amounts of maltose (Horlick's) can be given once daily in breast-fed infants in need of a laxative.

The Second Class. Those to be used in conjunction with fresh cow's milk. In this class belong Groups III and IV. These give us a far more rational infant food.

Group III. (A) The unchanged or partially dextrinized starches are especially to be used in solution in place of boiled water as diluents, best after the second month. A number of good cereal flours can be purchased on the market.

(B) In this group are found most of the highly advertised and detailed baby foods. They have little or no advantage over the plain cereal flours.

(C) These are especially valuable where maltose and dextrin are better taken than cane- or milk- sugar. Dextri-maltose (Mead's No. 1 and 2) and Nahrzucker.

DIRECTIONS FOR THE PREPARATION OF INFANT'S FOODS.

Tea.

To a small half-teaspoonful of fennel, chamomile, or "green" tea add 1 pint of boiling water, cover with a clean dish, and steep for two or three minutes, or till the tea is of a light yellow color; then pour through a clean sieve or muslin. It should be weak. If used for thirst only, in diarrheal cases, one-fourth of the above amount is sufficient.

Barley Water.

Soak 1 tablespoonful of washed barley (pearl) in water overnight; pour off water, add 1 quart of fresh water, and boil down to 1 pint (2 hours). Add boiled water to make 1 pint, if necessary. Strain through fine cloth. Keep in ice-chest.

Oatmeal and Rice Water.

They are prepared in the same manner, only boiled more slowly. They may be made from barley, oatmeal, or rice flours by using 1 rounded tablespoonful to 1½ pints of water, and boiling for 20 minutes down to 1 pint, in an open stew-pan, stirring constantly. (Approximates 3 calories per ounce.)

Oatmeal, Barley, and Wheat Jelly.

Use twice the quantity of cereal and same quantity of water.

To Dextrinize Barley or Oatmeal Water.

Cool to 105° F., add 1 teaspoonful extract of malt, cereo, liquid taka-diastase or diazyme, stir, allow to stand for 15 minutes, when the gruel becomes thin and watery. Add a pinch of salt, stir, only to mix, cool, strain, and put in ice-chest.

Flour Ball.

Tie 2 pounds of wheat flour in a cheese-cloth bag, and boil in 2 quarts of water for five hours. Remove from water; place in oven until quite brown on the outside. This will require from two to three hours slow baking. Break open and throw away the brown shell; the remainder, the baked flour, must then be grated into a powder, or may be ground in a mill.

Albumin Water.

To ½ cup of cold boiled water add the white of 1 fresh egg and a pinch of salt. Stir very thoroughly. A piece or two of artificial ice may be added before stirring. One-half teaspoonful of sugar and orange juice may be added, if not contraindicated. Barley water may be used.

Albumin Water with Beef Extract.

One-quarter teaspoonful of beef extract may be added to the cold water before adding the egg albumin.

White of Egg and Digested Gruel.

Whites of 2 eggs may be added to 1 pint of dextrinized barley, oatmeal, etc., gruels. Stir thoroughly.

Pasteurized Milk (double boiler).

Place milk in cold water bath, having water to level of milk; bring milk to temperature between 155° and 167° F. for 15 to 20 minutes.

Sterilized Milk (double boiler).

The milk mixture is put into the inner vessel cold, and the water in the outer vessel is also cold. The double boiler is then placed on the stove and allowed to remain until the water in the outer vessel boils for 6 to 8 minutes; the whole process requires 10 to 15 minutes. While the milk heated in this manner forms a much finer and softer curd than that of raw milk, it is not as fine as the milk boiled directly over the flame.

Whey.

Heat 1 quart of clean raw milk to 104° F., and add 1 level teaspoonful of chymogen or fresh essence of pepsin (Fairchild's). Allow it to stand for one-half hour, pour off the free whey, pour the curd into a straining cloth for one-half hour, and collect the remainder of the whey.

Chymogen Milk.

Boil milk for five minutes, cool to 104° F., and add 1 full teaspoonful of chymogen to each quart of milk, and stir for one-half minute. Let it come to a clabbard by allowing it to stand for 15 minutes; then beat it well until the curd is finely divided. Do not heat above 100° F., when preparing individual bottles for feeding, otherwise curds will clump, and will not pass through the nipple.

Indications for chymogen milk: (1) Vomiting in infancy; (2) indigestion due to the large curd formation.

Buttermilk in the Home.

A pure culture of lactic acid bacilli is added to raw, pasteurized, or boiled milk in an earthenware dish, and allowed to stand at about 80° F. for 15 to 20 hours, or until the casein is coagulated. Stir vigorously in a churn, or with a spoon or egg-beater until the curd is very small, and then push the contents through a fine wire strainer with a spoon. If the buttermilk is too thick, add a small amount of water. When the buttermilk is once made, a small portion (about 4 ounces) may be used as the inoculating agent for the next supply to be made. In this way the original culture may be made to last from six to eight weeks. The quality and action of the product made will vary but little. Add 4 ounces of buttermilk to 1 quart of fresh milk, incubate, and follow the above outline. Sometimes the milk will not coagulate, although it may smell sour. Stirring with a spoon will often produce coagulation in a few minutes. The fat present will rise to the top, and when coagulated appears as a brownish-yellow scum, which may be removed before the curd is broken up. At the present time the market is flooded with tablets for the preparation of buttermilk, but one must hesitate before using them to prepare milk for a baby. A pure culture should be used, or one recommended by the physician. Whole or skim milk is to be used as indicated in each individual case.

Startoline.

Carefully pasteurize 2 quarts of fresh whole milk to a temperature of 180° F. for one hour, or boil for five minutes; cool quickly to about 80° F., and add 1 ounce of Hanson's Lactic Ferment Culture, and let it stand undisturbed until well curdled, which should be in 15 or 20 hours, at a temperature of 75° F. Then place on ice. When ready to use, beat curd up with a spoon until it is of a creamy consistency.

Buttermilk for Hospital Feeding.

Pasteurize whole sweet milk to a temperature of 180° F. for one hour; then place in cold water until cooled to

80° F. Add 1 ounce of startoline to every quart of milk, stir with a spoon, and cover; allow to stand from 15 to 20 hours, then churn for one hour; then add a little cold sterile water to break butter away from milk; and strain buttermilk.

Buttermilk and Skim Milk Mixture.

To a few tablespoonfuls of buttermilk add 2½ level tablespoonfuls of flour (flour ball or dextrinized barley flour), to make a paste. Make up to 1 quart with buttermilk. (1) Bring to a boil, withdraw from fire. (2) Bring to a boil, withdraw from fire a second time. (3) Add 4 level tablespoonfuls of cane-sugar, and bring to a boil for the third time. (Maltose-dextrin preparations are best in all diarrheal conditions.) (1, 2, and 3 should require about twenty minutes time.) Make up to 1 quart with boiled water, if it has boiled away; put on ice. It is well to start with one-half the amount of sugar, and increase as indicated.

Brady's Buttermilk Mixture No. 1.

Dr. Jules Brady, of St. Louis, has suggested the two buttermilk mixtures following, which contain less carbohydrates than the above buttermilk mixture, and which he has found especially valuable in the feeding of infants in institutional practice.

Mixture No. 1, which is used for young infants during the first two months, contains 11 calories in each ounce; the young infant receives 4 ounces of this mixture for every pound of body weight as soon as it will take it. The baby weighing 6 pounds at birth is allowed to take 24 ounces in twenty-four hours, or 3.5 ounces every three hours, 7 feedings in twenty-four hours. The average infant at three or four days will take 1 ounce; at eight days, 1 to 2 ounces; at fourteen days, 1½ to 2 ounces; at three weeks, 2 ounces; at six weeks, 3 ounces; at eight weeks, 4 ounces.

Mixture No. 1.

¾ quart skim milk.
¼ quart barley water (thick).
1 ounce by measure, Mellin's Food.
½ ounce granulated sugar.

The ingredients are mixed together in the following manner: To the barley gruel is added the cane-sugar and the Mellin's Food, and then the buttermilk is slowly added, and the mixture strained. Note that the buttermilk is not boiled. The mixture is rather thick, and has the sour taste of buttermilk. As a rule, the milk is acidified with lactic acid bacilli twelve hours before being made up, having first agitated it.

Brady's Buttermilk Mixture No. 2.

On reaching a weight of 8½ to 9 pounds, infants receive the mixture No. 2, which contains 18 calories for every ounce. The babies are allowed 3 ounces of the mixture No. 2 for every pound of body weight.

Mixture No. 2.

⅔ quart whole milk.
⅓ quart barley water (thick).
1 ounce granulated sugar.

Indications for buttermilk and skim milk mixtures:

1. Fat indigestion.
2. Loose bowels (it may be necessary to reduce the amount of sugar. The high protein contents tends to constipate).
3. Malnutrition, with stationary weight.

Keller's Malt Soup.

To 11 ounces (330 Gm.) of warm milk gradually add 1⅔ ounces (50 Gm.) of flour, stir constantly, then pour through a clean sieve or muslin. In another dish dissolve 3 ounces (100 Gm.) by weight, or 2½ ounces or tablespoonfuls by measure, of Borcherdt's malt extract with potassium carbonate in 20 ounces (600 Gm.) of boiled warm water. Then mix both solutions, put on fire, stir continually, and boil for two or three minutes.

Indications for Keller's Malt Soup:

1. Fat indigestion.
2. Disturbed metabolic balance (fat-soap stools).
3. Chronic constipation (often relieved by simple addition of malt soup extract to ordinary milk mixture in place of part of sugar).

Contraindications:

1. Before the third month, if the stools are loose.
2. For a period of more than four to eight weeks (to be followed, where possible, by ordinary milk mixtures, the strength of the latter being gradually increased).

Cream Soups.

Cream soups may be made from vegetable pulp, using 1 tablespoonful of cooked potatoes, peas, or asparagus to ½ cup of water in which the vegetables were cooked, ½ cup of sweet milk, and ½ teaspoonful of flour, with a little butter and salt. Cook another minute or two. Strain if necessary. Serve.

Corn or tomatoes may be used in the same manner, using 2 tablespoonfuls of strained vegetables, with about one-third water and two-thirds milk. When tomatoes are used, add a small pinch of soda to tomatoes before adding other ingredients.

Vegetable Soup.

One-fourth pound lamb stew, cut into pieces, 1 potato cut into pieces, 1 carrot cut into pieces, 2 stalks of celery cut into pieces, 1 tablespoonful of pearl barley, 2 tablespoonfuls rice, 2 quarts water. Boil down to 1 quart; boil three hours. Add pinch of salt, and strain before feeding.

Lamb, or Veal Broth.

Lean meat chopped fine, 1 pound; cold water, 1 quart; a pinch of salt; cook slowly two or three hours to 1 pint. Add water from time to time, so that when finished there will be 1 pint of broth. Strain; when cold, skim off fat.

Chicken Broth.

Small chicken, or one-half of large fowl, with all skin and fat removed; chop bones and all into small pieces; add 1 quart boiling water and a little salt; cover closely, and allow to simmer over a slow fire for two hours. After removing allow to stand one hour; then strain. Add water, if necessary, from time to time, so that there will be 1 pint when finished.

Farina Soup.

To 1 pint of meat broth, gradually add, while stirring, 1 even tablespoonful of farina, and boil down to 1 cup (½ pint) in about twenty minutes. It is a good plan to boil the farina for from fifteen to twenty minutes before adding it to the broth; then broth and farina need to be boiled together for but ten minutes.

Dried Fruit Soup.

Wash thoroughly 1 cup of dried apricots and 1 cup of prunes. Cook in 1 quart of cold water until very soft. Strain and press out all juice. Sweeten to taste. Thicken with a tablespoonful of rice flour to 1 quart of the liquid. Cook twenty minutes to remove the raw taste of the flour.

Soy Bean and Condensed Milk (Ruhrah).

Add a level tablespoonful of soy bean flour to 2 level tablespoonfuls of barley flour, add a pinch of salt, and mix to a paste with boiled water, adding further water to 1 quart. Boil for twenty minutes, and add water to make up for the loss due to evaporation during boiling, so that total mixture is 1 quart. Condensed milk is now added, varying in quantity from ½ to 1 dram of condensed milk to each ounce of the mixture, depending upon the age and the condition of the infant. Double the quantity of soy bean and barley flours may be used for older children. Each ounce of soy bean gruel contains 10 grams of protein and 102 calories. Two ounces of soy bean gruel in a quart of water contains 0.56 per cent. protein, 0.62 per cent. fat, and 3.31 per cent. sugar.

The quantity of the feedings may be varied according to the condition and needs of the infant, varying from 1 to 8 ounces per feeding.

It is indicated whenever fresh clean milk is not obtainable, in infants with marasmus, in some intestinal disturbance associated with diarrhea.

Beef Juice.

Take ¼ to ½ pound round steak, broil slightly, cut into small pieces, and then press out the juice with a meat press or potato ricer, and add a small pinch of salt. Feed fresh, or warm before giving, but do not heat sufficiently to coagulate albumin.

Potatoes.

Boil potatoes in salt water in the ordinary way until they are thoroughly done. Then mash through a very fine sieve, and add a little butter.

Spinach.

Cook spinach in salted water until tender. Pour cold water over it, and drain. Chop fine, or rub through a coarse sieve. To 2 tablespoonfuls of spinach add 1 teaspoonful of fine breadcrumbs, ½ teaspoonful melted butter, and a little salt. Reheat and serve.

Asparagus.

Cook one-half of a bunch of asparagus in about a pint of slightly salted water. When tender, remove stalks one by one. Place on a warm plate, and remove pulp by taking hold of the firm end of the stalk, scraping lightly with a fork towards the tips. Use pulp only. Make a sauce with one-fourth of a cup of water in which asparagus was cooked, one-fourth of a cup of milk, 1 teaspoonful flour, a little butter and salt. Dip a small piece of toast in the sauce. Take what is left of the sauce and mix with 2 tablespoonfuls of asparagus pulp. Reheat. Place on toast and serve.

Carrots.

Cook ½ pound of young carrots in a pint of fat-free soup stock or slightly salted water, adding more if it cooks away before they are done. Rub through a sieve; add 1 teaspoonful of bread-crumbs, a little butter and salt. Reheat and serve.

Beans.

Soak 2 ounces or 4 tablespoonfuls of beans, and cook them slowly in a good deal of water until they are soft, but not broken. Rub through a sieve, add 1 cupful of soup stock, and let them cook for one-half hour, adding more stock if it boils away. Mix a little butter and flour, about a teaspoonful of each, and a little salt. Add to soup. Return to fire, and cook for a few minutes.

Green Peas.

Cook a cupful of green peas in boiling salted water until they are done. Drain, saving the water in which they are cooked. Rub through a coarse sieve. Make a sauce of 2 tablespoonfuls of water in which the peas were boiled, 2 tablespoonfuls of sweet milk, ½ teaspoonful flour, ½ teaspoonful fine bread-crumbs. Mix all together. Reheat and serve.

Fruits.

(*a*) *Orange Juice:* Take sweet orange, cut into halves, and squeeze out juice by hand or with a lemon squeezer; strain, put on ice, and use as ordered.

(*b*) *Prune Juice:* Take ½ pound of prunes, wash thoroughly, cover with cold water, and soak overnight. In the morning place on stove in the same water, and cook until tender. Add 1 teaspoonful of sugar, and strain.

(*c*) *Prune Jelly:* Cover 1 pound of prunes with 1 quart of water; cook slowly until tender; pit, and press pulp through a sieve. Add sugar to sweeten (2 teaspoonfuls) and ½ box of gelatin dissolved in a pint of water, and boil. Strain, cool, and keep covered.

(*d*) *Apple Sauce:* Take 6 apples and peel, core, and cut them into quarters. Place them in an enameled dish; sprinkle over them 1 tablespoonful of sugar; add 1 cup of cold water; put the dish on the stove, and boil the apples to a mush (about thirty minutes).

(*e*) *Orange Gelatin:* Soak ½ box of shredded gelatin in cold water for thirty minutes. Add 2 cupfuls of boiling water, and dissolve. Then add 1 cupful of sugar, the juice of 1 lemon, and a cupful of orange juice. Strain through a fine strainer (or a cloth) into moulds, and set away to harden.

Eggs.

Use only soft-boiled or poached eggs. Be sure that the eggs are fresh. Drop egg in boiling water; immediately turn flame out, and allow to stand for five minutes.

Pap.

Put 1 pint of milk on to boil; add butter the size of a walnut. Beat 1 egg thoroughly. When milk boils, add the beaten egg, stirring constantly. Mix 1½ tablespoonfuls flour into a paste and add to mixture, stirring constantly. Allow mixture to boil ten minutes. Just before taking from the fire add a pinch of salt. May be taken plain, or with milk and sugar as directed.

Cornstarch Pudding.

Take 1 pint of milk and mix with 2 tablespoonfuls of cornstarch; cane-sugar, 1 tablespoonful. Flavor to taste; then boil the whole eight minutes. Allow to cool in a mould.

Custard Pudding.

Break 1 egg into a teacup and mix thoroughly with sugar to taste. Then add milk to nearly fill the cup. Mix again, and tie over the cup a small piece of linen. Place the cup in a shallow saucepan half full of water, and boil for ten minutes.

If it is desired to make a light batter pudding, a teaspoonful of flour should be mixed in with the milk before tying up the cup.

Infant's Gelatin Food.

About 1 teaspoonful of gelatin should be dissolved by boiling in ½ pint of water. Toward the end of the boiling, ¼ pint of cow's milk and 1 teaspoonful of arrowroot (made into a paste with cold water) are to be stirred into the solution, and 1 to 2 tablespoonfuls of cream added, just at the termination of the cooking. It is then to be moderately sweetened with white sugar, when it is ready for use. The whole preparation should occupy about fifteen minutes.

Albumin or Eiweiss Milk (Finkelstein).

One quart. Take fresh whole milk, bring to a temperature of 98° to 100° F. Then add 2 level tablespoonfuls of chymogen powder to a quart of milk; place in a water bath of 107° F., for fifteen to twenty minutes, until coagulated. Then hang in a sterile muslin bag for one hour to drain.

To the curd of 1 quart of milk add 1 pint of buttermilk, and rub through a copper gauze strainer three times.

Then add 2 level tablespoonfuls of wheat flour, flour ball, or imperial granum, rubbed to a paste with 1 pint of water. Boil ten minutes, cutting back and forth constantly, not stirring, with a large wooden spoon, otherwise large curds will form. If needed, water should again be added, when directed by the physician. Finkelstein advises the early addition of 3 per cent. of carbohydrate in the form of a maltose dextrin compound. This is best done by dissolving the sugar in a moderate quantity of water, and adding while the mixture is being boiled. It must not be heated above 100° F. before feeding, otherwise it will clump.

Albumin milk contains: protein, 3 per cent.; fat, 2.5 per cent.; milk-sugar, 1.5 per cent.; starch, 1.0 per cent.; salts, 0.5 per cent. Caloric value is 450 calories per liter, or 12 calories per ounce.

Indications for albumin milk (Finkelstein):

1. Diarrheas and all cases of abnormal intestinal fermentation (sugar).
2. Fat indigestion with low sugar tolerance.
3. Gastro-intestinal infections associated with frequent stools.
4. Systemic infections with intestinal complications.

Albumin Milk (Müller and Schloss).

Use 1 quart of water and 1 quart of buttermilk, and boil for three minutes. Set aside for thirty minutes, and then pour off the upper 36 ounces of the whey. Boil the upper 4.5 ounces of a quart of fresh milk for three minutes. Add 1 ounce of dextri-maltose to the boiled top milk, and to this add the curds from the first mixture, which would equal 27.5 ounces, making 1 quart of the milk mixture.

Larosan Milk.

Two-thirds of an ounce of Larosan powder (p. 276) is added to ½ pint of milk, and mixed thoroughly. Another whole pint of milk is heated to the boiling point. When it has come to a boil, it is added to the Larosan milk mixture, and the whole is placed on the flame and allowed to boil for five minutes. This may be diluted with water in the proportion of one-half Larosan milk and one-half water, or two-thirds Larosan milk and one-third water.

Fig. 16.—Utensils needed for artificial feeding: Double boiler (small), pan, funnel, bottle-brush, 250-mil (8 oz.) graduated glass or pitcher, 6 nursing bottles and rack, paper caps for bottles (sterile), nipples, milk, sugar, flour, milk magnesia, citrate of soda, tablespoon, dairy thermometer, vegetable mill.

This mixture, because of its high protein content and comparative ease of preparation, can be used as a substitute for albumin milk in the home.

Meats.

Raw or slightly cooked beef, scraped and seasoned, can be fed in amounts equaling a tablespoonful at eighteen months or sooner, once daily.

Take meat, preferably from the round, free from fat. Place on a board and scrape with a silver spoon. When you have the desired amount of meat pulp, shape into a pat and broil on a hot, dry spider. Do not cook too long. When done, season with a little salt and butter. Serve. A few drops of lemon juice may be added.

Later, lamb, beefsteak, roast beef and chops are the best, and should be broiled. By no means fry any meat for the baby. Soup meat, well cooked, may also be given. All meats should be very finely cut before giving them to children.

BOTTLES AND NIPPLES AND THEIR CARE.

The nursing bottle should be of such a construction that every portion of it is easily reached with a proper brush. This necessitates the avoidance of sharp corners and angles, and makes the smooth stream lines in its construction desirable. It should be made of good glass, not easily broken, capable of being boiled repeatedly without cracking, and should hold about 8 to 10 ounces. Several nursing bottles should be kept on hand, and, if possible, as many bottles as there are nursings in a day should be available, so that the whole day's feeding may be prepared according to the particular formula, and the mixture then iced, and the individual bottles warmed on a water-bath whenever necessary. New bottles should be annealed by placing them in a vessel with cold water, and then bringing the water to a boil, boiling for twenty minutes, and then leaving the bottles in this water until it will cool off again. Bottles thus treated do not crack so easily when hot fluids are poured into them. After nursing, the bottle should immediately be rinsed with cool water, and then washed with hot water and soap suds by means of a bottle brush. Afterwards the bottle should be set aside, inverted, so as to drain. Before use, the bottles should be boiled for five minutes. To avoid cracking, they must be placed in cold water and heated slowly. After the food has been prepared, the individual

Fig. 17.—Good and bad nursing bottles. 1. Ordinary small-neck nursing bottle as sold in drug stores (8-ounce). 2. Improved large-neck nursing bottle (made in 5- and 10-ounce size). 3. Hygiea nursing bottle.

bottles may be filled and stoppered with sterile cotton, or, better, sterile paper caps, which are sold for this purpose.

Nipples that can be turned inside out and easily cleansed should be selected. The conical shaped nipple is preferable. The hole in the nipple should be of such size that the milk will drop rapidly and not flow when the bottle is inverted. New nipples should be boiled before they are used. After using, every nipple should immediately be washed with soap and water, being turned inside out, boiled and finally dropped into a sterile jar, where it is to be kept dry until ready for use again. Keeping the nipples dry lengthens the life of the rubber. Several nipples should always be kept on hand.

Fig. 18.—A milk station consisting of three rooms. Room 1. For all used bottles, bottle washers, and steam bottle sterilizers. Room 2. A clean room for preparation of formulæ. This room also contains milk separator, fat-testing apparatus and butter churn. Room 3. Pásteurizing and sterilizing apparatus.

CARE OF FOOD DURING TRAVELING.

Whenever possible, the baby should be kept on its usual diet during the long journey. This is usually accomplished without much difficulty when the baby is on boiled milk. If it has been fed on a raw milk mixture, the milk must be boiled before starting. When for any reason it is impractical to carry the milk mixture, evaporated milk or powdered milk may be used. (See Proprietary Infant Foods, p. 273.) In the use of evaporated milk, a fresh can must be opened at least once daily. When it is known that the baby's formula is to be changed, it should be tried out on the new food before starting on the journey. As soon as possible, the previous diet should be re-established. All water given to the baby while traveling must be boiled. The infant's food, after boiling for at least ten minutes, should either be placed in individual nursing bottles, or in bottles holding not more than 1 pint, so that not more than two or three feedings should be given from a single bottle. The bottle should be packed in ice, using care so that none of the ice reaches the top of the bottle. Upon reaching the train they should be placed in the ice-box of the dining or buffet car, unless a private ice-box is available. The baby's bottle can be warmed on the train by setting in a dipper of warm water, which may be carried hot in a thermos bottle, if the journey is to be a short one. Care must be taken that the water be not too hot, otherwise the cold bottles will be cracked. The nipples may be carried in a wide-mouthed, well-corked bottle, sufficient to cover the individual feedings. The nipples and bottles should be cleansed immediately after use.

THE DIAPER.

The diaper should be made of soft, light, and absorbent material, such as cotton diaper cloth, which can be purchased for this purpose. Cotton-flannel is too little absorbent, and soon becomes hard as a result of washing. A second diaper may be folded into a square, and be laid under the hips to prevent the moisture from reaching the clothes, or instead of this arrangement, which is rather heating and bulky for summer use, a small diaper may be folded two or three times to form a square of about nine inches, and this may be placed inside of the larger diaper to receive the urine and feces. About four dozen diapers are needed for an average baby.

A rubber or waterproof cover should never be applied outside the diaper. It is very heating, and liable to produce chafing and eczema. Diapers should be changed as soon as soiled, except at night, when they should be changed when the child is awakened for feeding, or when it is awakened by its own discomfort. Soiled diapers are always a source of discomfort, and not infrequently the cause of severe irritation of the skin, as well as of infections of the genital and urinary tracts. This is especially true in the case of female infants. No diaper should be applied a second time without first being washed. All diapers which have been soiled by discharges from the bowel should have the bulk of the feces removed from the diaper, and should be immediately washed with soap not too alkaline in character, and later boiled for twenty minutes, and thoroughly rinsed, so that all alkali may be removed. They should then be aired thoroughly. Soda and washing-powders should be avoided because of the danger of irritating the child's buttock's, after being moistened by the urine.

The diapers of an infant ill with an intestinal infection should be cared for separately from those of other children. After changing the diapers, the nurse's hands and nails should be scrupulously cleansed with brush and file.

BABY'S DAILY BATH.

The baby should be bathed at least once a day, and on hot days even as many as three sponge-baths may be given. In the first six months the temperature of the bath should be 100° F., and in the second half of the year from 90° to 95° F. The room in which the bathing is done should have a temperature of at least 70°, and not more than 75° F.

Toward the end of the first year the infant may be sprayed for 15 to 30 seconds with water at 75° to 80° F. This should be followed by brisk rubbing of the entire body. In young infants the bath is most conveniently given before the mid-morning feeding, and the face and hands may be sponged before the 6 o'clock feeding. In older infants, a cool sponge and massage may be given in the morning, and the warm bath at bedtime.

Before the umbilical cord has separated, sponge-bath only should be given, and never a submersion bath, for the fear of infection of the umbilical stump. Sponge-bath may be given on a towel, and when a tub-bath is given, the child should be allowed to rest upon the attendant's left arm, which is slipped under its back from the baby's right side. By grasping the baby under the armpit with the left hand a good hold is secured, which prevents slipping. The right hand is left free for washing the baby. A special wash-cloth, preferably of cheese-cloth, should be provided for washing the baby's face and head.

A pure, bland, white soap should be used. Very little soap is needed for cleansing the baby's skin, and it is most important that the skin should be thoroughly rinsed. If the skin is sensitive and easily irritated, soap should be avoided, and the bran-bath (made by putting a handful of bran in cheese-cloth bag and soaking this in the water until milky) should be used.

After the bath the baby should be wrapped in a large soft towel and dried by sponging, and not by rubbing. Special attention should be paid to folds and creases of

Fig. 19.—Hospital bathroom. Located between two small wards for infants, showing two metal water jackets resting on a porcelain sink. These can be filled with water, and have a registering thermometer for indicating the temperature before giving the bath. They are covered with a clean towel for each baby. Baby is showered from an automatic mixing tank, which registers temperature of the water in the tank. The room further contains a scale and a low dressing table, with the various dressings, powders and ointments to be used. Also low nursery chairs, collapsible bags for soiled linen, and waste basins.

the skin, and these should be well powdered after being thoroughly dried.

Only warm baths should be used in infants who become pale and cyanotic when a cooler bath is used.

Care should be taken in bathing all children suffering from coughs. Great care should also be used while bathing a child suffering from vulvovaginitis, to avoid infection of the eyes.

COLD BATH AND COLD PACK.

Cold bath is an efficient antipyretic and nervous depressant in cerebral irritation, but it is a somewhat severe procedure for the infant, and is less frequently indicated than in the adult. It is to be used only in infants who react well. The bath is started with water at 100° F., and the temperature is then gradually lowered by the addition of ice-water, down to about 80° F. The infant should be continually rubbed while in the bath. The bath should not be longer than five to ten minutes, and should be discontinued at once, if any cyanosis appears. The infant must be dried quickly, and then wrapped in a dry blanket, without dressing, and put to bed.

In most cases, however, a cold pack is preferable to cold bath, especially in young infants, as the former is a somewhat milder procedure. Cold pack is one of the best antipyretic procedures in infancy and childhood. The naked child is wrapped in a blanket wrung out of water at a temperature of about 100° F., and is then rubbed with ice through the blanket for about five to ten minutes. Ice-bag to head and hot-water-bag to feet are very useful—often necessary. After rubbing with ice, the child is left in the blanket, and covered well. The blanket may be removed, the child dried, and put into a dry blanket after about one hour.

HOT BATH.

Hot bath is indicated in cases of collapse or shock as a stimulating procedure, and prolonged hot bath as a diaphoretic procedure. It should be started with water at a temperature of 100° F., and the temperature gradually raised to about 105° F. by addition of hot water. An ice-cap or cold cloth should be applied to the head. A thermometer should always be used while giving a hot bath. The infant should be well rubbed during the bath, which should be continued for about ten minutes. After the hot bath the infant should be well dried, until the skin is red, and then wrapped in a blanket and put to bed.

MUSTARD BATH AND MUSTARD PACK.

Mustard bath and mustard pack are indicated for their stimulating effect in cases of shock or collapse, and in acute congestion of internal organs, and also in convulsions.

The amount of mustard used and the temperature of water is the same in both procedures. Powdered mustard, in quantity of about 1 level tablespoonful to each gallon, or 1 teaspoonful to each quart, when smaller quantities are sufficient, should be used. Full quantity of mustard powder is first dissolved in about a gallon of warm water, and to this the rest of the water is added, while preparing the bath. For giving the pack, a smaller quantity of water is usually required. The temperature of the water should be about 100° F., and it may be raised to about 105° F. by addition of hot water. Cold applications should be made to the head.

The bath should be continued for about ten minutes, accompanied by rubbing the skin, and followed by ablution with lukewarm water, rapid drying, wrapping in a blanket, and rest.

Mustard pack is somewhat less efficient than mustard bath, but it is also less severe and less disturbing to the infant. The naked child is wrapped in a blanket which has been wrung out of water prepared as above stated. The infant is left in the pack until the skin is well reddened—about ten to twenty minutes—then washed off with warm water, followed by lukewarm water ablution, dried, and put to bed without dressing.

STOMACH WASHING.

The apparatus for stomach washing consists of a soft rubber catheter, 20 to 24 French, or infant stomach-tube, a small funnel, attached to a rubber tube, and a glass connection between the catheter and the tube.

The infant is wrapped with the arms confined, and is held in the sitting position, with a large basin at the nurse's feet. The tongue is depressed with the forefinger of the left hand, and the right hand passes a catheter rapidly backwards into the pharynx and down into the œsophagus. Gagging is aggravated by passing this catheter slowly. After the catheter is part way in the œsophagus, it should be passed more slowly. As the cardiac orifice is passed, and the catheter enters the stomach, gagging again becomes more evident. This can be used as a sign that the catheter is entering the stomach. A good rule to follow in passage of the catheter is to measure the distance from the root of the nose to the tip of the ensiform cartilage, which approximates the distance from the teeth to the cardiac end of the stomach, and then pass the catheter about an inch farther. The passage into the stomach is usually marked by the appearance of curdled milk in the glass connecting tube. The funnel should now be raised as high as possible, to facilitate the escape of any gases from the stomach, and should then be lowered, in order to siphon any fluid contents. The funnel is then raised, and warm water at a temperature of about 100° F. is poured into the stomach quickly. The amount of water passed into the stomach at any time should about equal the quantity of the feeding to which the child is accustomed. The funnel is then lowered, just before all of the water leaves the tube, and the water siphoned out. This procedure is repeated a number of times, until the fluid comes back clear. During withdrawal, the tube must be compressed carefully to prevent leakage into the larynx. The washings should be collected and measured, so that the quantity remaining in the stomach may be estimated.

Sterile water or one-half strength normal saline, Ringer's solution, or a solution containing sodium chloride 5 Gm., sodium bicarbonate 5 Gm., and water 100 mils, may be used. It is frequently advisable to allow part of the solution to remain in the stomach.

Stomach washing is indicated in vomiting due to pylorospasm, hypertrophic pyloric stenosis, all forms of gastric irritation, chronic indigestion, acute dilatation of the stomach, and food and drug poisoning.

CATHETER FEEDING BY MOUTH.

The same apparatus is used as in stomach washing, the same technic being used for the introduction of the catheter, except that its tip should not be made to pass the cardiac end of the stomach, the food being allowed to enter the œsophagus just above the cardia. This is accomplished by passing the catheter about one-half inch less than the distance from the root of the nose to the tip of the ensiform cartilage. The infant should be lying on its back, and not in sitting posture, as recommended in stomach washing. When the feeding is finished, the catheter should be tightly pinched between fingers and rapidly withdrawn, to prevent any food from trickling into the larynx. It is often advisable to wash the stomach before the food is introduced.

Catheter feeding is indicated in the feeding of premature infants, infants refusing their diet, those too weak to nurse, in the presence of persistent vomiting, and in all cases of delirium and coma.

CATHETER FEEDING BY NOSE.

This is not indicated in young infants. In older children it is often impossible to pass the catheter through the mouth, without undue struggling. It is also indicated in throat paralysis following poliomyelitis and diphtheria, and after throat operations and intubation. The method is similar to that described in catheter feeding by mouth, except that a smaller catheter (No. 15 French) is to be used.

IRRIGATION OF THE COLON AND RECTAL FEEDING.

The apparatus varies somewhat with the purpose to be accomplished. Where large quantities of fluids are to be introduced, it is necessary to use a douche-can or fountain syringe, 4 to 5 feet of tubing, and a flexible rectal tube or soft rubber catheter (size 20 to 24 French). When small quantities are to be introduced, a glass funnel may be used in place of the douche-can. When large quantities of fluid are used, the can must not be raised more than 2 feet above the child's body. The child should be turned upon its side, with the lower limb extended, and the upper thigh flexed upon the abdomen. The catheter should be well oiled, and introduced for about 3 to 4 inches when large quantities are to be given, and further introduction of the catheter may be made while the solution is flowing into the rectum.

Indications. 1. To produce evacuation of the bowel. A salt solution containing a level teaspoonful of salt to a pint of tepid water or weak soap-suds solution, or a teaspoonful of glycerin in an ounce of water; or in the presence of large fecal masses, 2 or 3 ounces of sweet oil may be used.

2. To reduce temperature. At least 1 to 4 quarts of a salt solution or weak soap-suds enema at about 95° F. should be used, allowing about ½ to 1 pint to enter the rectum, and repeating after expulsion.

3. Rectal feeding. A normal salt solution or nutrient enemata containing 2 level tablespoonfuls of dextrose to the pint of normal saline solution may be used. It is indicated in cases of acidosis, and also in the presence of vomiting, intoxication, and decomposition where the body is in need of water. It is usually necessary that only a small amount (2 to 6 oz.) of this solution be introduced at a time, or that it be given by the drop method. Otherwise it will not be retained. It should be repeated at regular intervals of from two to four hours. It may be necessary to compress the buttocks for twenty minutes after administration, when the fluid is not well retained otherwise.

4. Medication. There are two indications for rectal medication: (1) For the systemic effect. The drugs most commonly used for this purpose are chloral hydrate

and the bromides, more especially in the presence of convulsions or coma. They should be diluted in small quantities of water or salt solution, not over 1 ounce, and may be administered in about four times the oral dose for the given age. (2) For local effect. Enemata are indicated for their local effect in the presence of marked tenesmus, inflammation, ulceration and hemorrhage. Not infrequently the tincture of opium (3 to 5 drops) and tincture of belladonna (3 to 5 drops) are administered, probably best in a 10 per cent. starch solution, for their sedative effect. In the presence of inflammatory processes, 1 per cent. silver nitrate solution may be used.

SALINE SOLUTIONS.

1. For subcutaneous use. They are especially indicated in the presence of considerable loss of body fluids through vomiting, refusal of diet, and diarrhea, and in the presence of acidosis. Rectal administration should first be tried, and, in case that sufficient fluids cannot be administered to meet the infant's needs in this way, hypodermoclysis should be instituted. In infants 2 to 4 ounces can usually be administered, and in older children 4 to 6 ounces. This can be repeated every four hours, if necessary, or until fluids can be supplied by another route. Fluids can be administered beneath the skin of the abdomen, chest, or lumbar region. There is some shock accompanying the administration of large quantities of fluids subcutaneously, probably due to the pain, and it is frequently necessary to give a child in collapse some subcutaneous stimulation of camphor in oil (10 per cent. 1 mil), or adrenalin solution (1:1000, about 5 drops), before administration. The stimulating injection

is to be made in regions of the body other than where the saline injection is made.

The best solutions for this purpose are

(a)	NaCl	7.5 grams.
	KCl	0.1 "
	CaCl	0.2 "
	Water, q. s. ad	1000.0 mils.

(b) Dextrose may be added to the above solution in proportion of 50 grams to the liter (5 per cent.).

All solutions used for subcutaneous administration should, if possible, be made from fresh distilled water, and re-sterilized shortly before use.

2. Intravenous injections. The same solutions as indicated for subcutaneous use may be administered intravenously. Sodium bicarbonate, 30 Gm. to the liter, being added in the presence of acidosis and dextrose, 50 Gm. to the liter in cases of malnutrition and decomposition. Either direct or indirect transfusions of blood are also of extreme value in the presence of marked marasmus.

Technic. In older infants and children the injection may be made into the external jugular or median basilic or median cephalic veins. In young infants with open fontanelle, the longitudinal sinus is the most convenient point for administration. However, in the use of the latter method extreme care must be used, because of the ease with which the sinus wall can be punctured. All apparatus used in the intravenous administration must be thoroughly and freshly sterilized before use. Where a moderate quantity of fluid is to be administered (2 mils, 10 mils, or 20 mils) all glass Record or Luer syringes can be used. In injection of fluids into the longitudinal sinus a short bevelled needle, about 0.75 inch in length, should be introduced at the posterior angle of the fontanelle.

The region of the fontanelle is sterilized, and the first syringe is three-quarters filled with the fluid to be injected. The syringe is now connected with a needle by means of a short piece of rubber tubing to allow flexibility in case of movements on the part of the child, and the needle is passed into the sinus, its entrance being recognized by a sudden lessening of the resistance. Helmholz* suggests that the question of negative pressure within the sinus is one that must not be overlooked, and it is always well in entering the sinus to have the syringe attached, and before injection to withdraw blood, to make sure that the needle is in the sinus. Unless a head-clamp, as described by Helmholz is available, two assistants are required, one to hold the child's head firmly, and the second to manage the syringe, while the physician steadies the needle. From 100 to 200 mils of either a saline, dextrose solution or citrated or fresh blood can usually be administered without difficulty. Unger† has described an apparatus whereby large quantities of fresh blood can be transfused.

HOME-MADE ICE-BOX.

The following home-made ice-box described by Holt and Shaw will answer, if a more elaborate refrigerator is not available.

Get from your grocer a deep box about 18 inches square, and put 3 inches of sawdust in the bottom. Place two pails in this box—one a smaller pail, inside the other

* Helmholz, H. F.: The longitudinal sinus as the place of preference in infancy for intravenous aspirations and injections, including transfusion. Am. Jour. Dis. Child., 1915, x, 194.

† Unger, J. J.: A new method of syringe transfusion. Jour. Am. Med. Ass'n., 1915, lxiv, 582.

—and fill the space between the outer pail and the box with sawdust. The nursing bottles filled with milk are placed in the inner pail. This pail is then filled with cracked ice, which surrounds the bottles. The inner pail should have a tin cover. Nail several thicknesses of newspaper on the under surface of the cover of the box. This ice-box should be kept covered, and in a shady, cool place. The water from melted ice should be poured off, and the ice renewed at least once each day.

Fig. 20.—An asbestos-lined copper receptacle for electric heating pads for use in the care of premature and debilitated infants (*Hess*). To avoid the danger of fire from short circuits in electric heating pads, a copper receptacle is used, 16 inches long, 13 inches wide, and 1¼ inches high, into which a 12 x 15-inch heating pad is laid. To allow of a maximum radiation from the lid or upper surface of the same, the floor and sides are lined with asbestos sheeting, while the lid is not lined. The cord passes through a small rubber insulator at the side to prevent contact with the metal and injury to the cord. This simple device can be used temporarily in wards and homes where better facilities for the care of this class of infants are lacking. It is to be placed in the bottom of a basket or crib, under the mattress or pillow.

CASE HISTORY.

(A) Present Illness.

1. Complaints: Mother's or patient's own statement.
2. Get history of present illness in detail: onset, course and duration. Fever. Vomiting. Stools. Urine. Eruptions. Sleep, etc.
3. Previous treatment, if any.

(B) Previous History.

1. *Birth*: Para, nature and complications.
2. *Development*: Teeth (time of eruption), sat erect, walked, talked, mentality.
3. *General Health*: Robust or delicate, appetite, colds, fevers, coughs, bowels, convulsions, mouth-breathing, running ears, bed-wetting, etc.
4. *Illnesses*: Diseases similar to the present. Kind, date, duration, severity, recurrences, complications, careful history of acute infectious diseases.
5. *Feeding*: In detail in every infant.
   (*a*) *Breast* feeding: How long, intervals, condition of the baby, why discontinued.
   (*b*) *Artificial* feeding: Kind of food, intervals, how prepared, how much at each feeding, total quantity, how long used, effect on baby and on bowels, why discontinued.

(C) Family History.

Parents, brothers and sisters.

(Constitutional diseases: Tuberculosis, syphilis, miscarriages (order of), rheumatism, nervousness or insanity, alcoholism).

(D) Examination.

Examine patient fully.

1. *General appearance* and *weight*: Nutrition and general development, facial expression (intelligence, pain, etc.), amount of prostration, pallor, cry, nervous condition, posture, respiration.
2. *Skin*: Eruptions, turgor.
3. *Temperature*: Pulse and respiration (in infant omit temperature until 11).
4. *Head*: Size, shape, fontanelles (size, tension), cranio-tabes, eyes, nose (mouth, tongue, teeth under 12).
5. *Neck*: Goiter, glands, rigidity.
6. *Chest*: Shape, deformities, inequalities, expansions, *lungs* and *heart* in detail.
7. *Abdomen*: Size, distention, retraction, tenderness, rigidity, *liver, spleen, bladder, kidney,* fluid and tumors.
8. *Spine*: Deformities, rigidity.
9. *Genitalia* and *genital region*: Phimosis, vaginal discharge, fissures, inflammation, eruptions, hemorrhoids, pin-worms, etc.
10. *Extremities*: Glands, deformities, paralyses, atrophy, muscle tone, reflexes, athetosis, swelling, tenderness, discoloration, joints, gait.
11. *Temperature*: In child under 3 years always rectal, and often in older children.
12. *Mouth*: Teeth, tongue, stomatitis, enanthemata, pharynx, tonsils, adenoids.
13. *Middle ear.*
14. *Special examinations*: Urine, blood, sputum, cultures, feces, vaccinations, serum reactions, etc.

AVERAGE WEIGHTS.

Age	Boys Pounds	Girls Pounds
Birth	7.55	7.16
Six months	16.50	15.50
Twelve months	20.50	19.80
Eighteen months	22.80	22.00
Two years	26.50	25.50
Three years	31.20	30.00
Four years	35.00	34.00
Five years	41.20	39.80
Six years	45.10	43.80
Seven years	49.50	48.00
Eight years	54.50	52.90
Nine years	60.00	57.50
Ten years	66.60	64.10
Eleven years	72.40	70.30
Twelve years	79.80	81.40
Thirteen years	88.30	91.20
Fourteen years	99.30	100.30
Fifteen years	110.80	108.40
Sixteen years	123.70	113.00

MEASUREMENTS.

Age	Height in.	Chest in.	Head in.
Birth	20.5	13.25	13.75
6 months	25.0	16.0	17.0
1 year	29.0	18.0	18.0
2 years	32.5	19.0	18.75
5 years	41.5	21.0	20.5

Head at birth, 13.75 inches. First year, gain 4 inches; second year, gain 1 inch; 2 to 5 years, gain 1.5 inches for the 3 years.

Large head and small chest suggests rickets. The head is larger than the chest until second year, normally.

GENERAL DEVELOPMENT.

A healthy infant speaks single words toward the end of the first year, uses short sentences at the end of the second year; sits erect at the seventh month; stands with assistance at ninth or tenth month; attempts to walk at twelfth or thirteenth month, and walks freely at the fourteenth or fifteenth month.

SLEEP.

The healthy infant sleeps practically all the time except when being fed.

	Hours per day
At birth	20 to 22
At end of 1st year	16 " 18
During 2d and 3d years	12 " 13
During 4th and 5th years	10 " 11
During 12th and 13th years	8 " 9

ORDER AND AVERAGE TIME OF ERUPTION OF THE TWENTY DECIDUOUS TEETH.

	Months
2 lower central incisors	6 to 9
4 upper incisors	8 " 12
2 lower lateral incisors and 4 anterior molars	12 " 15
4 canines	18 " 24
4 posterior molars	24 " 30

At 1 year should have 6 teeth.

At 1 year 6 months should have 12 teeth.

At 2 years should have 16 teeth.

At 2 years and 6 months should have 20 teeth.

PERMANENT TEETH.

	Years
1st molars	6
Incisors	7 to 8
Bicuspids	9 " 10
Canines	12 " 14
Second molars	12 " 15
Third molars	17 " 25

CLOSURE OF FONTANELS.

Posterior fontanel usually closes by the end of the second month. Anterior fontanel at the end of the first year is about 1 inch in diameter, and usually closes at the eighteenth month. Normal variations, from fourteen to twenty-two months.

AVERAGE DAILY QUANTITY OF URINE IN HEALTH.

	Ounces
1st 24 hours	0 to 2
2d 24 hours	⅓ " 3
3 to 6 days	3 " 8
7 days to 2 months	5 " 13
2 to 6 months	7 " 16
6 months to 2 years	8 " 20
2 to 5 years	16 " 26
5 to 8 years	20 " 40
8 to 18 years	32 " 48

AVERAGE RATE OF PULSE AND RESPIRATION.

	Pulse	Respirations
Birth	140	35 to 40
1 month	120	25 " 40
6 to 12 months	105 to 115	25 " 30
2 to 6 years	90 " 105	25
7 to 10 years	80 " 90	22 " 25
11 to 14 years	75 " 80	20

BLOOD-PICTURE IN HEALTHY CHILDREN.

	Newborn	Infants	Older children
Hæmoglobin	110 per cent.	70 to 95 per cent.	65 to 95 per cent.
Erythrocytes	5 to 8 millions	4.5 to 5.5 millions	4 to 4.5 millions.

AVERAGE WHITE CELL COUNTS.

1. Healthy children between 1 and 15 years of age average between 7000 and 15,000 leucocytes, approximately the same as adults.

2. Polymorphonuclear neutrophiles increase gradually from 30 per cent. in the first year to about 70 per cent. in the fifteenth year.

3. Lymphocytes decrease from 60 per cent. in the first year to about 30 per cent. in the fifteenth year. (This represents combined (large and small) lymphocytes).

4. The reversal of the percentages of neutrophiles and lymphocytes occurs usually about the sixth year.

5. Eosinophiles average between 4 to 6 per cent., but vary greatly in different children at the same ages.

6. Transitional cells average approximately 2 to 3 per cent., not varying greatly at the different ages.

7. Mast-cells, about 0.3 to 0.6 per cent. Frequently absent.

8. Large mononuclear neutrophiles, 1 to 3.3 per cent. About the same at different ages.

Stool symbols	Urine symbols
N = normal.	A = albumin.
S = soft.	S = sugar.
W = watery.	Ac = acetone.
F = fat-soap.	D = diazo.
M = mucus.	I = indican.
Bl = blood.	C = casts.
C = curds.	P = pus.
G = green.	Bl = blood.
	Ep = epithelium.

RECORD SHEET.

A brief description of the clinical sheet used in our wards may be of value, as it answers both the needs of a history sheet and of a daily chart as well. The points illustrated by it are: a graphic relationship between the temperature, weight, quality, and quantity of food taken, and the end-results on the stools and urine. Also separate spaces are provided for complications which may influence the preceding under the heading of symptoms, together with spaces for treatment other than dietetic, energy value of foods, vomiting, blood examinations, tuberculin reactions, etc. The small figures 1-10 are used to make an electrical reaction curve in cases showing a spasmophilic diathesis.

SARAH MORRIS HOSPITAL FOR CHILDREN

Dr.______ Name______________ Diagnosis ______________

Case No.______ Address______________ Complications ______________

ENTRANCE { Date______ Age ______ Weight ______ Condition ______

DISCHARGE { Date______ Age ______ Weight ______ Condition ______

Weight	Temp.	Date	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M	P M.
	108°	MEDICATION 10																														
		9																														
		8																														
Lb. Oz.	107°	7																														
		6																														
	106°	5																														
		4																														
Lb. Oz.	105°	3																														
		2																														
	104°	1 Millaamperes																														
Lb. Oz.	103°																															
	102°																															
Lb. Oz.	101°																															
	100°	SYMPTOMS																														
Lb. Oz.	99°																															
	98°																															
Lb. Oz.	97°																															
	96°																															
	95°																															
FEEDING ORDERS																																
FOOD CONSUMED																																
TOTAL CALORIES CONSUMED																																
PERCENTAGE COMPOSITION of FOOD																																
Stools Number Quality																																
VOMITING																																

DEPARTMENT OF PEDIATRICS

UNIVERSITY OF ILLINOIS — COLLEGE OF MEDICINE

No.

Name Address

Date Sex Age Race

Diagnosis

Name

Doctor

History of Patient.

Duration, progress, onset, earliest symptoms and later developments

Previous History.

BIRTH: Para? Nature and Complications.

DEVELOPMENT: Teeth

Sat Erect Walked Talked

Mentality

GENERAL HEALTH:

PREVIOUS ILLNESSES

FEEDING HISTORY

Breast No. of Months Interval

Why discontinued

ARTIFICIAL FEEDING. In Detail

FAMILY HISTORY

PHYSICAL EXAMINATION

TEMPERATURE P R Weight Height

LABORATORY EXAMINATIONS

TREATMENT

ASSIGNED TO

SUBSEQUENT TREATMENT AND REMARKS

Date	Weight	

INDEX.