Diet in infancy : the essential introduction to the study of disease in childhood / by A. Dingwall-Fordyce.

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THE ESSENTIAL INTRODUCTION TO THE STUDY OF DISEASE IN CHILDHOOD

A. DINGWALL-FORDYCE

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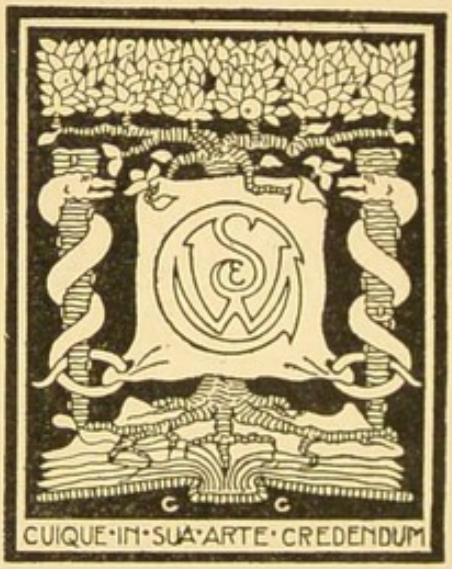
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DIET IN INFANCY

THE ESSENTIAL INTRODUCTION TO THE STUDY OF DISEASE IN CHILDHOOD

BY

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PREFACE

THIS little volume is offered to the Profession in the belief that even at the present time of enormous medical literary fecundity its existence is desirable.

More especially is it offered for the consideration of general practitioners in medicine and of medical students, upon whose shoulders lies much of the responsibility for the present and the future welfare of the children of this country, the medical guidance of their parents, and the diffusion of rational information concerning preventive and curative pædiatric medicine among the laity generally.

It pretends to no heights of eloquence and no profound depths of scientific information. It aims at being of practical utility to practical men working among children.

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DIET IN INFANCY

GENERAL CONSIDERATIONS

THE HEALTHY INFANT

1. THE NATURAL DIET OF AN INFANT IS ITS MOTHER'S MILK.—*Never forget this, never countenance the premature discontinuance of suckling without good cause clearly shown, and never commence artificial feeding in the early months of life without extreme care and continued supervision. All artificial infant feeding in its initiation must of necessity be experimental.*

2. *The exact composition of mother's milk is unknown.* —The scientific methods at our disposal at the present day demonstrate to us most of the important constituents of mother's milk, but there is ample evidence to show that constituents exist which defy detection. Many cases of scurvy, rickets, and malnutrition occur owing to the fact that there has been a lack or absence in the infant's diet of some of these constituents which occur in mother's milk, but which are not as yet accurately defined.

3. *The nature of many of the known constituents of mother's milk is peculiar to that milk.* — Two very important constituents of mother's milk are the protein and the fat. The chemical elements of these constituents differ both quantitatively and qualitatively from those found in other milks or elsewhere. When these substances are acted on by the digestive juices

the results are therefore different from those with any other form of diet.

4. *Consequently it is impossible to form artificially a "human" milk.* — No combinations or modifications of milks, or milk mixtures, can accurately resemble mother's milk. The qualities of the various milks and the quantities of their various constituents can be dexterously manipulated so as to approximate superficially to the composition of maternal milk, but no manipulation can artificially evolve the inherent peculiarities of that milk.

5. *The object, in artificial feeding, is to supply the infant with a food which as closely as possible resembles mother's milk.*—As mother's milk is the ideal food for infantile digestion, nutrition, and development, so it is obvious that the closer the artificial food approximates to the ideal the better suited it will be to the needs of the infant. The necessity of resembling mother's milk is more imperative than the administration of a simple food. Simplicity of procedure is always desirable, but slight additional manipulation, modification, or mixture which renders the resemblance to maternal milk more distinct is in the best interest of the infant.

6. *The chief characteristics of mother's milk are* (a) *purity*, (b) *ready digestibility*, (c) *suitability for adequate nutrition and development.*

(*a*) Milk withdrawn aseptically from the breast of a healthy mother is sterile. In the process of suckling, milk passes directly from the maternal breast to the infant's digestive canal, and consequently no opportunity is given for the development of extraneous organisms even should they enter—from the nipple, or lips of the infant.

(*b*) The nature of the maternal milk and the quality of the infant's digestive juices are naturally adapted to each other, and consequently serve in the highest degree to ensure ready digestion.

(*c*) By means of good digestion adequate nutrition and general development are ensured. The infant's powers of digestion are steadily and gradually stimulated to fuller completion.

7. *The milk of an animal is pre-eminently suited to the requirements of the young of that class. It is not naturally fitted for the human infant.*—The young of the various classes of mammals develop with degrees of rapidity differing from each other, and from the human infant. Their digestive capacity is at birth of varying amount, the process of digestion differs largely in many, and digestive development proceeds along varying lines according to the ultimate life-habits and food of the animal.

8. *Animal milk is consequently not a suitable diet for a young infant.*

(*a*) It differs in quality from mother's milk.
(*b*) It consequently reacts differently with the infant's digestive juices,
(*c*) and the processes of digestion must therefore take place in an unnatural manner.
(*d*) The natural stimulus to the gradual development of the powers of digestion is wanting,
(*e*) and consequently general development and future well-being are only satisfactory when the infant's vitality and powers of digestion are originally strong.

9. *But animal milk is the nearest natural substitute for mother's milk.*—Patent and artificial foods all lack the essential quality of freshness. Soups, gruels, jellies, beef-juices, and other preparations are also quite unsatisfactory; none contain the elements of the food-stuffs essential to the infant's healthy nutrition, in a form so closely resembling mother's milk, as does animal milk; many differ from it very markedly in quality, many are deficient in certain constituents, and many contain totally unsuitable constituents.

10. *Modified cow's milk is the best food for a hand-fed infant.*—Of animal milks, the milk of the cow is the

most readily obtainable in any quantity. It contains the known milk constituents in an amount sufficient for adequate infantile nutrition. Owing to disproportion in the quantities of the various constituents, it is, however, necessary to modify this milk in order to make it approximately similar to human milk. Such modification can be readily performed. *It is, however, essential to remember that even with accurately modified cow's milk both the intrinsic and extrinsic qualities of that milk remain totally different from those of human milk.* Thus the fresh, vital qualities and the inherent peculiarities and virtues of mother's milk remain absolutely unattainable by mixtures of cow's milk, cream, whey, sugar, and water; and the possibility has always to be borne in mind that the resemblance may be rendered closer by the further addition of some substance foreign to cow's milk, but which renders the processes of metabolism more like those taking place when human milk is ingested. Of extrinsic differences in the qualities of human and cow's milk, it is sufficient to mention the filthy and germ-laden condition of very much commercial cow's milk.

11. It is essential (a) *to know the composition of the food given.*—Knowledge of the nature of the food given must obviously be of advantage to the physician. Such knowledge can *never* be accurate: it *can* be so approximately accurate as to be of the utmost value. The constituents of the milk more particularly to be noted are the protein, fat, and sugar.

12. It is essential (b) *to know the amount given at each feeding.*—Knowledge of the quality and of the quantity of the food must go hand in hand. Either separately is of great value, but is immensely enhanced by knowledge of the other. The receptive capacity of the infant's stomach alters quickly with increasing age.

13. It is essential (c) *to know the length of the intervals between the feedings.*—With a known quality and quantity of food, the intervals of feedings must be carefully attended to. It is impossible to expect rigid adherence to regulations as to the length of feedings and the

intervals between them, but none the less is it desirable that such regulations should be strictly laid down.

14. It is essential (d) *to remember broadly the anatomy of the infantile digestive system.*—In a growing infant, alterations of size, capacity, structure, and frequently relationship of the various parts of the alimentary canal are constantly occurring.

15. It is essential (e) *to understand the outlines of the physiology of infantile digestion.*—Such knowledge is of the very greatest value to the physician. By its acquisition only can he clearly survey the field of infant feeding; with its possession, apparently hopeless anomalies can be satisfactorily grouped, and widely differing facts and conditions systematically placed each in its own particular niche. Adequate knowledge simplifies all future work on the subject, and is the only satisfactory basis for all dietetic treatment in healthy and unhealthy infants.

16. It is essential (f) *to recognise the importance of adequate digestive and general development.*—Progress is imperative in infancy; there is no satisfactory stationary condition. Lack of progress means retrogression. Digestive development is recognised by the power of digesting food of increasing strength. General development is gauged by the regular use of the weighing machine.

THE SICK INFANT

17. THE ENORMOUS INFANTILE MORTALITY IS VERY LARGELY DUE TO UNNATURAL AND IMPROPER FEEDING.—*A large proportion of it is therefore preventable. Stricter regulations safeguarding the conditions of pregnancy and motherhood; a higher sense of responsibility and a more rational knowledge of the subject of infant diet among the public generally; the development of a more intelligent interest in the subject among the members of the medical profession, and the exertion by them of a more strictly responsible and authoritative influence—such are the conditions necessary for its prevention.* (See Appendix E.)

18. *A healthy digestive capacity at the commencement of an acute illness often means the saving of an infant's life.*—The power of digestion is always an important factor in forming the prognosis of a disease. In infancy it is of even greater importance than in later life. Satisfactory initial digestion is the most powerful natural antidote to infection.

19. *In every illness it is of primary importance to care for the infant's digestion.*—Risk no artificial interference with digestion without urgent need or definite cause. If possible, refrain from symptomatic drug treatment.

20. *A condition of general ill-health necessarily means diminished digestive capacity.*

21. *In cases of general illness guard the digestive ability.*—Keep well within the digestive possibilities; risk no over-taxation. Simplify the diet—in quality, quantity, or both. Do not discourage the functions of digestion by the unnecessary use of peptonised or predigested food, but give such food as is capable of ready digestion.

In cases of continued high temperature, always give peptonised or predigested food.

22. *In acute digestive illness rest the digestive functions.*—Render, so far as possible, digestion unnecessary. Starvation for short periods is well borne in infancy: more particularly is this the case where the infant is originally strong and a plentiful supply of water is administered.

23. *In acute digestive illness add and increase the constituents of the food gradually and separately.*—By the addition or increase of the constituents, such as cream, sugar, or whey, separately to the food, it is possible in the case of the occurrence of unfavourable symptoms to put a finger on the cause of the condition. Separation of the constituents therefore tends to accuracy.

24. *In chronic digestive illness keep well within the digestive capacity.*—Over-feeding is infinitely more disastrous in its results than under-feeding.

A small supply of food which can be well-digested and assimilated is of much greater value than a large supply ill-utilised.

25. *Be exact in all food prescriptions.*—Food for an infant must be *prescribed.* A written prescription is essential for the sake of the infant, the mother, and the physician himself. Memory is unreliable, and it is unfair to tax unnecessarily the memory of the mother. Orders must be definite and prescriptions exact.

26. *Listen patiently to the report of the mother or nurse, however unreliable she may seem.*—A truism perhaps, but none the less one which it is important to bear in mind and to carry into effect.

27. *Pay close personal attention to stools and vomit.*—Knowledge of what is taking place within the alimentary canal can at best be but vague and ill-defined. It is of the utmost importance that we should lose no opportunity of adding to such knowledge. The outflows from the gastric and rectal terminations of the canal are consequently worthy of our fullest consideration.

28. *Avoid drugs.*—As often as possible forget the existence of the pharmacopœia. Always regulate digestive disturbances in the first place by alterations of the diet.

29. *Always seriously attempt to make a diagnosis.*

PART I

NORMAL INFANCY

A. General

1. *A normal infant.*—A normal infant is one which is the offspring of average healthy parents, which suffers under no physical defects or deformities on its entrance into this world, which enjoys a physiological maternal lactation for a period of eight months, and which exhibits an average degree of growth and development.

2. *Heredity.*—It is necessary to recognise the great importance of hereditary predispositions, peculiarities, or traits—mental and physical. Physically, digestion and nutrition are powerfully affected by heredity. There are, doubtless, immense numbers of normal infants the digestive capacity of no two of which is exactly similar. The term, "normal" digestive capacity in infancy, is consequently a varying and somewhat comprehensive one. It is common to meet with individual idiosyncrasies.

3. *The health of the mother during pregnancy and lactation.*—Pregnancy, childbirth, and lactation are physiological conditions; they seldom, however, are in their entirety physiological. The intimate connection between the child and his mother renders it vitally important that the health of the latter be efficiently maintained. Comparatively slight sickness of the mother may cause serious or permanent injury to the child.

4. *Growth and development of the infant.*—The infant diet has a double rôle to play. It has to provide not only—as in the adult—for the repair of waste and adequate nutrition, but it has also to ensure the steady progress of growth and development. An unsuitable diet may be defective in both particulars or in only one.

5. *Weaning.*—The development of the normal infant, at a period varying from the eighth to the twelfth month after birth, has reached such a stage that an entirely independent existence is desirable.

By this time the digestive power is such that additional feeding is necessary.

6. *Conditions in other mammals.* — The milk of a mammal serves to nourish its young during the period when the digestive powers are as yet incapable of dealing with the natural food of the independent animal. The milk develops these powers along certain lines according to the later food, and it is suited in each class to the different degrees of rapidity with which such development takes place.

B. The Mother

1. During the period of uterine gestation nourishment is supplied to the infant by the mother in such a form that ready assimilation is possible and infantile digestion rendered unnecessary. Full nutrition and development of the fœtus take place without the exercise of the infantile digestive functions. Exercise of these functions only commences after birth. The mother practically supplies to her unborn child a predigested food.

The condition of pregnancy affects the function of every organ in the mother's body; in the majority of cases the organ is stimulated to increased activity.

We are unaware of the exact relationship between many of these changes and the condition of the child.

The mammary glands share with the other organs the influence exerted by the condition of pregnancy; stimulation of their function results in the provision of a natural form of nourishment for the new-born infant.

2. A satisfactory food for any human being—adult or infant—must contain certain constituents.

These constituents are known as the protein, fat, carbohydrate, mineral salts, and water; in addition, it is found that a "vital" fluid such as milk contains chemical bodies such as ferments. It is necessary to consider the nature of each of these constituents, and their particular function in nutrition and growth.

It is specially necessary to understand the nature of these constituents when dealing with the diet of an infant, because an improper amount of one of them in a milk or other food may cause serious danger to the child.

Milk is a simple food, but the infantile digestive capacity is also simple, and may be very gravely affected by alteration of one of the constituents of milk.

For practical purposes, the protein, fat, and carbohydrate are the most important constituents to consider, as they are the ones over which it is possible to exercise most control. Any of the constituents of milk may be at fault in a given case, or several together.

It is very important to remember this ultimate composition of milk, but in doing so it is necessary never to lose sight of the nature of milk as a whole, nor of its characteristics as a definite, special substance.

3. *Protein* is a substance which contains nitrogen.

The constant waste which takes place in the body results in a constant loss of nitrogen from the tissues; and as protein is the only form of food which contains nitrogen, it is consequently essential to continued life.

There are different kinds of protein, some being more simple and consequently more easily digested than others.

One of the chief differences between woman's milk and cow's milk is the nature of the proteins, and the consequent difference in the size of the curd which is found in the infant's stomach.

Fat is the chief source of the heat of the body. It also assists in the absorption of the mineral salts.

By the presence of a proper amount of fat in the

food it becomes unnecessary for the protein to undertake any of the nutritional work proper to the fat, and consequently all the energy of the protein can be devoted to its own special work.

Carbohydrate.—Sugar and starch are carbohydrates; there is no starch in mother's milk. Sugar, like fat, is an important aid to the protein, and is a source of animal heat. It also assists in the formation of the fat of the body.

Sugar is, as a rule, very readily digested.

Owing to its ready digestibility and to the fact that it adds to the amount of body fat, many patent foods contain a very large amount of sugar. Infants fed on these foods become stout, but otherwise delicate owing to deficiency of protein and fat.

Mineral salts are very valuable in infancy owing to the rapid growth of the infant, and more particularly the development of his bones.

Water is present in very large amount in the food of an infant. It is necessary for the solution of some parts of the food, and for the suspension or minute subdivision of others, so that digestion may be rendered easier.

4. During the latter part of pregnancy secretion commences in the mammary glands of the mother, and at, or about, the time of childbirth a natural sustenance is thereby prepared for the infant. For the first two or three days after birth the secretion is known as *colostrum*. Colostrum is secreted in much smaller quantity than is the later milk, and differs from it also in quality. It serves as a preparation for the ingestion of milk. It is inadvisable to put the infant to the breast more frequently than four times in the twenty-four hours during these days, as the amount of secretion is small. It is well, however, to give the infant in addition water to drink. About the third day after birth the secretion of *milk* becomes established. The process of suckling stimulates the secretion of milk, and it is possible for a mother to suckle her infant for a very much longer period of time than is good either for the health of her

infant or herself. It is not very uncommon to meet a mother who suckles her infant for eighteen months, two years, or even longer. Such procedure is extremely undesirable. (See Appendix A.)

5. Mother's milk, when looked at under the microscope, appears to consist of large numbers of droplets of fat floating in a watery fluid. The size of the droplets is small—smaller than in cow's milk.

Chemically it is found to consist of (*a*) protein, (*b*) fat, (*c*) sugar, (*d*) salts, (*e*) ferments, (*f*) water.

The following table is given by Holt, and is taken from analyses made by Pfeiffer, Koenig, Leeds, Harrington, and others:—

Common healthy Variations in Human Milk.

	Per cent.
Fat . . .	3·00 to 5·00
Sugar . . .	6·00 to 7·00
Protein . . .	1·00 to 2·25
Salts . . .	0·18 to 0·25
Water . . .	89·82 to 85·50

In addition, there are many ferments incapable of ready definition. Such a table is for general purposes extremely useful; it is obviously not strictly accurate or definite.

6. The *protein* occurs in several forms, the most important of which are lact-albumen and caseinogen. Of these the most abundant is the lact-albumen, which occurs, roughly speaking, in twice as great amount as the caseinogen. The lact-albumen is the simpler form of protein, and when milk is curdled with rennet it is found in the whey. Caseinogen is a more complex body, and is the chief cause of the curd of milk.

7. *Fat*, we have seen, is present in the form of small droplets. Fat and carbohydrate are the chief sources of animal heat. In the adult the value of fat in this respect is only a little more than half that of carbohydrate; in the infant the conditions are reversed,

fat being of nearly twice as great value as carbohydrate.

8. *Carbohydrate—sugar—or lactose* occurs in solution. It is said to be very constant in amount throughout lactation. Lactose or sugar of milk, by taking up water, is changed into a still simpler form of sugar, which can be directly assimilated, but it is probable that lactose can itself be absorbed unchanged by the epithelial cell.

9. According to Rotch, the inorganic *salts* occur in woman's milk as follows:—

	Per cent.
Calcium phosphate	23·87
Calcium silicate	1·27
Calcium sulphate	2·25
Calcium carbonate	2·85
Magnesium carbonate	3·77
Potassium carbonate	23·47
Potassium sulphate	8·33
Potassium chloride	12·05
Sodium chloride	21·77
Iron oxide and alumina	0·37
	100·00

It was noted previously (s. 5) that the percentage amount of all the salts in milk is about 0·2 per cent. It has been found that animals from whose food the salts have been extracted sometimes die even more rapidly than animals which have been altogether deprived of food, and it appears that some at least of the mineral matters of the food—notably calcium—must be in their natural condition, which is probably that of combination with protein.

10. For practical clinical utility the examination of mother's milk is unsatisfactory. The milk varies considerably in composition in the same woman, and readily applied tests are inaccurate. A study of the clinical condition, habits, and diet of the mother is of considerably more value.

The milk should, however, be examined before weaning an infant in the early months because of the belief that the mother's milk is unsuited to it.

After the infant has nursed for five minutes, withdraw the milk from the breast by a breast-pump or gentle massage. Examine a drop under the microscope for pus-cells or blood. If further examination is considered necessary, the reaction and specific gravity can be determined and the fat estimated by Holt's cream-gauge.[1]

11. Mother's milk is a fluid of varying composition; we do not thoroughly understand the range of these variations, nor their causes.

The milk varies in quality during each act of suckling; at its commencement the percentage of fat is low and of proteid high, while towards the close the reverse is the case.

The frequency of suckling also affects the quality of the milk. Transitory attacks of acute illness of minor degree have, as a rule, no marked effect on the milk; the same holds good for the occurrence of menstruation.

The diet of the mother and the condition of her general health naturally exert the most powerful influence on the composition of the milk.

It is possible for a mother in poor health to suckle and rear a healthy infant, but such a condition is uncommon; it is also inadvisable, as the condition of ill-health of the mother is inevitably aggravated.

12. The importance of sound health in the nursing mother is very great. To this end her regular mode of life must be well-ordered and her diet satisfactory. She is no invalid, and consequently requires no special rules to guide her. Let her understand the common rules of a healthy life, and that if she departs from them her infant will suffer.

13. The direct effect of drugs upon the composition

[1] "The glass cylinder holding ten cubic centimetres is filled to the zero mark with freshly drawn milk. This is allowed to stand at the temperature of the room (66° to 72° F.) for twenty-four hours, and the percentage of cream is then read off. Under these conditions, the relation of the percentage of cream to that of fat is very nearly as five to three; thus 5 per cent. of cream will indicate that the milk contains 3 per cent. of fat, etc."

of the milk is uncertain. Never hesitate to prescribe any drug to a nursing mother if her condition demands it; it is the long-continued administration of drugs which may injuriously affect the infant through the milk. Whenever possible, treat the infant through the mother —not, unless necessary, by the use of drugs, and never to the risk of impairment of the mother's health. Many of the minor ailments of the suckling can be satisfactorily treated by alteration of the periods or duration of nursing times; general tonics are frequently of great value in permitting the continuance of lactation or partial lactation.

14. The infant demands that *all* its sustenance should be derived from its mother up till the close of the eighth month of life. The value to the infant of maternal nursing is greatest in the early days and weeks of life. Usually by the ninth month of life infantile digestion is so developed as to make additional nourishment advisable. Suckling is beneficial for the average healthy mother.

15. The return of menstruation is not uncommon during lactation. As a rule, this is an occurrence of no importance to either mother or child. It is no sign of ill-health on the part of the mother. Occasionally the child's digestion is disturbed at this period; partial or complete artificial feeding for the few days readily counteracts this. Retain the supply of breast milk in these cases by the regular use of the breast-pump. Never wean for this condition without definite signs of ill-health on the part of the mother or the child. Pregnancy may occur during lactation, but its occurrence is uncommon before the eighth month. It is advisable to commence weaning when pregnancy occurs.

16. Mother's milk is the ideal food for the infant: in certain cases it must, however, be forbidden. Do not allow suckling where the mother is the subject of serious chronic organic or infective disease; where no such disease exists, but the general condition is very poor, strive to improve the condition, but be prepared for weaning by the institution of "mixed feeding."

Serious acute illness frequently and acute affections of the mammæ always necessitate weaning.

17. When breast nursing is supplemented by artificial feeding we speak of "mixed feeding." Even a small amount of breast milk daily is of great value to the child.

The plan of mixed feeding must be adopted when the maternal secretion of milk is insufficient, or when the state of her general health renders it inadvisable that she should bear the whole strain of nursing. In the early days of lactation a little artificial assistance such as this may serve to render full maternal suckling possible later.

18. Weaning is a gradual process, and should in average cases be commenced at the close of the eighth month.

C. The Infant

19. It is unnecessary to enter in detail into the subject of the anatomical changes which take place in the infant at birth. Vitally important changes occur, more particularly in the circulatory and respiratory systems; the initiation of functional activity takes place in some organs, in others there is alteration of function, and for all it is a period of change, development, and activity. In the presence of such conditions rest is essential. No extraneous stimulus to functional activity is advisable, and no immediate sustenance of nutrition is necessary. The alimentary canal and the digestive functions share in the general conditions. Rest them.

20. Secretion and excretion take place actively after birth. The meconium present in the bowel is voided shortly after birth, and the kidneys secrete freely.

The small amount of colostrum present in the breasts of the mother, along with sips of water, is, as a rule, entirely sufficient food for the infant during the first two or three days of life. Occasional drinks of plain boiled water are always advisable; the urine of infants at this time very often shows concentration of solids, and uric acid crystals may cause irritation in the

kidney (infarcts) or elsewhere. The colostrum has a mild purgative action and helps to cleanse the bowels; it also appears to have most valuable properties, by means of which it is enabled to supply the infant with the vitality and energy requisite for the fully successful commencement of independent existence.

21. *Digestion* is the process occurring in the alimentary tract through the interaction of the body fluids and the ingested food-stuffs, by means of which the constituents of these latter are broken up and simplified, and thereby so altered as to permit of their *absorption* through the lining membrane of the alimentary canal.

Assimilation is a power possessed by all the cells of the body, by means of which they are enabled to make use of the material provided for them by the processes of digestion and absorption.

Absorption and assimilation depend upon digestion. With good digestion and absorption, assimilation may yet be poor, and consequently nutrition suffer; but without satisfactory digestion, nutrition must inevitably suffer. Good digestion is the foundation of good health.

22. The processes of digestion in the healthy adult are briefly as follows:—When food is ingested it is at first acted upon by the saliva in the mouth. The salivary secretion (acting through its ferment, ptyalin) carries out its function in an alkaline solution, also in a neutral and in a weakly acid solution, and consequently it continues to act on the food in the stomach for some considerable time after a meal has been taken—in fact, until free hydrochloric acid is present. By means of its action starch is broken up and rendered more simple in composition by being converted into sugar.

As agents in the process of gastric digestion, there are the rennet ferment or rennin, pepsin, and hydrochloric acid. Through the action of the rennin, milk undergoes coagulation, caseinogen (a form of protein) in the presence of calcium salts being converted into casein (or curd). Pepsin, acting in the acid solution of hydrochloric acid, then splits up the protein—the casein or curd, and the lact-albumen or whey protein—into

simpler forms. The digestive processes, while largely gastric in the adult, are by no means entirely so, but are continued in the intestine. The bile renders the contents of the duodenum alkaline, and favours further digestion by the ferments of the pancreatic juice.

These ferments are trypsin, which, like pepsin in the stomach, acts on the protein; amylopsin, which, like ptyalin in the saliva, acts on carbohydrates; and steapsin, which splits up fat.

In addition, the succus entericus or intestinal juice has a certain amount of digestive power.

23. At birth, the digestive capacity is much smaller than in adult life, and the manner of digestion somewhat different.

In order to obtain a clear idea of the digestive processes as they occur throughout infancy, it is useful to consider them in some detail.

24. At birth the secretion of the salivary glands is extremely small in amount; so also is the secretion of amylopsin in the pancreatic juice.

Ptyalin in the saliva and amylopsin in the pancreatic juice are the two agents in the body by means of which the complicated molecules of starch are broken up and changed into the much more simple molecules of sugar. The starch molecule itself cannot be directly absorbed and assimilated. It must first be acted upon by these ferments and changed into sugar, and then this sugar is still further broken up and simplified by the hydrochloric acid of the gastric juice and by the juices of the intestine, and so rendered fit for absorption. As we have previously noticed, breast milk contains no starch, and breast milk is entirely sufficient food for the infant for the first eight months of life. It is consequently unnecessary for the infant to possess the power of digesting starch at the commencement of life. At the period of weaning (ninth month) we find that the infant has the power of digesting a considerable amount of starch, and this power does not develop with great suddenness. Throughout the period of infancy the power of starch digestion is gradually

increasing. The rapidity of its development largely depends upon the nature of the food supplied to the infant and upon individual peculiarity.

Remember—(1) There is no starch in mother's milk.

(2) All forms of food (cow's milk, etc.) other than mother's milk are unnatural for the infant before the ninth month of life.

(3) Starch is an unnatural constituent of food for the infant before the ninth month of life.

(4) The power of starch digestion in *many* infants is, however, present in the earliest months of life in small amount.

(5) Where artificial feeding is being employed—in other words, where the infant is being supplied with an unnatural form of food—it may be advisable to take advantage of this modified power of starch digestion by aiding nutrition through the administration of a weak starch mixture (barley water).

25. The stomach of the infant at birth is almost tubular in shape, the fundus being only slightly developed. It is almost vertical in position, and consequently fluid enters and escapes from it at either extremity very readily. It increases in size very rapidly in early life, and its capacity at different ages varies very largely according to the body-weight and also to some extent with each individual child. The average size, as regulating the average feed for the average infant, it is important to remember, and is readily and sufficiently accurately indicated in the following simple table:—

Capacity of Infant Stomach.

At birth		1 fl. oz.
At commencement of	2nd month	2 „
„ „	3rd „	3 „
„ „	4th „	4 „
„ „	5th „	5 „
During	6th „	6 „
„	8th „	7 „
„	10th „	8 „

26. The stomach of the infant acts very largely as a receptacle for food, and in it digestion takes place to a much smaller extent than in later life.

It has been already stated that, owing to the position of the stomach, fluid readily enters or escapes from it: it must also be remembered that the intestines in infancy are very freely movable. As infancy is a period when muscular spasm and muscular incoordination are of very common occurrence, it can readily be seen how easily regurgitation of food from the stomach can take place.

27. At birth the stomach walls are thin and contain much lymphoid tissue, the gastric glands being but imperfectly developed, and their development gradually occurring as age advances. Through the walls of the stomach a small amount of absorption of fat and of mineral salts takes place.

28. The chief action of the gastric juice is on the protein. When milk has entered the stomach of an infant, curdling occurs through the action of the rennin on the caseinogen. In other words, the caseinogen which was previously dissolved in the fluid milk has been changed by rennin into lumps or curds. Though more solid, this form of protein is now in a simpler form than previously, and can be readily acted upon and further digested by the pepsin and hydrochloric acid of the gastric juice. The originally simpler form of protein—the lact-albumen—is present in the whey or fluid part of the milk, and is directly acted upon by the pepsin and the hydrochloric acid. The curd which is formed in the stomach by mother's milk is very soft and flocculent, and consequently passes readily through the pylorus, and much of the later digestion takes place in the intestine.

29. The liver is of large size at birth, and, thanks to the bile which it pours into the small intestine, the requisite alkaline medium is obtained to permit of the action of the pancreatic ferments. Of these, as we have already noted, amylopsin acts on the carbohydrates; steapsin breaks up and simplifies the fat in

a manner not accurately known. The action of trypsin on the protein corresponds to that of pepsin in the stomach, and by means of it the simplification of protein, which was but imperfectly obtained in the stomach, is thoroughly carried out and absorption rendered possible. The intestinal juice also has a slight digestive action.

30. At birth the ferment rennin is secreted by the stomach in quite considerable amount; pepsin and hydrochloric acid are, in the early days, secreted in but small amount, but their secretion increases steadily. The digestive functions of the stomach are constantly stimulated to fuller development as age advances, owing to the ever-changing amount and quality of the fluid secreted and the consequent changing reactions between it and the milk (see later, Cow's Milk).

The fine, flocculent curd of mother's milk passes very readily through the pylorus without necessitating much breaking down by the pepsin and hydrochloric acid in the stomach. Consequently the main bulk of the work of digestion takes place in the intestine, and the length of time the milk remains in the stomach is comparatively short. In the first few weeks after birth the stomach is empty in from one hour to one and a half hour after food.

31. It is important to determine periodically how an infant is thriving. This is best done by ascertaining the weight of the child and keeping a record of it. When possible, it is well to weigh the infant weekly for the first six months, and every second week during the next six months. A record of continuous gain in weight does not necessarily mean that the infant is growing and developing satisfactorily, but for satisfactory growth and development increase of weight is essential. During the first week of life there is usually a loss of weight amounting to perhaps six ounces. Thereafter there is a steady gain in weight, interrupted it may be at times by slight functional disturbances. It is useful to remember that an average baby ($7\frac{1}{2}$ pounds) doubles its weight at six months (15 pounds), and trebles it at twelve months ($22\frac{1}{2}$ pounds).

32. Regurgitation of food is very frequent in healthy infants. It consists in the return of the milk immediately or within a few minutes after the baby has been nursed at the breast. The milk returns unchanged (no curd), and simply wells out of the mouth with little effort. It is due to over-filling of the stomach. Shorten the time of nursing, and interrupt the period of nursing with short rests to make sure that the milk is not taken too fast.

33. Vomiting is a sign of ill-health ; it never occurs with a healthy infant.

34. During the first few weeks of life the infant has three or four movements of the bowels daily. Later, two movements daily are common.

The character of these stools is important. They consist of some two or three ounces of a light yellow, homogeneous, semisolid fluid, with a faintly acid reaction to litmus paper.

Stools change in colour on exposure to the air, and consequently it is necessary to examine a stool shortly after it has been passed.

35. Undisturbed sleep is a sign of good digestion.

The infant usually falls asleep shortly after nursing.

D. Breast Feeding

36. Every healthy mother should be urged to suckle her infant. In considering the question, however, of the duration of lactation to be recommended in any particular case, many points have to be considered.

We must remember—

(*a*) That eight months is the full lactation period for a healthy mother and a healthy child.

(*b*) That the most important time for the infant to be fed from the maternal breast is during the first few weeks of life.

(*c*) That, though desirable, it is not absolutely essential for the satisfactory health of either mother or child that a healthy infant be

suckled after the third month, provided the process of weaning and the later artificial feeding be strictly carried out under medical supervision.

37. Every effort should be made in the case of all healthy mothers to establish the flow of milk from the breasts. Even where, owing to some insuperable difficulty which will prevent prolonged lactation, the period of suckling can be but short, the full extent of this period should be utilised. Every day of suckling granted to the infant during the first few weeks of life is of immense service to it. During this period, not only is the infant becoming every day more capable of utilising an artificial diet, but maternal milk directly supplies to the infant substances which are wanting in its constitution, and which, without digestion, are immediately assimilated, become an integral part of the organism, and are necessary for the development and continuance of complete vitality.

38. Social conditions inevitably enter largely into the question of the duration of lactation. In the higher grades of society, even in cases where prolonged lactation is physically possible, custom and society have claims which it is, humanly speaking, impossible to ignore. To mothers in such a social position the vital necessity to the infant of at least a short period of lactation must be explained.

In the lowest grades of society we can but recognise that necessity knows no laws. The mother can but do her best, and the infant has to take its chance.

39. During the first two or three days of life the infant is put to the breast six-hourly as a rule for a period of five to ten minutes at a time. It thereby obtains colostrum, and the process of suckling stimulates milk secretion in the breasts. In addition, it is to be given frequently small quantities of warm boiled water.

40. It must be recognised that the training and the development of the infant commence as soon as the maternal milk secretion is established. Regularity in

occurrence of nursing periods and limitation of the time of nursing are from the first all-important.

41. During the first month the infant is given the breast at intervals of two hours during the day (eight nursing periods) and twice during the night. Each nursing period is limited to fifteen minutes.

The infant should be wakened if necessary at the regular nursing time.

42. During the second and third months the breast is to be given at intervals of two and a half hours during the day (seven nursing periods) and once at night. At this period the infant will sleep five or six hours at night without feeding.

43. During the third, fourth, and fifth months the infant is given the breast at intervals of three hours during the day (six nursing periods) and once at night.

44. After the fifth month the breast is to be given at intervals of three hours during the day (six nursing periods), and it is unnecessary at night.

45. Weaning is a gradual process. At the beginning of the ninth month one of the nursing periods in the morning is omitted and a bottle feed is substituted. After two or three days the substitution of another feed—in the afternoon—is made, and gradually the infant is entirely weaned from the maternal breast. It is always advisable during lactation to accustom the infant to the bottle by offering it once a day a bottle containing warm boiled water.

The Sick Suckling.

46. Sickness in the suckling may be due to—(1) variations in the health of the mother; (2) variations in the health of the child; (3) improper nursing, *e.g.* irregular feeding or over-feeding.

47. (1) Stress has already been laid on the fact that for the conduct of a satisfactory lactation good health is necessary in the mother. Worry, nervous impressions, the claims of society, or the necessities consequent upon the struggle for existence all play their part in

determining the character of the mammary secretion. Of these, the first named is, in the early days of the infant's life, perhaps the most important influence.

48. "Inanition fever" is the term given to a condition occurring occasionally in an infant during the first few days of life. The condition is characterised by high temperature, restlessness, dryness of the skin and lips, a constant tendency to suck at anything within reach, and later by weakness and prostration. It is due to insufficiency or lack of nourishment—the maternal breasts may be dry, or nearly so. Such an infant must be given plentiful drinks of water frequently, artificial feeding must be commenced, and efforts made to stimulate the supply of maternal milk.

49. Apart from this dangerous condition in early infancy, the infant may at any period of lactation show symptoms of inadequate nursing. These symptoms are fretfulness and disturbed sleep, unsatisfactory gain in weight and flabby condition, abnormality of stools, and a keen desire to suck immediately after a full nursing period. When the mother is healthy and the nursing regular, mixed feeding must be commenced. When the unsatisfactory condition of the milk is due to irregularity of nursing this must be corrected, and the mode of life and manner of dieting of the mother, as bearing on the quality of her milk, must be strictly investigated.

50. Lack of exercise and excess in diet tend to make the maternal milk rich in quality (high percentage of fat and protein). Debility, loss of sleep, and the excessive absorption of fluids tend to cause the secretion of a poor milk. Mixed feeding is greatly to be preferred to continued inadequate suckling, and if necessary complete weaning should be effected.

51. The return of menstruation during lactation is usually a sign of robust health, and not of weakness. If the digestion of the infant becomes disordered at this time employ temporarily mixed feeding, or if necessary complete artificial feeding, and have the milk drawn off the mother's breast regularly so as to ensure

continuance of the secretion. Pregnancy, on the other hand, is always an indication for weaning.

52. (2) A premature or unusually small and weakly infant requires special care and attention. Warmth is as essential as food. Ascertain that the infant can suck satisfactorily and that there is secretion in the maternal breast. Such infants take little food at a time, and it may be necessary to offer the breast more frequently than two-hourly. It is usually necessary to supplement maternal nursing with artificial feeding (solution of sugar of milk 1 drachm in boiled water 1 pint).

53. It is not uncommon at the time of development of the maternal milk secretion (third to fifth day) to find that the infant is fretful, has perhaps a slight tendency to diarrhœa, or vomits occasionally. Where all the conditions otherwise—maternal and infantile—are satisfactory, this condition is unimportant, and passes off with the full development of the maternal milk secretion and of the infantile digestive capacity.

54. Maternal milk, as the safest and most readily digested form of nourishment, is the best form of nourishment for the infant during an illness. Unless the continuance of lactation is of serious danger to the mother (infection), continue lactation so long as the power of sucking is maintained. If suckling is impracticable, the maternal milk should be drawn off and given to the infant in a spoon.

55. (3) Improper nursing means irregular or excessive feeding, with consequent changes in the quality of the milk and disturbances of infantile digestion. Fretfulness, vomiting, colic and diarrhœa are the common symptoms of the condition. If continued for any length of time, growth and nutrition become affected and the digestive capacity seriously impaired. In cases of short duration, institute regular nursing habits; in cases of longer duration, remove the contents of the alimentary canal (castor oil 2 drachms), omit one or if necessary two nursing periods, and then commence regular nursing habits.

PART II

SUBSTITUTES FOR MOTHER'S MILK

A. General

1. As an animal develops from the primitive cell into the perfect organism, the manner of its nutrition becomes more complex and its powers of digestion become broader and fuller. Up till the period of weaning the sole nourishment is derived from the body of the mother, and the digestive powers are, during the period of lactation, finally prepared for the acceptance and management of an independent diet. In all mammals a profound change takes place in the digestive tract during lactation, owing to the fact that the reactions between the mother's milk and the digestive juices of the infant are such that development of the digestive powers is automatically induced.

2. The milk of a healthy mother remains, within limits, constant in quality throughout the period of lactation ; it does not become stronger or richer as the infant grows older. The infant of seven months consequently receives a milk of practically the same strength as the infant of two months, and though it takes more at a nursing period, yet it is satisfied with longer intervals between the feeds. The composition of the food has remained the same, and yet it has ever gradually and continuously supplied an added stimulus to the development of the digestive powers.

3. The essential constituents of food — protein, fat, carbohydrate, mineral salts, and water — are present

in very many foods of utterly different kind, but in no food are they present in forms so fitted for the nutrition of a young mammal as in the form of milk. In addition to the chemical side of the consideration of milk, it is very important to remember its physical characters as well; the formation of curds on the introduction of milk into the stomach is a fact of great importance.

4. When the milk of the cow or the milk of the goat is acted upon by rennin, dense masses of curd are formed: in the case of mare's milk or ass's milk the curd is much smaller and finer.

The adult cow and the adult goat digest most satisfactorily when the stomach is filled with masses of bulky food, while the stomach of the mare or the ass is small, and food remains a very short time in it. The reaction between the rennin and the milk during suckling in each case serves to develop the powers and conditions which will be called upon when weaning occurs.

It is very largely the reactions between the caseinogen of the milk and the gastric juice which serve to produce satisfactory digestive development.

5. While the maternal milk and the digestive juices of the young of any species of mammal are so suited to each other as automatically to produce satisfactory digestive development, the maternal milk of one species of mammal and the digestive juices of the young of another species are not so fitted. It is necessary to consider not only the quality of a milk and its consequent value as a food to the infant (the amount of protein, fat, sugar, etc., it contains), but also the nature of its digestive reaction.

6. Animals, other than the cow, from which milk may be obtained for the nutrition of the infant, are the ass, the goat, and the mare. A plentiful supply of milk from any of these sources is, however, not readily obtainable. The goat is apparently less prone to suffer from tuberculosis than the cow, while its milk is rich both in protein and fat. Ass's milk, on the other hand,

is poor in protein and contains a very small proportion of caseinogen, so that the curd formed with rennin is very soft and flocculent. It is also very poor in fat.

The milk of the ass or the mare is consequently more readily digestible than that of the cow, and, where obtainable, may be a valuable temporary substitute for cow's milk. Owing to the very small amount of fat in both milks they are, however, unsuitable for continued nourishment.

For practical purposes the importance of cow's milk is pre-eminent.

7. Before proceeding to consider the composition of cow's milk, it is advisable to fully recognise the manner of curd-formation in the stomach, and its relationship to digestive development. This has been studied more particularly by Van Slyke and Hart.

When maternal milk enters the stomach of an infant it is acted upon by the rennin ferment and curd is formed; thus the protein—caseinogen—which occurs in combination with calcium (calcium caseinogen), when acted on by rennin, forms a curd (calcium paracasein).

8. This curd—calcium paracasein—is a soft curd, which can pass readily through the pylorus ; and as in the early days of life very little hydrochloric acid is secreted in the stomach, and thus pepsin has very little action, so this soft curd passes almost unchanged into the duodenum, and the bulk of digestion takes place in the intestine.

9. As life advances a greater amount of hydrochloric acid is secreted in the stomach, and consequently more digestion of the soft curd—calcium paracasein—can take place in the stomach. The hydrochloric acid causes the soft calcium paracasein curd to become tougher and denser (paracasein) ; and as the amount of acid secreted by the stomach gradually increases, this curd becomes more and more suited for digestion by pepsin, and consequently digestion becomes gradually more gastric and less intestinal.

Early weeks of life .	Milk (calcium caseinogen) + rennin	= Calcium paracasein (soft curd). This soft curd passes to the intestine and is digested there.	
Later . . .	Milk (calcium caseinogen) + rennin	= Calcium paracasein (soft curd). Part of this soft curd passes to the intestine and is digested there; a part is acted upon by HCl	= Paracasein (hard curd), which is broken down by gastric digestion.
Close of lactation .	Milk (calcium caseinogen) + rennin	= Calcium paracasein (soft curd) + HCl	= Paracasein. Digestion largely gastric.

It is very important, however, to remember that, owing to the large size of the curd formed with cow's milk in the stomach, even in the earliest infancy its passage to the intestine is delayed.

B. Cow's Milk

11. The composition of cow's milk varies according to the condition of the animal, the period of lactation, the character of the feed, the amount of work and of rest, and the season of the year. The milk from a herd is more constant in composition than that from a single cow.

The milk also varies very markedly in composition according to the breed of the cow. The milk of Jersey, Guernsey, and Alderney cows is, as a rule, unsuitable for infant feeding; this milk contains a very high percentage amount of fat, and the nature of this fat is more unlike the fat of human milk than is the fat in the milk of other breeds of cows.

12. We may compare the average composition of human milk and cow's milk, as given by various authorities at different times, and note the variations in their results, but it is quite sufficiently accurate for all practical purposes to remember the following figures:—

	Human Milk. Per cent.	Cow's Milk. Per cent.
Protein	2	4
Fat	4	4
Sugar	6	4
Mineral salts	0·2	0·6

(See Appendix K.)

13. In addition, there are differences due to lack of freshness and impurity, as also properties more or less characteristic of living tissue, and peculiar to the species of mammal from which the milk comes.

14. The varieties of protein present in cow's milk are, like those in human milk, chiefly caseinogen and

lact-albumen. They are, however, present in double the amount of that in human milk. In cow's milk, also, the caseinogen is approximately four times as plentiful as the lact-albumen, whereas in human milk it is only present in half the quantity of the lact-albumen—the caseinogen in a given quantity of cow's milk thus being five or six times as plentiful as in an equal quantity of human milk. The lact-albumen, on the other hand, is only about half as plentiful in cow's milk as in human milk.

15. The importance of this difference in the quantity and quality of these forms of protein in the two milks is obvious when we consider the effects of the digestive juices on them. Thus by the action of rennin the curd produced with cow's milk is nearly six times as great as that produced with an equal amount of human milk.

In a test-tube it is found that in the case of the human milk the curdling produced is almost invisible to the naked eye and the mixture quite fluid, while the greater bulk of the cow's milk consists now of a solid tough mass of curd, surrounded by the whey. (See Appendix C.)

16. Lactic acid bacilli are always present in cow's milk ; and though neither they nor the lactic acid which they form are hurtful themselves, yet the reaction of the lactic acid with the rennin curd may interfere with normal digestion. A tough curd is formed in the stomach, which may be more than the stomach can cope with and which is unsuited for intestinal digestion.

17. Fat is present in cow's milk—other than Jerseys, Guernseys, or Alderneys—in approximately the same amount as in human milk. This fat, however, chemically considered, is not of identical composition with that found in human milk, and consequently it is not reasonable to assume that its digestion can be as readily compassed as that of the natural milk.

18. Sugar occurs in solution as in human milk, but in considerably less quantity, and it consequently is of less value as a protein-sparing agent. Thus, associated

with an excess of protein, there is a certain deficiency of carbohydrate in cow's milk. These two facts considered together are of great importance. In feeding with pure cow's milk, owing to this deficiency of carbohydrate (the amount of fat in the two milks being approximately equal), a larger supply of protein is necessary for the demands of the organism, and consequently a greater strain is thrown on the protein-digesting mechanism.

Lactic acid in any appreciable amount is an abnormal content of the infant's stomach, but, as previously noted (s. 16), lactic acid bacilli swarm in cow's milk, and the lactic acid produced by them may interfere considerably with digestion.

19. The salts in cow's milk are about three times as plentiful as in human milk. The action of rennin can only take place when soluble calcium salts are present, and cow's milk is very rich in calcium. It is probable that the salts of cow's milk occur largely in states of combination different from those found in human milk; consequently their absorption takes place less readily.

20. Cow's milk is a fluid designed by Nature to suit the wants of the young calf; it is fitted for its satisfactory nutrition and special digestive development, and it is supplied directly from the mother animal to the young; it consequently is clean, fresh, and contains in their natural conditions all its constituent ferments.

As supplied to the infant it is impure, stale, and consequently lacking in certain original qualities, in addition to differing considerably in chemical composition from the ideal food—mother's milk.

21. Fresh milk possesses the property of inhibiting bacterial development, and this power is considerable where the infant receives its mother's milk. New cow's milk has slight power in this respect, but milk which is old or milk which has been heated lacks the power, while milk which has been merely frozen after milking retains it to some degree.

22. Milk when stale becomes sour. This is caused by the action of lactic acid bacilli; and even before a

degree of sourness has been reached which is readily appreciable by the examiner, these bacilli may have caused such changes in the milk as to have rendered it very indigestible for the infant. The longer milk is kept, the greater is this danger.

23. Practically, all milk as drawn from the udder of the cow contains many bacteria, and milk is a fluid in which bacteria grow readily. In the byre, during transport, at the dairy, in the home, and in the bottle, there are countless opportunities for more bacteria to enter the milk. The strictest cleanliness is always essential in every procedure connected with milk. The presence of lactic acid bacilli in milk tends to hinder the growth of other organisms.

24. The number of bacteria present in much of the milk in this country is enormous. Many of these bacteria are very dangerous, some are comparatively harmless; but in the case of an infant large numbers of bacteria are always dangerous, quite irrespective of their nature. Epidemics of diarrhœa, typhoid, and diphtheria are often spread by milk; the tubercle bacillus, the staphylococcus, and the streptococcus are very frequently present in it; the organisms which cause decomposition of the protein constituent of the food abound, and there are many others.

25. Disease of the cow, and more particularly of the udder of the cow, is one source of contamination of the milk. Pyogenic organisms (staphylococcus, streptococcus, etc.) are found in the milk in cases in which there is local infection of the udder, but more important, because less readily noticed, are cases of tuberculosis. Tuberculosis is a very common disease among cows, and in the milk of infected animals tubercle bacilli are very frequently found. These bacilli of bovine tuberculosis are undoubtedly capable of causing tuberculosis in the human being, and consequently milk from a tuberculous cow is extremely dangerous food for an infant.

26. It is extremely important that milk be obtained from a non-tuberculous cow. By the injection of tuberculin into a cow it is possible in the great majority

of cases to discover whether the animal is infected with tuberculosis or not. All cows whose milk is used as food for an infant should be tuberculin-tested. (See Appendix J.)

27. Tubercle bacilli, human or bovine, may, like any other organism, be introduced into the milk after it has been drawn from the udder. To prevent the growth of organisms, milk should be cooled over ice immediately after milking, and, till used, should be kept at a temperature below 45° F. The transportation should be as short as possible.

28. Contamination of milk in the home must also be most strictly guarded against. The milk must always remain in a cool place and be kept covered up, otherwise a comparatively pure milk may become readily infected and dangerous. The baby's bottle must, of course, always be kept in a condition of surgical asepsis.

29. To sum up briefly :—

Cow's milk which is to serve as food for an infant—

(*a*) should not come from Jersey, Guernsey, or Alderney breed of cows;

(*b*) should come from a herd rather than from one cow;

(*c*) should come from animals in good health which have passed the tuberculin test;

(*d*) should come from a farm where scrupulous cleanliness is enforced;

(*e*) should be cooled over ice immediately after milking;

(*f*) should be kept at a temperature below 45° F. until used;

(*g*) should have no great distance for transport to the dairy, and should be transported in sealed bottles;

(*h*) should be scrupulously guarded in all manipulations, both in the dairy and in the home, against organismal infection. (See Appendices F and G.)

30. Practically, it is found to be impossible to entirely exclude bacteria from milk; the extent of infection is, however, enormously increased by careless handling. There is in this country no legislation regarding the limitations of the bacterial content of milk.

It is necessary, therefore, to realise fully the fact that practically all commercial milk swarms with bacteria; that these bacteria may be of a more or of a less dangerous species; but that, of whatever nature they be, when in large numbers they are an immediate source of danger to the infant.

31. In giving cow's milk to an infant it has to be remembered that this food suffers from the following disadvantages:—

1. It is impure.
2. Its composition is different to that of mother's milk.
3. It is not so readily digested as mother's milk.

32. With the object of remedying or minimising these disadvantages, various methods of modification of the milk are commonly employed. These methods may be suitably grouped under three headings, and will now be severally considered:—

1. Modifications of cow's milk to counteract impurity.
2. Modifications of cow's milk to alter the percentage composition of the different constituents.
3. Modifications of cow's milk to increase or favour its digestibility.

C. Modifications of Cow's Milk to Counteract Impurity

33. When the handling of milk during its course from cow to consumer is undertaken with the most scrupulous regard to cleanliness, and when the milk,

immediately after it is withdrawn, is placed and kept on ice, the number of bacteria found in it is comparatively small. *Cold hinders the development of bacteria*, and ice is essential for the good conduct of a dairy farm. Cold limits the degree of impurity of the milk, and in no way renders the milk less satisfactory as a food for the infant.

34. In order to *ensure the destruction of germs* contained in milk, the application of heat is the method commonly employed.

Various degrees of heat are employed which may, however, be grouped under the following headings:—

1. Pasteurisation.
2. Boiling.
3. Sterilisation.

It is important to consider the effect which the different degrees of heat have, not only upon the bacteria, but also upon the constituents of the milk.

35. All the constituents of milk are affected by the application of heat; and the higher the degree of heat applied is, the greater is the change in them.

We choose cow's milk as the first and best substitute for mother's milk because it more closely resembles that milk than any other food, and consequently we must expect that marked alteration of the quality and composition of cow's milk will lessen its resemblance to mother's milk.

By the application of heat we wish to ensure safety to the infant—we must employ heat of sufficient degree to remove bacterial danger, but we strive to limit the degree of heat to that which is essential.

36. The various bacteria in milk may conveniently be divided into three classes:—

1. Pathogenic germs of various infective diseases—tubercle, typhoid, etc.
2. Bacilli of the lactic acid group, producing carbohydrate fermentation.
3. Organisms of the *Bacillus subtilis* group, which produce protein decomposition.

Pasteurisation causes death of bacteria of group (2) and most of group (1), while group (3), spores, and probably the tubercle bacillus survive.

Boiling kills the bacteria of all groups, possibly excepting the tubercle bacillus, but the spores survive.

Sterilisation provides a sterile milk.

37. By *Pasteurisation* we understand the heating of milk at a temperature of 150° F.–160° F. for twenty or thirty minutes, with subsequent rapid cooling. The term is a somewhat indefinite one, and the methods used differ considerably. A special "Pasteuriser" may be employed, or simply a thermometer used.

By *boiling* we understand the raising of milk to its boiling point, with subsequent rapid cooling. This procedure is naturally subject to less variation than the preceding one.

By *sterilisation* we understand the exposure of milk to a temperature of not less than 212° F. for a period of forty minutes, with subsequent rapid cooling.

38. The application of heat to milk causes the coagulation of the whey protein lact-albumen. With Pasteurisation, this coagulation is inappreciable in amount; with boiling, it is distinct; and with sterilisation, it is very marked. Pasteurisation and boiling have but slight effect on the fat and lactose; sterilisation, however, interferes with the fine condition of emulsion of the fat, and produces large agglomerations of fatty material, and also causes caramelisation of the sugar.

39. It has previously been stated that the presence of soluble calcium salts in milk is necessary to permit of curdling through the action of rennin on caseinogen. Calcium salts are very plentiful in cow's milk. The application of heat to milk causes precipitation of calcium salts, and the higher the heat employed the greater is this precipitation. As a consequence, curd formation takes place less readily the higher the heat is to which milk is subjected.

40. The ferments present in milk are certainly

destroyed by boiling and by sterilisation. The process of Pasteurisation was introduced with the object of avoiding destruction of ferments, while guarding against impurity. Unfortunately, the temperature necessary for the removal of most bacterial danger and the temperature at which ferments are destroyed correspond very closely—the margin between the two is at best but of the smallest. Thus to ensure ferment vitality means to risk bacterial danger, and to ensure bacterial destruction means to abandon ferment activity.

41. The condition of milk after treatment by these processes may be compared thus:—

	Pasteurised Milk.	Boiled Milk.	Sterilised Milk.
1	Partial destruction of bacteria	Approximate sterility	Sterility.
2	...	Partial coagulation of protein	Large coagulation of protein.
3	...	...	Interference with fat emulsion.
4	...	...	Caramelisation of lactose.
5	Slight precipitation of calcium salts	Greater precipitation of calcium salts	Large precipitation of calcium salts.
6	Probable destruction of ferments and soluble enzymes	Destruction of ferments and soluble enzymes	Destruction of ferments and soluble enzymes.

42. Consequent on the above changes induced in the milk by the different degrees of heat, alterations occur in its digestion. With large precipitation of calcium salts, rennin curd forms but slowly in the stomach, and consequently is a softer and more flocculent curd the higher the degree of heat to which the

milk has been subjected. The flocculent curd of highly heated milk is not so fitted for gastric digestion as that of milk heated at a lower temperature, and it passes more readily onwards to the intestine. (See Appendix C.)

43. The relative nutritive value of unheated and of heated milk is very uncertain. We know that by the application of heat, alterations take place in the composition of milk which may improve its digestibility, but cannot increase its nutritive value. We know, further, that through heating it loses many of the qualities peculiar to it as a milk; and that though cow's milk is an unnatural food for an infant, yet the ideal food—mother's milk—is a fresh milk. We appreciate the immense value of heat in its capacity as bacterial destroyer, and daily are witnesses of its clinical efficacy; we are forced to admit the necessity of its use, but we deplore the existence of such necessity.

44. Another method of removing bacterial impurity has been suggested by Dr Budde of Copenhagen.

This method consists in heating milk to a temperature of 122° F. for some hours, and adding to it a solution of peroxide of hydrogen.

D. Modifications of Cow's Milk to alter the Percentage Composition of the Different Constituents

45. The dilution of milk with water is the simplest of these methods, and has as its principal object the reduction of the percentage amount of protein in the fluid, so that the amount present may approximate more nearly to that in human milk.

There is twice as much protein in cow's milk as in mother's milk, and so a mixture of 1 part milk and 1 part water renders the amount equivalent to that in mother's milk. The caseinogen, however, is still present in much greater amount than in mother's milk,

and consequently the curd formed with rennin is large.

46. It is inadvisable to dilute milk so much as to render approximately the percentage amount of caseinogen equivalent to that in mother's milk. By such dilution the other constituents of the milk are almost entirely washed out of existence.

Dilution renders the rennin curd less dense.

It is unwise to give an infant for any length of time a mixture weaker than 1 part of milk and 2 parts of water.

47. When milk has been diluted with water so as to reduce its percentage protein content, the amount of fat and sugar this mixture contains is less than that in mother's milk. This can be remedied by adding lactose to the milk and cream which contains nearly all the fat of the milk. It is not possible to add satisfactorily mineral salts or ferments to the mixture.

48. Lime water is frequently used as a diluent of milk. In addition to acting as a diluent, it alters the proportion of lime salts present in the mixture, and also serves to render the mixture more alkaline. This last action is the most important, because rennin acts only in the presence of an acid, and consequently its action is delayed, and a less dense curd in the stomach is the result.

49. The calcium content and the alkalinity of lime water vary according to the method of its preparation.

The Liquor Calcis or lime water of the Pharmacopœia is very weakly alkaline and contains less calcium than does cow's milk ; the advantages to be expected from its use are consequently small. If distinct effects are desired, much stronger solutions must be employed. As commonly prepared (a piece of unslaked lime dissolved in water), lime water is a solution of very variable strength, but always very weak.

50. Lime water is added to milk because of its alkalinity. Bicarbonate of soda may also be used for this purpose in the proportion of 1 gr. or 2 grs. to each

ounce of the food. By its employment the amount of added alkali is more readily determined. Solution of magnesium carbonate, "Fluid Magnesia," may also be used.

51. Barley water is a very common diluent of cow's milk used in infant feeding. It is prepared by boiling washed barley grains in cold water and then straining, or by adding prepared barley flour to water and then boiling. The method of preparation varies very considerably, the amount of barley which is added to a certain quantity of water being very indefinite. The exact composition of barley water is therefore, as a rule, unknown. It is, however, a matter of some considerable importance. (See Appendix H.)

52. Barley water contains minute amounts of protein, fat, and mineral salts, and a more considerable, though still small, amount of starch. The amount of starch present may vary from below 1 per cent. to above 4 per cent. It is always advisable to know the strength of the barley water which is being employed, and consequently it is necessary to lay down regulations for its preparation.

A common and useful method of procedure is to add 1 tablespoonful of prepared barley flour to 1 pint of water, boil for 20 minutes, and make up with plain water again to a pint; the barley water so prepared contains rather less than 1 per cent. of starch.

53. It has previously been noted that the power of the infant to digest starch is small, but varies considerably in extent in different children. It is thus still more important that the starch content of the barley water in use should be approximately known, and that its method of preparation should be constant. Where it appears advantageous to give barley water, it may be possible by diminishing its strength to avoid difficulties of starch digestion, and consequently to continue its use.

54. Barley water has been found clinically of considerable value in infant feeding. The exact cause of

its value is somewhat uncertain, and it has been described as due to—

(1) mechanical action ;
(2) developmental stimulus ;
(3) direct nutritive content ;
(4) indirect nutritive aid.

55. The amount of mechanical action which it exerts in rendering the rennin curd less dense through the interposition of its starch granules is very small and unimportant. (See Appendix C.)

In the later months of infancy the contained starch must undoubtedly participate in the development of the infant's powers of starch digestion, but in the early months such powers are unnecessary ; they call for no development, and forced development is harmful rather than advantageous. The direct nutritive value of barley water is at best but small—the amounts of protein, fat, starch, and salts are but small—but in any particular case this small value may be of considerable importance. There is reason to believe, however, that when not directly harmful, it may indirectly serve to stimulate secretion of digestive juices and to facilitate assimilation. A combination of two or more of the foregoing qualities of barley water probably accounts for the benefits derived from its employment in suitable cases.

56. In addition to barley, other cereals may be used for the preparation of weak gruels. Thus we may use rice water or oatmeal water.

57. Milk may be modified by separating it into its constituents, and subsequently mixing them again in different proportions. Thus, by means of artificial treatment with rennin, the whey can be separately obtained by the use of the centrifuge, or simply by standing in vessels the cream can be obtained, and a "modified" milk consisting of a mixture of milk, whey, cream, lactose, and water, or as many of those as are desired can be formed.

58. Such a method of procedure is termed the "percentage method," and for its satisfactory conduct requires

knowledge of the original degree of richness of the milk. Thus, before we can calculate the amount of lact-albumen in the whey or fat in the cream, we must know the amount of these constituents there was in the original milk.

59. *Approximate knowledge of the original composition of the milk used is entirely sufficient for all practical purposes.*—Enthusiasts in the subject have given birth to mathematical formulæ and algebraic tables of the most complicated and imposing character, which professedly make it a simple matter to prescribe the constituents of milk to an infant in percentage quantities varying by decimal points. Such mental gymnasties are entirely unnecessary. The results are inevitably inaccurate; the medical indications for such minute refinements are non-existent; in grasping at shadows we jeopardise the substance of the food.

60. The theory of "percentage feeding" is undoubtedly excellent as conducing to accuracy, and the practice of "percentage feeding" has been most useful in inculcating recognition of the value of accuracy in milk prescription. Accuracy in prescription is the great desideratum; accurate knowledge of the quantity and quality of the food, irrespective of minute fractional percentages. There is as yet no reliable scientific basis for very refined alterations of the elements of the food; such changes must be based on clinical signs and symptoms in each individual case, and consequently accurate knowledge of the quantities of milk, whey, cream, etc., given at each feeding, and knowledge of their approximate composition, serves to enable the physician satisfactorily to vary the ingredients to suit the particular case.

61. Milk is a composite fluid of many constituents; some of these we know, while some we recognise the presence of but cannot detect.

Milk possesses properties, therefore, peculiar to itself as milk; by subdivision and readmixture we deal mainly with certain factors, and have perforce to ignore, or at least disregard, others.

62. "Split-proteid" is a term implying the separation of the caseinogen and lact-albumen in milk. Curd contains the caseinogen, whey the lact-albumen.

Whey is commonly prepared by adding 1 drachm of liquid rennet to a pint of milk and heating at 100° F. for 20 minutes.

The curd is then broken up with a fork and the whey strained away. To prevent further action by the rennet ferment, the whey is quickly boiled before cooling; but as, in the course of this procedure, a small amount of the lact-albumen is coagulated, it is sometimes deemed advisable to heat the whey to 150° F., and no higher.

Whey is a watery solution of about 1 per cent. lact-albumen and 5 per cent. lactose, with a minute quantity of fat and most of the inorganic salts of milk.

63. Cream is practically milk rich in fat.

The constituents of the two are identical, the important difference in quality being the comparatively large amount of fat in cream. The fat content of commercial cream varies within fairly wide limits; it depends upon the richness of the original milk from which the cream was obtained, and on the method by which it was obtained.

Cream may be obtained by skimming after the milk has stood for some hours, or it may be obtained by means of the centrifuge.

64. Laboratories have been developed (Walker-Gordon), more particularly in America, in which milk mixtures are made up, according to the physician's prescription, after the percentage method.

This milk comes from tuberculin-tested cows, is cared for with scrupulous cleanliness throughout, and its richness is tested chemically. Consequently, by mixing in varying proportions the whole milk, the skimmed or separated milk, the cream (of different graded strengths of fat), the whey, solution of lactose, and water, the different elements are suitably fitted into the mixture.

65. The following is a prescription-blank as used in a Walker-Gordon laboratory:—

The Walker-Gordon Laboratory.

℞ Per cent.

Fat . . . . . .
Milk sugar . . . . . .
Whey proteids . . . . . .
Caseinogen . . . . . .
Lime water . . . . . .

Heat at_____ Number of feedings_____

Amount at each feeding _____

Ordered for_____

Address_____

Date_____190__

_____M.D.

66. The "top milk" method of milk modification consists in allowing milk to stand several hours and then removing the upper layers. According to the original richness of the milk, the length of time it is allowed to stand, and the depth of the layers removed, a milk is obtained of varying degrees of fat richness.

67. For the great majority of medical practitioners in this country, the only milk available for infant feeding is a milk of uncertain quality—more especially of an indefinite fat content. Mathematical accuracy in the prescription of milk elements is impossible. The "percentage" principle must, however, be the basis for forming a prescription.

E. Modifications of Cow's Milk to increase or favour its Digestibility

68. All the methods of modifying milk mentioned under D indirectly aim at increasing its digestibility. There are, however, certain methods which are employed for this purpose more directly.

69. By the addition of the salt, sodium citrate, to milk, alterations take place in the calcium content of the milk, and the quantity of soluble calcium salts is diminished. The presence of these soluble calcium salts is, however, necessary if curdling of the milk by rennin ferment is to take place, and consequently by diminishing the amount of these salts the action of rennin is limited, and a smaller and softer curd is the result.

70. The presence of such a curd in the stomach causes less irritation than where untreated milk is used as the food, and it passes more readily through the pylorus. Gastric digestion is in no way delayed; but by the ready passage of the milk to the intestine, digestion tends to be rendered more intestinal than would otherwise be the case. One grain of sodium citrate added to 1 ounce of pure milk, or to so much of a milk mixture as contains 1 ounce of milk, serves partially to prevent rennin action, while 2 grains prevent it entirely. (See Appendix C.)

71. It has to be remembered that the protein of cow's milk is not identical qualitatively or quantitatively with that in mother's milk, and that its reaction with the rennin ferment is widely different. Alteration of the protein, so as to render more natural for the infant the result of its action with rennin, is consequently theoretically not unscientific. For satisfactory gastric digestive development the full curd of untreated cow's milk is certainly unnecessary, and partial diminution of the curd can in no way be a hindrance to such development.

72. When sodium citrate, however, is used in the proportion of 2 grains to each ounce of pure milk, and as a consequence no rennin curd is formed in the stomach, it is probable that with its continued use gastric digestive development will be unsatisfactory. Sodium citrate should be only a temporary ingredient of the milk prescription, and should be deleted from it gradually, but as quickly as possible.

Constipation is a common symptom among infants fed on citrated milk.

73. The artificial digestion of food previous to its administration naturally spares the digestive powers of the infant. The process which is employed in order to effect this is termed peptonisation.

74. The most ready means of carrying out this process is to use peptonising powders, which are prepared commercially by Fairchild. These powders are composed of pancreatic extract and bicarbonate of soda, and the digestive action is consequently due to the ferment trypsin. The method of employment is simple, and consists in mixing the powder with the milk and placing the bottle containing the mixture in water at a temperature of 110° F. for the length of time desired. The powder is added to the milk in the proportion of 5 grains of pancreatic extract and 15 grains of bicarbonate of soda (one powder) to each pint of milk. When the mixture is kept for 20 minutes in the water at 110° F. partial digestion occurs, while the longer it remains there the more complete is the action—after two hours' stay the full action is obtained. When the duration is 15 or 20 minutes there is practically no bitter taste in the milk, but when the process is continued longer, bitterness becomes more and more marked. After the desired time of warming, the milk should be brought to the boil to stop further action of the ferment, and then cooled.

75. The process is spoken of as peptonisation, but in reality they are pancreatic ferments, and not peptic ferments, which are employed. The main action is that on protein, but in addition the fat of the milk is also to some extent affected. The amount of alkali alone is an important addition to the milk.

76. The use of peptonised milk rests the digestive powers, and consequently is valuable in conditions where such rest is required — such conditions, for example, as high fever, or after a severe operation. Theoretically, also, predigestion should allow fuller nutrition in cases where the digestive powers are weak; practically, however, it is not so useful as might be expected, and when peptonised milk is given for

alimentary disturbance, it is advisable to commence with a dilute mixture of milk.

77. The long-continued use of peptonised milk is not advisable. It is necessary to give the digestive powers some work to do and some inducement to develop, and after four to six weeks' use peptonised milk must be changed for some other kind of food. Peptonised milk is also wanting in the antiscorbutic element.

F. Varieties of Infant Foods

78. Stress has already been laid upon the fact that animal milk is the best substitute for mother's milk, and it has been noted that, for all practical purposes, the cow is the animal above all others to be looked to as the source of such milk. It consequently follows that all other forms of food for the infant must be of very subsidiary value to that of cow's milk. The value of many of them is, however, very considerable, and their nature worthy of accurate study.

79. *Buttermilk.*—In the ordinary preparation of butter, fresh cow's milk is allowed to stand for twelve to eighteen hours; it is then creamed, and the cream is allowed to sour or "ripen." This "ripening" is due to the appearance of numbers of bacteria and the production of lactic acid. "Ripening" having progressed to the desired extent, the sour cream is subjected to the process of churning, under the stress of which the fat globules coalesce, and the liquid which drains away from this nascent butter is the buttermilk.

80. This liquid has practically the same protein and inorganic salt content as the ordinary milk: it contains, however, extremely little fat, and also a diminished amount of sugar, as some of the sugar has been changed into lactic acid. Its two chief characteristics are a small amount of fat and a large amount of lactic acid.

81. This milk is very readily digestible. The method of its formation and the development of a comparatively large amount of lactic acid serve to alter the condition of the caseinogen so that it is less readily acted upon

by rennin in the stomach, and consequently heavy curds are not formed. Lactic acid has here acted upon the caseinogen before the milk is drunk, and, by preventing rennin action, has increased the digestibility. An exactly opposite effect from the presence of lactic acid has previously (Part II., B., s. 16) been noted. In this former case, however, the amount of lactic acid was not sufficient to alter the condition of the caseinogen or prevent the rennin action, and consequently rennin curds were formed in the stomach, which were afterwards rendered still more indigestible from the action of the lactic acid: in this case rennin acted first, and then the lactic acid; in buttermilk, lactic acid acts first, and prevents rennin action.

82. Buttermilk may be given to the infant in the raw condition, and thus all the benefit due to the presence of living lactic acid bacilli is obtained.

As the ordinary putrefactive changes in milk, occurring in the digestive tract, take place through the agency of organisms acting in an alkaline medium, and as the presence of large numbers of lactic acid bacilli in the milk prevent the action of these organisms, so, in certain conditions, the employment of buttermilk has been considered advisable.

83. Buttermilk is also frequently given, mixed with flour and sugar, and then boiled. When it is considered desirable to subject the buttermilk to heat, it is essential that a gruel of some sort be previously added to it, as otherwise dense coagula are formed. One tablespoonful of wheat flour, 1 dessert-spoonful of sugar, and 1 pint of buttermilk is a common mixture. Boiling, naturally, kills the lactic acid bacilli, and the value of a buttermilk mixture such as the above is probably largely due to the fact that it contains practically no fat.

84. Buttermilk obtained by the natural process described in paragraph 79 obviously must contain many organisms in addition to the lactic acid bacilli, and consequently a process for its artificial formation has been introduced. This consists in the addition of

cultures of lactic acid bacilli, or "lactobacilline" (the name of the commercial preparation), to milk. The advantages of this method are several—the presence of other bacteria is avoided, and the degree of acidity can be voluntarily regulated. The cultures also can be added to milk of any quality or composition—fresh, Pasteurised, boiled, sterilised, or milk mixtures—which is a point of some importance.

85. *White-wine Whey.*—By using sherry instead of rennet in the treatment of milk, white-wine whey is obtained. The curd here resulting is, however, more flocculent, and consequently less fat is entangled in it when the whey is strained off. The preparation of the fluid, as described by Myers and Still (*Lancet*, January 12, 1907), is as follows:—"10 ounces of milk were heated until just boiling, then $2\frac{1}{2}$ ounces of cooking sherry were added, and heat was applied again until the mixture began actually to 'boil up,' when it was removed from the fire and allowed to stand 3 minutes; the curd was then strained off through a twofold layer of butter muslin." Their analysis showed this whey to contain protein, 0·45 per cent.; fat, 0·95 per cent.; and sugar about 5 per cent.

86. Sherry-whey has, in addition, the following characteristics. It has a markedly acid reaction, varying in intensity with the sherry employed; it has a peculiar flavour, by virtue of which it exerts a certain amount of carminative effect; and, most important of all, it contains a considerable quantity of alcohol.

87. *Albumen Water.*—As usually made, the white of a fresh raw egg is taken and cut in various directions with a pair of clean scissors. It is then shaken up with the desired amount of water and strained through muslin. The white of 1 egg in 1 pint of water gives a protein content of rather less than 1 per cent., and in addition there is present an extremely minute amount of fat and of salts.

88. *Malt Soup.*—"Loeflund's Malt Soup Extract," a preparation of malt and potassium carbonate after the formula of Keller, is a variety of food in great repute

in some places. The directions for the preparation of the food are as follows :—

"3½ ounces of Malt Soup Extract are added to 1 pint of warm water and dissolved. This is solution No. 1. Then suspend or mix 3 ounces by measure or 2 ounces by weight of wheat flour in 1 pint of milk. When the wheat flour and milk solution is strained it is added to the Malt Soup Extract solution and slowly brought to a boil, being stirred constantly over a slow fire."

"For young and weak children dilute the Malt Soup with ⅓ part water." More copious dilution is frequently necessary.

89. Malt Soup is used when the infant is under weight and is not gaining satisfactorily, and when there are no definite signs of gastro-intestinal disturbance. The power of the Malt Soup to dextrinise the flour used in the mixture is infinitesimal, and the reasons for the successful use of this method of feeding are probably the high carbohydrate content, increased facility of protein digestion, and low fat content. It is consequently likely to be of most value in cases where there is difficulty in the digestion of fat.

90. *Raw beef juice* is of but very doubtful nutritive value, and *beef extracts* are of none. They must always be avoided in cases in which there is evidence of much intestinal putrefaction. Raw beef juice is, however, a very useful article of diet. When given well diluted it is readily digested by infants, and it provides protein in cases in which there is difficulty in digesting the caseinogen of milk. It may in other cases be given along with milk.

91. *Animal broths*, though stimulating, and consequently useful at times, are not of marked nutritive value. They should only be used temporarily when milk is contra-indicated.

92. *Condensed Milk.*—This is cow's milk from which a large amount of water has been removed through heating and evaporation. As a rule, about one-third of the water is removed in this manner, so that by the addition to condensed milk of twice its bulk of water

the composition of the original cow's milk is obtained. The composition of the original cow's milk varies considerably, and consequently the composition of different brands of condensed milk varies accordingly. In addition to condensation of the milk, there is frequently also the addition to it of cane sugar. We meet, therefore, with three types of condensed milk:—

1. Condensed whole milk unsweetened.
2. „ „ „ sweetened.
3. „ skim milk „

93. It is obvious that for the use of the infant all types require plentiful dilution. Twofold dilution with water restores the original composition of the milk with or without, according to the type, the addition of cane sugar. Further dilutions, to make the amount of protein approximately correspond to that in mother's milk, results in the amount of fat being reduced to a minimum. The vast majority of all condensed milks are artificially sweetened with cane sugar, and their two outstanding characteristics are accordingly *lack of fat* and *abundance of sugar*.

94. Condensed milk of any kind must always be given to the infant freely diluted, and in the process of dilution fallacies occur. The measurement of condensed milk is difficult; a teaspoonful in the hands of one person is a very different amount to that in the hands of another person, and calculation of the resulting composition of the fluid from the amount of dilution is not reliable. Clinical experience is much more valuable. It has been found that when a condensed whole milk is employed, it is advisable to begin with a dilution of an average teaspoonful of the milk in six tablespoonfuls of water. The strength of milk can, of course, be gradually increased. The Nestlé, Milkmaid, and Anglo-Swiss Condensed milks are good samples of the condensed whole milks sweetened; the Viking is a condensed whole milk unsweetened; and there are almost innumerable brands of condensed skim milk sweetened.

95. Dilute condensed milk is a very digestible food. Rennin action does not take place so readily here as with fresh milk; the amount of protein and the amount of fat is small. Infants so fed digest readily and grow fat, but the prolonged use of such a food is dangerous. Scurvy is not uncommon with lengthy administration, and it is probable that, in addition to the poverty in protein and fat, the antiscorbutic property is wanting. It is advisable, accordingly, to give a little orange juice to the infant occasionally during the use of this food.

96. In the process of condensation of the milk the degree of heat applied is not sufficient to ensure sterilisation, and consequently it may be considered advisable to boil the mixture before use.

If considered desirable, cream can be added to supply the deficiency of fat.

97. *Proprietary Foods.*—In every branch of commerce it is recognised that, under ordinary circumstances, the supply of an article is suited to the demand. When the demand is great the supply rises, and *vice versa.* It has consequently to be recognised that the demand in this country for proprietary infant foods is enormous; and more than that, it certainly is not on the decline. Vast numbers of "Foods" are in the market to-day, and "the cry is still they come." The demand for them is great: they satisfy some longing; they realise some desire; they fill some want. What is the reason of this demand? Why this insistent call? The answers to such questions must be intimately connected with the whole national system of infant feeding, and must be of the greatest importance to all physicians dealing with children.

98. For the breast-fed infant, nourishment is supplied in its ideal form; animal milks and proprietary foods are of no manner of interest or value to it.

Want of maternal nursing must necessarily be an important cause of the demand for proprietary foods.

99. In the case of artificially fed infants the demand

for these foods may be due to one of three possible causes, viz.—

(1) The results of feeding with proprietary foods are better than the results of careful feeding with some form of cow's milk.
(2) Proprietary foods are used because of the amount of unsatisfactory feeding with cow's milk, and give better results.
(3) Proprietary foods are used as offering, in general, the path of least resistance.

100. It is necessary, before considering these three possible explanations, to examine the composition of these proprietary foods. Their composition varies very considerably, and numerous groupings of the different foods are possible.

In Appendix I, I quote fully from Dr Robert Hutchison's book on "Food and Dietetics" a most excellent and comprehensive table of analyses of many proprietary foods. In it they are grouped as follows:—

(1) Foods prepared from cow's milk, with various additions or alterations, and requiring the addition of water only to be ready for use.
(2) Farinaceous foods prepared from cereals (usually wheat), of which the starch has been partly or wholly transformed into soluble substances (dextrins or malt sugar), and which require the addition of milk to fit them for use.
(3) Farinaceous foods in which the starch has not been predigested.

101. Judging by the standard of human milk, and bearing in mind the reasons formerly adduced for the advantages to be expected from the use of cow's milk, groups (2) and (3) can at once be put out of count as infant foods comparing in value as the sole food with cow's milk.

Foods in group (1) are much more satisfactory, but

they, in common with the foods in the other groups, suffer under the following disadvantages.

All lack the antiscorbutic property, all are excessively poor in fat, the great majority are very poor in protein and very rich in sugar, and very many contain starch.

102. With such disadvantages, no food can be considered of equal value in infant feeding with cow's milk, and explanation 1 (the results of feeding with proprietary foods are better than the results of careful feeding with some form of cow's milk) must fall to the ground.

103. The points in favour of the employment of a proprietary food are, shortly,—

The food is usually easily prepared, and is always accompanied with definite precise instructions as to the method of preparation and manner of using; it is frequently readily digested by the infant (with the exception of foods which contain much unchanged starch); it is sweet to the taste, and the infant consequently takes it readily; the infant very often gains weight and becomes for the time being very fat.

With such an array of favourable arguments to back it, the infant food is certainly, at the first glance, in a strong position.

104. On the other hand, we have to consider unsatisfactory feeding with cow's milk. This feeding may be unsatisfactory owing to (a) *the condition of the milk.* Milk with a minimum of fat, an enormous number of bacteria and much filth, is suitable for no human being. Cooked or uncooked, it is poison to the infant. The infantile defensive powers vary enormously, and many infants reared on this liquid mess survive the period of infancy; but for the vast majority health during infancy is, under these circumstances, an unattainable elysium. A safe proprietary food of the most suitable composition is infinitely better than a thoroughly polluted milk. Milk from a respectable dairy is, however, preferable to any proprietary food.

105. Unsatisfactory feeding with cow's milk may be due (b) *to the fault or misfortune of the mother or nurse.*

The home preparation of milk for an infant and the feeding of the infant undoubtedly entail the expenditure of considerable time and trouble. In the poorer classes the mother may be utterly unable to spare the time from duties essential to the continued existence of the family, or with the time available she may be ignorant or careless in the spending of it. In all cases the infant suffers; ignorance, carelessness, and want of time are the causes. Is a proprietary food the remedy? By its employment temporary improvement is common—it is readily prepared and readily digested, it tastes sweet and keeps the baby quiet. But the improvement is merely temporary—rickets and malnutrition supervene, and the infant becomes a weakly child. Cow's milk, ease in its preparation for the feed, and regularity in the feedings are the essentials here, and not a proprietary food. Milk prepared at the dairy in suitable mixture, and delivered in bottles containing the suitable amount for each feeding, and of the number corresponding to the number of feedings required, is the remedy. (See Appendices F and G.)

106. In the third place, unsatisfactory feeding with cow's milk may be due (c) *to inefficient prescription by the physician.* The remedy is obvious, and certainly is not the employment of a proprietary food. A good proprietary food, with its accurate instructions intelligently carried out, will, however, in many cases produce improvement, in default of other remedy.

107. Is the employment of a proprietary food the path of least resistance for physicians, mothers, and infants in the process of infant feeding? Human nature is credulous and proprietary foods are cleverly advertised—they are safe, they are strong, they are expensive; they offer everything that can satisfy a mother's dearest ambitions as regards the welfare of her infant! As an adjuvant in feeding with cow's milk, they are certainly frequently most valuable; in certain pathological conditions they may be useful; and as a temporary food they are often used with advantage. Their good points—and many are most excellent—are

constantly before the public; the public is duly impressed, and the wave of encomium laps around the feet of many medical practitioners. But when all is said and done, proprietary foods must be considered third-rate food for the infant: in the first class we have mother's milk, and in the second class cow's milk.

PART III

ARTIFICIAL FEEDING

The Healthy Infant

1. Cow's milk, boiled (scalded) and suitably modified, is the best obtainable artificial food for the infant.

2. Care must be taken to see that the milk comes from a clean, reputable dairy; that if possible it is obtained from a herd of tuberculin-tested cows; that there is no lengthy distance of transit; and that it is carefully guarded throughout from risks of contamination.

3. Raw cow's milk is for the average infant a more satisfactory and wholesome food than heated cow's milk; it is however, as a rule, unsafe, because of bacterial impurity.

The infected condition of most of the commercial milk in this country necessitates the application of heat.

4. Sterilisation (heating to 212° F. for forty minutes) is unnecessary and inadvisable. In exceptional circumstances, where there is suspicion of the character of the milk, this method, however, should be employed.

Pasteurisation (150° F.–160° F. for twenty minutes) is unsatisfactory and the result indefinite.

Boiling (scalding) must be the usual procedure. Bacterial danger is thereby rendered insignificant, the process is simple, and the resulting nature of the milk is not markedly less satisfactory than when Pasteurisation is employed. Circumstances alter cases, and no hard-

and-fast rule can be laid down, but boiled (scalded) milk should be the routine practice.

5. The milk should be modified according to the age, weight, and digestive capacity of the infant.

This modification, as a matter of routine, consists of dilution with water and the addition of cream and sugar; further modification is necessary in special circumstances, and may consist of the addition of sodium bicarbonate, sodium citrate, gruel, etc.

6. The most approximately accurate basis for the conduct of infant feeding consists in knowledge of the composition of maternal milk, and recognition of the fact that no other food, however manipulated, can be rendered exactly similar to it.

The digestive capacity of every infant is peculiar to itself, but broad rules, founded on existing knowledge, can be formulated which are applicable in the great majority of cases.

So far as possible, cow's milk must be brought into resemblance in composition with mother's milk, but it must always be remembered that it is impossible to obtain exact resemblance, and consequently that the addition of some other substance to cow's milk may increase the resemblance or favour more natural conditions of digestive reaction.

7. The value and suitability of food for the infant are determined chemically and physiologically: chemically, by estimation of the percentage composition of the food; physiolgically, by the readiness with which it is digested and absorbed.

The physical test of the heat energy of the food—calorie estimation—is practically of very limited value.

8. Estimation of the exact percentage composition of the food is both unnecessary and impossible.

In this country there are few facilities or milk laboratories for obtaining a routine estimation: where such facilities do exist, the results are only approximately accurate.

9. We ought, however, to be able to depend upon a milk of a certain strength and a certain purity.

The composition of cow's milk previously mentioned is a safe standard to take for fresh whole milk from a first-class dairy.

That standard reads:—protein 4 per cent.
fat 4 „
sugar 4 „
mineral salts 0·6 „
(See Appendix K.)

10. These figures are incorrect, but by employing them we have an approximately accurate basis for future calculations, and, moreover, *we know what our error is.* It is, that we calculate on rather too much fat and rather too little sugar in the milk. This error is one which makes for safety in infant feeding—fat is more difficult of digestion than sugar, and excess of fat causes more serious trouble than excess of sugar.

By reasoning from the above figures, we give the infant less fat and more sugar than is calculated; the excess of sugar is fraught with no danger, and the want of fat is very small when whole milk from a first-class dairy is employed.

11. In addition to modifying cow's milk so as to render its composition approximately similar to maternal milk, the physiological difficulties of its digestion have to be remembered. It consequently is always advisable at the commencement of artificial feeding to give the infant a modified milk of composition less strong than mother's milk.

As great variations exist in an infant's capacity for digesting artificial food, it is well to consider the subject in connection with various types of healthy infants.

12. *Average healthy infant.*—When artificial feeding is necessary from birth, the administration of milk is commenced on the third day. During the third day the infant is given six bottles, in addition to two during the night.

Each bottle contains ½ tablespoon cow's milk, 2½ tablespoons boiled water.

On the fourth day the infant receives eight bottles

and two during the night, and this number of bottles is continued till the end of the first month.

On the fifth day each bottle contains 1 tablespoon cow's milk, 2 tablespoons boiled water. No cream should be given till the end of the first week, but sugar should be given earlier, 1 teaspoonful of sugar of milk during the fourth and during the fifth days, 2 teaspoonfuls during the sixth day, and three teaspoonfuls during the seventh.

13. The diet of the first week is thus as follows:—

1*st* and 2*nd days*, boiled water *ad lib.*

3*rd day*—

Amount of food 12 oz. = 10 oz. water
2 oz. milk
8 feedings of 1½ oz. each.

4*th day*—

Amount of food 15 oz. = 12½ oz. water
2½ oz. milk
1 ʒ sugar of milk.
10 feedings of 1½ oz. each.

5*th day*—

Amount of food 15 oz. = 10 oz. water
5 oz. milk
1 ʒ sugar of milk
10 feedings of 1½ oz. each.

6*th day*—

Amount of food 15 oz. = 10 oz. water
5 oz. milk
2 ʒ sugar of milk
10 feedings of 1½ oz. each.

7*th day*—

Amount of food 15 oz. = 10 oz. water
5 oz. milk
3 ʒ sugar of milk
10 feedings of 1½ oz. each.

14. The entire amount of food for the day should be prepared at once. The sugar is added to the water, which has been boiled and cooled, and thereafter the milk is added. The whole mixture is then brought

rapidly to the boil and quickly cooled by placing in cold water.

15. Cream should be added during the second week to the amount of 3 i in the twenty-four hours' food to begin with. During the second week the quantity of water and of milk are kept as at the seventh day, while cream is gradually added, and also another drachm of sugar of milk, so that by the fourteenth day the feeding is:—

14th day—

Amount of food 16 oz. = 10 oz. water
5 oz. milk
½ oz. sugar of milk
½ oz. cream
10 feedings of rather over 1½ oz. each.

16. After this time the mixture is gradually increased in quantity and strengthened in quality; the two alterations should never take place at the same time. Addition to the food or strengthening of the food must always take place gradually.

By the end of the 1st month the daily feeding is—

Amount of food 20 oz. = 12 oz. water
6 oz. milk
1 oz. sugar of milk
1 oz. cream
10 feedings of 2 oz. each.

17. The relative proportion of milk to water is hereafter gradually increased until at some period during the third month the amount of the two is equal.

End of 3rd month—

Amount of food 28 oz. = 12½ oz. water
12½ oz. milk
1½ oz. sugar of milk
1½ oz. cream
7 feedings of 4 oz. each.

18. *During the 6th month* the following prescription is attained :—

Amount of food 42 oz. = 12 oz. water
24 oz. milk
2 oz. sugar of milk
4 oz. cream
6 feedings of 7 oz. each.

During the 8th month—
Amount of food 48 oz. = 42 oz. milk
1½ oz. sugar of milk
4½ oz. cream
6 feedings of 8 oz. each.

19. The sugar of milk naturally dissolves in the mixtures, and consequently its quantity should not, strictly speaking, be included when calculating the total amount of the mixture. I have, however, included it on the understanding that the mixture is made up to the required amount by the addition of water. *The prescription of the diet must in every case be in writing, and complete in all details.*

20.—See table, page 67.

21.—See table, page 68.

22. The above tables appear comparatively complicated; the essential matter is, however, simple. The percentage tabulation is purely a matter of interest, and is only accurate within comparatively wide limits. *Remember* the approximate size of the stomach, which is the indication for the amount of food at each feeding at any particular age, and remember the number of feedings usually necessary at each age. Knowing these two, the total amount of the mixture necessary for the day is easily calculated. Remember further that the mixture at the end of the 1st month contains twice as much water as milk, at the end of the 3rd month equal quantities of water and milk, during the 6th month twice as much milk as water, during the 8th month pure milk.

23. For the satisfactory conduct of the artificial

Feeding for First Week.

	Total Mixture.	Amount at each Feeding.	Number of Feedings and Intervals between Feedings.	Percentage Composition of Mixture, taking Milk = Protein 4 %, Fat 4 %, Sugar 4 %, and Cream = Protein 4 %, Fat 15 %, Sugar 4 %.		
				Protein.	Fat.	Sugar.
3rd day	12 *oz.* =10 oz. water 2 oz. milk	1½ *oz.* =2½ tablespoons water ½ tablespoon milk	8 *feedings* =6 during day 2 during night	0·7	0·7	0·7
4th day	15 *oz.* =12½ oz. water 2½ oz. milk 1 ʒ sugar of milk	1½ *oz.* =2½ tablespoons water ½ tablespoon milk 6 grains sugar of milk	10 *feedings* =8 during day 2 during night	0·7	0·7	1·5
5th day	15 *oz.* =10 oz. water 5 oz. milk 1 ʒ sugar of milk	1½ *oz.* =2 tablespoons water 1 tablespoon milk 6 grains sugar of milk	10 *feedings* =8 during day 2 during night	1·3	1·3	2·1
6th day	15 *oz.* =10 oz. water 5 oz. milk 2 ʒ sugar of milk	1½ *oz.* =2 tablespoons water 1 tablespoon milk 12 grains sugar of milk	10 *feedings* =8 during day 2 during night	1·3	1·3	2·9
7th day	15 *oz.* =10 oz. water 5 oz. milk 3 ʒ sugar of milk	1½ *oz.* =2 tablespoons water 1 tablespoon milk 18 grains sugar of milk	10 *feedings* =8 during day 2 during night	1·3	1·3	3·7

Feeding after First Week.

	Total Mixture.	Amount at each Feeding.	Number of Feedings and Intervals between Feedings.	Percentage Composition of Mixture calculating Milk = Protein 4%, Fat 4%, Sugar 4%. Cream = Protein 4%, Fat 15%, Sugar 4%.		
				Protein.	Fat.	Sugar.
14th day	16 *oz.* = 10 oz. water 5 oz. milk ½ oz. sugar of milk ½ oz. cream	1½ *oz.* = 2 tablespoons water 1 tablespoon milk ½ teaspoon sugar of milk ½ teaspoon cream	10 *feedings* = 8 during day 2 during night	1·4	1·7	4·5
End of 1st month	20 *oz.* = 12 oz. water 6 oz. milk 1 oz. sugar of milk 1 oz. cream	2 *oz.* = 2½ tablespoons water 1¼ tablespoon milk [milk 1 small teaspoon sugar of 1 small teaspoon cream	10 *feedings* = 8 during day 2 during night	1·4	2·0	6·4
End of 3rd month	28 *oz.* = 12½ oz. water 12½ oz. milk 1½ oz. sugar of milk 1½ oz. cream	4 *oz.* = 3½ tablespoons water 3½ tablespoons milk 1 small dessert-spoon sugar of milk 1 small dessert-spoon cream	7 *feedings* = 6 during day at intervals of 2½ hours, 1 at night	2·0	2·6	7·4
During 6th month	42 *oz.* = 12 oz. water 24 oz. milk 2 oz. sugar of milk 4 oz. cream	7 *oz.* = 4 tablespoons water 8 tablespoons milk 2½ teaspoons sugar of milk 5 teaspoons cream	6 *feedings* = All during day at intervals of 3 hours	2·7	3·7	8·4
During 8th month	48 *oz.* = 42 oz. milk 1½ oz. sugar of milk 4½ oz. cream	8 *oz.* = 14 tablespoons milk 1 dessert-spoon sugar of milk 3 dessert-spoons cream	6 *feedings* = All during day at intervals of 3 hours	3·9	4·9	7·0

feeding of the average infant, the remembrance of the following figures is entirely sufficient (page 70):—

24. *Undersized infant.*—When in good health, the food for this infant should be that for an infant of younger age. *As a rule, it should be adapted more with regard to the weight of the infant than to its age.* This, however, is not always the case; and where satisfactory gain in weight is not attained, the food must be increased in amount or quality, or other addition must be made to it. (See par. 28.)

25. *Premature infant.*—This infant is frequently unable to suck satisfactorily. When possible, the secretion of the maternal breast should be drawn off and given to the infant by the spoon. If artificial feeding is necessary, the infant should be fed by the spoon every hour or 1½ hours, according to its age and strength. It is usually wise to commence with 1 tablespoonful of sugar and water (ʒi sugar of milk in 1 pint water) every hour for a day or two, and afterwards to add ½ teaspoonful of peptonised milk to each feeding, and feed every 1½ hours instead of every hour. The amount of milk is later on gradually increased, and thereafter the degree of peptonisation gradually diminished. It is frequently necessary to add 2 or 3 drops of brandy to the feed.

26. *Big, strong infant.*—This infant requires stronger food and more of it than the average infant. Guard, however, against the tendency to over-feed. Seven ounces of pure milk with 1 large tablespoonful of cream and 1 dessert-spoonful of sugar is, as has been noted, full nourishment for one feeding for the *average* infant of 8 months. This amount and richness of milk mixture should never be exceeded for an infant under 6 months of age, however powerful its digestive capacity may appear. If satisfactory gain in weight is not attained with this mixture, it is necessary to add some other form of nourishment to the food. The most satisfactory addition is 1–2 ounces of a cereal gruel, such as oat-flour gruel or barley gruel.

27. The variations of the infantile digestive powers from the average are sometimes so marked as to con-

Amount at each Feeding.	*No. of Feedings.*	*Relative Amounts of Water and Milk.*	*Cream and Sugar.*
At birth . . . . . 1 oz.	10	Water only	*Cream.*—Begun in 2nd week. Maximum amount attained to be rather over 1 table-spoon in a bottle.
At commencement of 2nd month 2 ,,	9	Water 2 parts, milk 1 part	
,, ,, 3rd ,, . 3 ,,	8		
,, ,, 4th ,, . 4 ,,	7	Water and milk equal parts	*Sugar.*—May be begun at birth. Maximum amount attained to be rather over 1 dessert-spoon in a bottle.
,, ,, 5th ,, . 5 ,,	7		
During 6th month . . . 6 ,,	6	Water 1 part, milk 2 parts	
,, 8th ,, . . . 7 ,,	6	Pure milk	

stitute definite peculiarities. Our knowledge as to the causes which produce these peculiarities is marvellously small. We recognise that heredity, and the age and general condition of the parents, must exert an all-powerful influence, and that the physical metabolism of the individual infant, and more particularly the nature of its internal secretions, doubtless exercise an important influence. But the physical conditions associated with such peculiarities have not been accurately defined, and consequently in the great majority of cases the particular peculiarity is only determined by the result of empirical alterations in the diet.

28. We find (*a*) infants for whom cereal gruels—starch-containing food—is of great value. These infants are of two classes—the exceptionally big and strong infant, and the exceptionally small infant. For strong infants with large digestive powers a cereal gruel—barley or oatmeal—should be added to the food during the 5th or 6th month, as has been noted in par. 26. In such cases the additional nutritive material contained in the gruel—the starch and the vegetable protein—is of considerable value, and can be fully taken advantage of by practically all these infants.

The method of preparation of the gruel must be clearly explained to the mother or nurse; and as the age of the infant increases, the strength of the gruel may also be increased.

29. For the exceptionally small infant, the administration of a cereal gruel is not of such universal value. When this infant is in good average health, is taking and digesting a milk mixture which has been gradually increased to a richness suited to its age—and consequently somewhat excessive with regard to its weight—but is still gaining weight only slowly, the addition of a gruel is *usually* succeeded by marked increase of the gain in weight.

In such cases the gain in weight is often much more marked than can be attributed to the nutritive value of the gruel added to the food, and in these cases the beneficial result is due more to the indirect stimulation

of, and assistance to, assimilation than to the direct nutritive value of the gruel.

30. We find (*b*) infants to whom the administration of cereal gruels is most inadvisable, and fraught with danger of digestive disorder. For the majority of all infants, a small amount of a cereal gruel is perfectly safe; but it is also true that, for the majority of all infants, the administration of this gruel is quite unnecessary and inadvisable.

Do not give barley water as a routine practice to infants during the first six months of life; after six months it is safe for practically all healthy infants. On the other hand, if there appears to be an indication for its employment at any period of infancy, do not hesitate to use it.

31. Occasionally (*c*) an infant is capable of digesting pure cow's milk at birth. Many cases have been recorded where this method of feeding has been employed and excellent results have been obtained.

In practically all these cases the milk was fully sterilised for lengthy periods, and consequently underwent all the changes and suffered under the disadvantages previously mentioned as resulting from this process.

There is no advantage to be gained from this method; it is only the *exceptional* infant who possesses this digestive power, and even for this exceptional infant it necessitates unnecessary digestive strain. *The method is dangerous and should not be employed.*

32. On the other hand, (*d*) it is sometimes found that the infant is unable to take cow's milk of a strength suited to its age and weight, and consequently of the richness necessary for its adequate nutrition. This condition is rare in a *healthy* infant, carefully fed, in this climate and in this country. The conditions associated with this diminished digestive power are more fully considered in Part IV., but it is well here shortly to state that in such cases the difficulty is either with the protein or with the fat of the milk.

When the protein is the source of the trouble, vomit-

ing and gastric pain after feeding are the common symptoms, and the addition of sodium citrate to the milk mixture, or the substitution of a cream and whey mixture for the milk mixture, are the most satisfactory methods of treatment. In the absence of excessively warm weather, difficulty due to fat digestion is even less common—when the fat is administered in suitable quantities. When the condition does occur, diarrhœa is the striking symptom, and is remedied by the administration of a fat-free milk, or a milk poor in fat—milk from which the cream has been removed by the centrifuge or by skimming.

33. Many healthy infants, after being fed, regurgitate a little from the stomach. When the amount of food administered has been suitable, this condition is due to air which has been sucked in along with the food, or in some cases to a small amount of gas liberated in the stomach. Along with the regurgitation of this air or gas a small quantity of the gastric contents may be lost, and consequently, in order to avoid this loss of nourishment, it is advisable to sit the infant up slightly after feeding, when the gaseous matter readily escapes, while the liquid remains in the more dependent part of the stomach.

34. During the greater part of a healthy infancy there are two motions of the bowels in the day. In early infancy the stools are rather more frequent than this, and during later infancy they are less frequent. The stools are light or brownish yellow in colour, and of a semisolid, even consistence.

35. Neither constipation nor diarrhœa is a natural condition for the healthy infant, and drugs must always be avoided when possible. Regulation of the bowels must to a very great extent depend upon regulation of the diet. It is, however, advisable to administer once a fortnight to the average healthy infant a dose of castor oil (one dessert-spoonful being an average dose), and to succeed this dose for a period of twenty-four hours by a diet considerably weaker than that which was previously given.

36. Plain boiled water is readily taken by the infant. It may be offered freely between the periods of feeding, and its administration is beneficial.

37. The regular weighing of the infant is important, as being a guide to the condition of its nutrition. The weight should be taken weekly during the first six months of life and fortnightly after—not oftener. More frequent weighing is undesirable, as slight daily variations are quite unimportant. The infant should always be weighed as nearly as possible at the same time of day and the same period after feeding.

38. In addition to the weight, the important guides to the healthy condition of the infant are plumpness without softness—a good muscular development without the undue deposit of fat—a satisfactory complexion, quiet, restful sleep, a readiness for food, and the absence of any abnormal sign.

Weaning

39. Weaning, when possible, must always be a gradual process. When weaning, always begin with the administration of a milk mixture, weaker than the average mixture for a healthy infant of that particular age, and consequently aim at keeping well within the infant's digestive powers.

Never begin with a milk mixture stronger than equal parts of milk and of water; and never, to begin with, add anything else—cream, sugar, etc.—to this simple mixture of milk and water.

The amount and strength of the mixture may be quickly increased and other ingredients added, but at the commencement the simpler the mixture the better.

40. *Natural weaning* (see par. 45, Part I.).—At the beginning of the ninth month one of the nursing periods in the morning is omitted, and a bottle feed consisting of 4 ounces of cow's milk and 4 ounces of water is substituted. After two or three days the substitution of another feed—in the afternoon—is made, and gradually the infant is entirely weaned from the maternal

breast. Pure milk can very quickly be given and cream and sugar added as well as a cereal gruel.

41. *Premature partial weaning or mixed feeding.*—It is not infrequently necessary, from social or other reasons, in cases where both mother and infant are healthy, to supplement mother's milk with artificial food. The mother may be able to suckle her child only during part of the day, or during the night and not during the day.

Whatever the period of suckling be, the hours for feeding must be adhered to. The infant here begins with a milk and water mixture corresponding in strength to that for an infant four or six weeks younger, and this mixture is gradually strengthened till it is of suitable strength for the infant of that particular age.

42. At any age conditions may arise which necessitate weaning. These conditions may be summarised as follows:—

(i.) *Weaning of infant previously entirely breast-fed.*

(*a*) Abrupt weaning where mother and infant were previously healthy. (*Cp.* Acute illness of mother.)

In this case it is sufficient to reiterate the necessity for commencing with a dilute milk. In all cases of abrupt weaning it is also advantageous to administer to the infant, twenty-four hours after the commencement of the artificial feeding, a dose of castor oil, as the very first milk is apt to be imperfectly digested.

(*b*) Gradual weaning where mother and infant are healthy. (*Cp.* Mother wishing or needing—because of social or other duties—to discontinue lactation.)

(*c*) Weaning where the maternal milk supply is deficient, and the nutrition of the infant consequently unsatisfactory, or where the maternal milk is unsuited to the infant. (*Cp.* Pregnancy or illness.)

These cases require no comment further than a repeated caution against unnecessary weaning.

(*d*) Weaning because of illness of the infant. (*Cp.* Infection.)

Such a case must of necessity be rare. Mother's milk is the natural and most digestible food for the infant, and consequently is pre-eminently desirable in cases of infantile illness. If the infant is too ill to suck, the milk should be drawn off and administered by hand; and if the infant should recover, it could return to maternal nursing. If the mother and infant are necessarily separated, the diet of the infant must depend upon the nature and virulence of its illness.

43. (ii.) *Weaning of infant partly breast- and partly bottle-fed.*

(*a*) Where mother and infant healthy.

(*b*) Where mother debilitated, etc., and infant consequently not thriving satisfactorily.

These cases require no further comment.

(*c*) Weaning because of illness of infant.

1. Acute illness.
2. Previous improper artificial feeding.

(1) This also requires no additional remarks other than that as in this case the infant has become accustomed to a certain amount of artificial feeding, the difficulty associated with weaning may be thereby diminished.

(2) The infant should never be weaned because of this reason. The treatment varies according to the severity of the illness, but in every case the aim must be to return to maternal nursing. Generally speaking, the treatment consists in the immediate substitution of drinks of plain

water for all artificial food and the administration of a dose of castor oil. The maternal nursing periods are to be continued, and if possible gradually increased in number so as to become the entire source of nourishment for the infant. If this is impossible, partial artificial feeding must be gradually recommenced with a very dilute mixture of milk and water.

PART IV

ARTIFICIAL FEEDING—THE SICK INFANT

A. Improper Feeding

1. The digestive capacity of a healthy infant is comparatively wide, and adapts itself readily to unusual conditions. It is, however, neither right nor safe to rely upon exceptional digestive power.

2. Infants are frequently given mixtures and amounts of milk totally unlike those which would be obtained from the mother's breast, the composition and nature of the food is altered at short intervals, the intervals between the feeding times are irregular or almost non-existent, and one mixture or food is rapidly changed for another, and then another.

3. *The most serious element in improper feeding is irregularity.*—This irregularity is almost never of the nature of too few feeding times; it practically always consists in their over-frequency. For infants who are not seriously ill, and who are capable of taking a milk mixture of a strength not less than 1 part of milk to 2 parts of water, two hours must be the minimum limit between feeding times. It is obviously advisable that the call upon the digestive functions should not be an absolutely continuous one; and more particularly is this the case when an unnatural diet, such as cow's milk, is being administered—and being administered, it may be, of a totally unsuitable composition.

4. When the food supplied to the infant is of unsuitable composition, but adequate for satisfactory nutrition,

it frequently happens that no untoward symptoms occur during infancy. The foundation is, however, laid for future digestive trouble. On the other hand, it not infrequently happens that the continued use of such a food is rendered impossible owing to the resulting illness of the infant. Excess of fat is comparatively rarely an error of the diet of the healthy infant in this country ; excess of protein—or in a less degree of sugar —is more commonly the cause of trouble. Very frequently—and more particularly when proprietary foods are employed—lack of protein and lack of fat are the cause of nutritional disorder.

5. Contamination of the food is a prolific cause of trouble. Serious contamination frequently occurs in the home, and it must always be remembered that milk which has been heated is more susceptible of bacterial contamination than unheated milk, and that it consequently must be guarded with scrupulous care.

6. The constant changing of the nature of the food is also fraught with serious disadvantages. The sudden substitution of one form of food for another is always inadvisable in the case of an infant, unless the change is one to a food much more easily digested. It is also well to remember that even with a food of perfectly suitable composition there may be slight digestive difficulty at the commencement of its administration, which, however, passes off with its continued use.

7. Improper feeding, whatever the nature of the impropriety be, tends sooner or later to cause disturbance of the digestive functions. An unnatural strain is thrown upon stomach secretion—a strain to which the stomach may be unable to respond. Vomiting occurs, due, it may be, to the mechanical irritation of massive curds, or the undue development of organic acids. The contents of the stomach do not undergo the natural gastric changes. Mechanical and chemical irritation of the mucous membrane of the stomach, along with functional abnormality, in the course of time produce organic changes.

8. The unnatural reaction between the digestive juices

and the unsuitable food thus started in the stomach continues often more markedly in the intestines. The contents, mechanically and chemically, are irritating; gases are liberated, colic is caused, and diarrhœa occurs. The condition advances to well-marked catarrh—it may be comparatively localised, as in the duodenum or colon, or it may be widespread—inflammatory changes occur, small submucous hæmorrhages develop, the natural powers of bacterial resistance become seriously impaired, intestinal infection or auto-intoxication occur, the organic changes in the wall of the bowel develop rapidly, and a fatal issue is imminent.

9. Such diagnoses as colitis, duodenal catarrh, hepatic dyspepsia, gastric catarrh, are in the great majority of cases in infants totally unsatisfactory. They are, as a rule, usually the main sign or the main symptom of improper feeding.

10. With well-marked alterations in gastro-intestinal digestion, the processes of absorption and assimilation necessarily are impaired, and nutrition suffers. A condition of malnutrition is developed—a condition secondary to improper feeding, and supervening, it may be, upon functional or upon organic changes in the alimentary tract. Rickets or scurvy may also be the sequelæ.

B. General Principles of Treatment

11. However simple the condition appears, preface treatment with a careful examination and an approximate diagnosis. In alimentary disturbances avail yourself directly of all means of assistance in arriving at a diagnosis; examine the vomit and examine the stools.

12. Be exact and definite in all orders. Give written orders as to the method of feeding.

13. Aim at simplicity in prescription of food. If in doubt, prefer the simpler prescription.

14. It is safer temporarily to under-feed than to over-feed. Starvation for a short period is well borne in

infancy, and digestive rest is frequently of the utmost value.

15. In acute digestive disturbances give immediate digestive rest, and commence with nourishment in its simplest form, and increase it gradually in strength; the same holds true for many cases of chronic digestive disturbance.

16. Always alter the diet gradually, except when the change is to a diet of a markedly smaller nutritive value, or one which is much more readily digestible.

C. Treatment of Improper Feeding as a whole; recognising that it may cause disorder of any or of many digestive functions, and organic alimentary changes

17. (a) *Acute symptoms.*—(1) You are asked to see an infant which has been taken ill suddenly and severely. You learn that the method or the nature of the feeding has for some time past been unsatisfactory; that for several weeks past the infant has not been thriving satisfactorily; that there have been during this time frequent or constant minor symptoms of "indigestion"; and that recently the infant has taken its food badly. Some six to eighteen hours previously symptoms of acute digestive disorder commenced; little or no food has been taken or retained; the child is seriously ill and very weak; there are no evidences of disease other than those which can be accounted for as the result of improper feeding.

18. The alimentary canal of this infant is intolerant of food; its digestive power is disordered, and for the time being inactive; its gastro-intestinal tract is unduly irritable, and constantly irritated by obnoxious contents; digestion is at a standstill; diarrhœa and vomiting constantly drain away the strength; vitality is at a low ebb. The two primary indications are to sustain the infant's strength and to remove the irritating contents of the alimentary canal.

19. Order the immediate cessation of all attempts to

administer food; administer an enema of soap and water; encourage frequent sips of warm water; two hours after the last attempt to give food administer a dose of castor oil (ʒij–ʒiv according to age of child). As a rule, the castor oil, if given in this manner, will be retained; if it is rejected at the second attempt, the stomach must be washed out with sterilised water, or with a weakly alkaline solution previous to its readministration. Four hours after the administration of the castor oil recommence nourishment. When prostration is marked, stimulants are necessary previous to this, and brandy well diluted (ʒi in ℥i water) may be given in 5 to 20 minim doses hourly according to age. Stimulants are, however, frequently unnecessary, and the same may be said of the mustard pack, the mustard bath, saline transfusion, hypodermic strychnine, etc.

20. The length of time during which the administration of food is refrained from and the nature of the food first given must depend upon the age of the child and the severity of the condition.

The following scheme of dietetic progression may be taken as typical of the manner of steps to be observed in gradually regaining a satisfactary nourishment:—

1*st.* Saline transfusion—brandy.
2*nd.* Albumen water—brandy.
3*rd.* „ „ and whey—brandy? Gradually increase the relative amount of whey till it is pure.
4*th.* Whey and cream—brandy? Gradually increase the amount of cream.
5*th.* Dilute fully citrated milk (or peptonised milk).
6*th.* Gradually diminish the degree of dilution and the amount of citrate separately (or the degree of peptonisation), and gradually and separately add cream and milk sugar.
7*th.* Plain milk.

21. In older infants, barley water is occasionally valuable along with or instead of albumen water. It

should not be given to an infant under 3 months of age, and the results of its initial administration must be most carefully watched.

Always increase the strength and amount of the food separately; do not hurry to regain a full diet; the rapidity with which it can be attained is widely different in different cases, but it is always wiser to be rather slow than rather fast. Watch the condition of the stools.

22. (2) The infant displaying acute digestive symptoms may, in spite of previous improper feeding, be comparatively strong, and with but slight digestive impairment, apart from the acute symptoms.

Acute digestive disorder is always serious in a young infant, but when the general condition of the infant is fairly satisfactory, this acute disorder is usually quickly recovered from under suitable treatment. In such cases delay the recommencement of feeding, give nothing but sips of water for 6, 8, or 10 hours, and then commence feeding with a dilute milk.

In all cases the nature of the previous impropriety of feeding has to be remembered, as such knowledge aids in the counteracting of individual peculiarities.

23. (b) *Chronic symptoms.*—(1) Chronic symptoms of digestive disorder not infrequently result from irregularity in feeding with a suitable food.

In such cases it is usually sufficient to lay down strict orders as to the intervals to be observed between the feeding times.

These infants have, however, become accustomed to frequent feeding, and crave it. Advise frequent sips of water between the feeding times; if thereby the craving is not satisfied, it is frequently advantageous to somewhat increase the strength—not the amount—of each feed. By so doing, the time during which each feed remains in the stomach is somewhat prolonged; digestion of it is, however, a continuous process instead of a superposition of digestive acts, as it was with too frequent feeding, and with frequent sips of water the gastric contents become progressively more dilute.

24. (2) The trouble may be caused by the administration of an excessive amount of food at each feeding period—the correct intervals of feeding being observed. When the composition of the food is suited to the age of the infant, and the amount only is excessive, it is usually sufficient to limit the amount. When the composition of the milk mixture is over-rich for the infant, it may be possible to determine the food element which is in excess; but, as a rule, this is not readily ascertained. The mixture must accordingly be weakened in all its elements, and it must at first be given of a strength less strong than that theoretically suitable to an infant of this age. The digestive powers have been over-taxed; they must be partially and temporarily rested. The various forms of over-taxation will be considered later (s. 37 and s. 38).

25. (3) The administration of a totally unsuitable food may be the cause of the disorder. In such a case the diet obviously must be altered, but it must be altered gradually. When one particular form of unsuitable diet has been administered continuously for some length of time, the digestive functions have become trained and over-taxed in some particular direction or directions, and, it may be, have suffered from lack of development in other directions. A diet theoretically suitable for an infant of this age is consequently unsuitable for this particular infant. Do not, therefore, immediately stop the diet in use and substitute a theoretically suitable diet, and do not alternate feeds of such two diets. It is at first impossible to say what is a suitable diet for this infant, and the administration of a suitable diet must be gradually attained by removing obviously unsuitable elements from the previous diet, and substituting for them those which are naturally more suitable. Frequently, a proprietary food has been the cause of trouble, and the process of treatment usually consists in gradually replacing a part of each feed with a small quantity of a dilute milk mixture. In the more severe cases it is sometimes advisable to treat as for acute symptoms, viz.

immediately stop the diet previously in use, administer a purge, commence feeding with albumen water or whey, and gradually progress by the steps mentioned in par. 20, and thus feel the way to a suitable diet.

26. The previous diet may, however, have consisted of a series of rapidly changing, unsuitable forms of food. Here there has been no special form of digestive taxation, and no special line of digestive non-development. All the digestive functions are more or less disordered. Give a dose of castor oil (ʒ ij–ʒ iv according to age), commence feeding at suitable intervals with a dilute mixture of milk and water, and give thrice daily a dose of calomel ($\frac{1}{12}$–$\frac{1}{6}$ of a grain according to age) for a week.

27. (c) *Malnutrition.*—Malnutrition obviously may be due to many causes other than improper feeding, but all infants improperly fed must inevitably eventually suffer from malnutrition. Malnutrition is a natural concomitant of chronic digestive disorder; in its severer forms it is a malady which taxes to the utmost the resources of the physician. Each particular case must be approached without any preconceived theory as to the most suitable treatment. Details as to the dietetic history are essential, the clinical examination—including examination of the stools—must be thorough, and the general hygienic conditions must be carefully attended to.

28. (d) *Rickets and Scurvy.*—Both these conditions are largely the result of improper feeding; the nature of the impropriety is in both conditions a variable one. Rickets is an active disease usually only between the 6th and the 18th month of life, and at this period accordingly treatment is most valuable. This treatment consists in securing for the infant a suitable diet; and as it is frequently found that a diet poor in fat has preceded the development of the symptoms, it is specially important to secure the administration of an adequate amount of fat, which is best given in the form of cream. The treatment of scurvy also consists

in suitable feeding, and along with this the administration of fresh fruit juice. Rickets and scurvy frequently occur together, and frequently there is difficulty in the feeding of the infant suffering from scurvy. Where this is so, first treat the scurvy before definitely attempting the establishment of a suitable diet. Commence immediately with frequent sips of a fresh fruit juice, and, if necessary, give no nourishment for 24 or 48 hours other than albumen water. The scurvy quickly improves, and with its improvement the digestive functions speedily develop in power.

29. (e) *Marasmus.*—Marasmus is a very indefinite term. It is sometimes used to denote a condition of extreme malnutrition, whatever the nature of the cause of the condition may be; it is frequently used in connection with cases of extreme malnutrition due to prolonged improper feeding or long-standing digestive disorder; but, as the title of a separate condition, it signifies extreme wasting due not to any acquired disability called forth during post-natal nutrition, but to an inherent weakness of digestive power. As such its treatment is largely empirical, and usually very unsatisfactory.

We are ignorant of its exact cause. In certain cases it appears probable that it may be connected with disorder of certain of the internal secretions, and in some cases small doses of thyroid extract ($\frac{1}{4}$ grain–$\frac{1}{2}$ grain) thrice daily give beneficial results. In all cases excessive care in dieting is called for.

D. Consideration of Special Digestive Disorders

30. (a) *Constipation.*—The treatment of constipation must in all cases be—at first, at least—dietetic. It is a condition not uncommon among breast-fed infants: in these cases the digestive health and diet of the mother must in the first place be regulated. Frequently methods more directly connected with the infant are necessary, and these consist in the administration of a tablespoonful of a fresh fruit juice thrice daily, or a

dilute cereal gruel, or a solution of milk sugar, as may seem most suitable in each particular case.

31. Habit is important as a prophylactic of constipation, and careful training is always valuable in its cure. The habit of irregular and inefficient fæcal elimination tends to produce muscular atony of the intestinal wall. A like condition is frequently also met with in cases of rickets. The correction of the diet which goes to remedy the condition of rickets tends to relieve the constipation; but frequently, for a short time at the commencement of treatment, other aids are necessary. The most satisfactory of these are a teaspoonful of olive oil thrice daily, or a nightly enema of soap and water.

32. With the administration of a theoretically suitable artificial diet, constipation may yet occur. In all cases of constipation careful examination of the stools is essential: the appearance of pale, pasty masses may suggest indigestion in the small intestine, the rapid evacuation of normal contents after the administration of an enema demonstrates rectal atony. The theoretically suitable diet may be unsuited to this particular infant, and some slight alteration may relieve the condition. The addition of barley water, an increase in the amount of cream, or a change from milk sugar to cane sugar, may prove eminently satisfactory.

33. The employment of citrated milk is frequently associated with the condition of constipation. The addition of sodium citrate to milk mixtures must always be only a temporary expedient, and as the relative amount of citrate is diminished the constipation improves. In cases where there is difficulty in diminishing the citrate, a slight addition of cream should be made to each food. The amount of cream in each bottle, whatever the age of the infant—up to 9 months—should never exceed 2 tablespoonfuls, and that only temporarily. When this amount of cream does not produce the desired effect, some other means must be employed, viz. soap and water enemata.

34. Improper feeding is occasionally the cause of

constipation, though more frequently of diarrhœa. Correction of the diet is the obvious treatment: very frequently the correction consists in the addition of fat in the form of cream.

Insufficient feeding, owing to the small bulk of the residue in the intestine, may also be the cause of constipation, and necessitates a more ample diet.

In every case of infantile constipation, however clear the cause may appear, it is advisable by personal observation to exclude any local cause in the region of the anus or rectum.

35. (b) *Vomiting.*—Allusion has already been made to the ease with which the stomach contents are ejected in infancy.

Vomiting is an easy process in infancy: it is a common symptom in a wide variety of conditions; its nature and significance vary considerably. It is impossible entirely to dissociate the symptom of vomiting from other symptoms of digestive disorder, as frequently it is only one symptom of the general condition. It is, however, possible to differentiate between various forms of vomiting, and to consider the cause, and consequently the general lines of treatment in the different forms.

36. All infants occasionally regurgitate a small quantity of fluid soon after drinking. This fluid comes up easily and is expelled gently. The condition may be due to overfilling of the stomach in cases where the amount of food is too large: it may be brought about by the infant drinking too quickly, or it may be due to gas formation in the stomach. Do not move the infant about much after feeding, but prop him slightly up in the crib. The condition is not serious, but it is a condition which must be stopped. A habit of vomiting is readily developed in certain infants which is often very difficult to treat, and consequently regurgitation of food must be prevented as far as possible.

37. The chief cause of serious vomiting is irritability of the stomach, due to the presence in it of undigested or unsuitable food. This vomiting does not commence

immediately after feeding, but usually some little time afterwards, and it may continue till all the contents of the stomach have been evacuated. Careful attention must be paid to the quality of the food. This may be found to contain an excess of sugar, in which case the vomiting is usually accompanied by much eructation of gas. The protein content of the milk mixture may be too high, or there may be intolerance of comparatively small amounts of protein: these cases are usually accompanied by symptoms of colic, the presence of curds in the stools, and tough curds in the vomited matter. If the protein content of the food appears too high, diminish it; if it is not unnaturally high, the substitution of barley water for plain water may remedy the condition in infants over 5 months of age, but for all infants sodium citrate (gr. ij to ℥i of the milk in the mixture) is the most valuable treatment.

38. Excess of fat in the food may likewise be the cause of the condition. The stools of these infants are pale grey, slimy, and more solid than is natural; all the processes of digestion are delayed, and the abdomen becomes distended with gas. The vomited matter has a markedly sour and acrid odour. In these cases diminution of the fat content of the food is essential. As a rule, the removal of all cream from the mixture, the administration of a simple milk-and-water mixture, and a dose of calomel thrice daily (gr. $\frac{1}{12}$–gr. $\frac{1}{6}$ according to age), for two or three weeks, serves to prepare the way for a fuller dietary.

39. In cases of congenital pyloric stenosis, the elements of success in medical treatment, when the case is seen early, consist in a supply of human milk and repeated washing-out of the stomach. Cases not uncommonly are met with which in some respects simulate an early stage of congenital pyloric stenosis. These infants vomit constantly, and with all forms of food, and the vomiting may be of a type somewhat similar to the "expulsive" vomiting of the stenosis cases. There is marked bulging of the upper part of the abdomen, and the stomach outline may be readily

discernible, but there are no visible peristaltic waves, and there is no palpable pylorus. These cases are very resistant to treatment; the vomiting frequently persists in spite of every effort, and the infant dies of exhaustion. Definite rules for dietetic treatment there are none. The most valuable form of treatment is repeated and frequent washing-out of the stomach.

In some cases it may prove beneficial to lengthen the interval between feeds and give stronger food; in others it may be wise to diminish the intervals and give small amounts of weak food frequently. Peptonised or citrated milk may be retained, or it may be that some food other than milk will prove more satisfactory. Frequent small doses of alkalies, of calomel, cocaine, opium, chloral, or large doses of bismuth, all may at times prove useful, or feeding may be undertaken by means of the nasal tube.

40. Vomiting as a symptom of acute diseases, such as intestinal obstruction, is not a condition which permits of dietetic treatment.

41. (c) *Diarrhœa.*—Diarrhœa is a condition which occurs extremely readily in infancy. It may be caused by, or occur along with, any sudden alteration of the bodily functions such as may be produced by a change of diet or a marked change of temperature; it is the principal sign of irritation in the digestive canal, and it may, reflexly, be caused by local conditions far remote from the alimentary canal. Diarrhœa *per se* may consequently be of ominous import, or of but minor significance; but *never treat marked diarrhœa lightly in infancy.* It is a warning, and a warning which must never be disregarded. Profuse diarrhœa is of itself a very dangerous condition; the drain of fluid is of vital importance, recovery rapidly becomes more difficult and more hardly won, and the shock to the general system is evidenced by protracted convalescence and frequently prolonged digestive disorder.

42. The *first indication* of treatment in this condition is the clearing away of all the contents of the alimentary canal; the *second indication* is temporary digestive rest;

and the *third* is sustenance of the vital powers. Examination of the stools is frequently of great value in helping us to determine the cause of the condition. (See Appendix D.)

43. A transient catarrh of the intestinal mucous membrane is a common cause of diarrhœa. This occurs most characteristically in otherwise healthy infants. It is associated with fretfulness, disturbed sleep, abdominal pain, and the discharge of green watery motions containing lumps of curds, but usually with no marked rise of temperature.

Give the infant a dose of castor oil, give only boiled water by the mouth for 4, 6, 8, or 10 hours according to the severity of the symptoms, and gradually thereafter recommence feeding with a milk mixture of a strength markedly less than that which was previously being taken. If difficulty is experienced in gradually strengthening the milk mixture, add sodium citrate to it. If there was a history of previous similar attacks with likewise ill-defined cause, give bismuth subnitrate gr. 20 thrice daily in powder form for two or three days.

44. Improper feeding is a very common cause of diarrhœa as it is of vomiting, and the two symptoms very commonly occur together. The original cause of the digestive disturbance may have been excess in the total amount of food, excess of fat, of sugar, or of protein, but usually by the time the patient is seen all the digestive functions are disordered, and the initial symptoms are superseded by general digestive intolerance. The stools usually offer no guide as to the exciting cause. In slight cases a dose of castor oil and rearrangement of the diet is sufficient treatment. In more severe cases it is necessary to act more thoroughly. Wash out the stomach with sterile water, administer castor oil, and give nothing but plain water by the mouth for some hours. Recommence feeding with whey, and very gradually strengthen the food. If diarrhœa persists give pulv. ipecac. co. (gr. $\frac{1}{4}$–gr. $\frac{1}{2}$ according to age) four-hourly until it *commences* to improve; thereafter give bismuth subnitrate 20 grs. four-hourly

for 24 hours; then give castor oil in 5 m. doses thrice daily, and gradually strengthen the food.

45. Gross bacterial infection of the milk is a frequent cause of diarrhœa, more particularly in hot weather.

When there is reason to suspect this cause, thorough sterilisation of the mixture is imperatively indicated, and the infant should be given thrice daily a calomel powder ($\frac{1}{12}$ gr.–$\frac{1}{6}$ gr. according to age) for two or three days.

46. Summer diarrhœa, infective diarrhœa, acute gastro-enteric infection, are terms applied to a morbid condition prevalent among infants in very hot weather.

It is specially prone to occur among weakly infants in unsatisfactory hygienic surroundings. It is caused by alimentary bacterial infection, and consists in irritation, congestion, and, later, inflammation of the entire gastro-intestinal tract, with bacterial intoxication. It is evidenced by constant vomiting and profuse diarrhœa, by high fever and collapse.

47. Treatment in severe cases must be prompt and thorough; death not infrequently results within a few hours owing to bacterial intoxication and the drain of fluid from the body. Give immediately a hypodermic injection of strychnine (gr. $\frac{1}{100}$). Wash out the stomach and the rectum while the infant is in the recumbent position. Transfuse normal saline solution into the axilla ($\frac{3}{5}$ v in 30 minutes) and give a dose of castor oil. Repeat the saline transfusion when the fluid previously transfused has been absorbed; and as the tendency to vomiting subsides, give frequent sips of plain water, and, later, water with a few drops of brandy in it. Give nothing but brandy and water by the mouth for at least 24 hours.

In cases where the initial collapse is less marked, a hot bath or a mustard bath (1 tablespoonful mustard in 1 gallon water) is of great value.

48. Feeding must be commenced with albumen water and brandy, and the food very gradually increased in strength, as noted in Part IV., C, p. 20. As a rule, dilute milk should not be given until the temperature is normal or approximately normal. Buttermilk is a

food of great value in this condition. Commercial buttermilk may be employed, and may be given either raw or Pasteurised. It is well to commence its administration raw, and if deemed advisable it may, after two or three days, be subjected to Pasteurisation. When Pasteurisation is undertaken, it is well to mix with the buttermilk a small amount of a cereal flour, and the mixture should be constantly beaten during heating to prevent the formation of hard masses. The addition of the cereal increases the nutritive value of the milk, and also serves to render the intestinal medium less suitable for the development of putrefactive organisms.

49. Buttermilk is a food of low nutritive value, and is consequently not a suitable food for prolonged administration. When artificially acidified milk mixtures are employed this disadvantage is obviated, as the strength of the milk can be gradually increased. In all cases, however, the administration of buttermilk should be of as temporary a nature as possible. There is a tendency for the infant to become so accustomed to this form of nourishment as to render it difficult to return to a more suitable diet.

50. (d) *Acute gastric indigestion—acute gastritis—acute intestinal indigestion.*—It is quite impossible to differentiate sharply between these conditions; acute disorder in the upper part of the alimentary canal is inevitably associated with disorder in the lower parts, and *vice versa.* When gastric symptoms are the most pronounced the stomach must be immediately washed out with sterile water, nothing but warm water given for 4 to 12 hours, and feeding gradually recommenced with albumen water and, if necessary, brandy. Bismuth subnitrate (gr. 10–gr. 20 frequently) is useful in these cases, and also warm applications to the epigastrium, and a purgative is invariably indicated. When intestinal symptoms predominate a purgative dose of castor oil must be at once administered, and stomach washing is frequently unnecessary. As before, water only is to be given for 4 to 12 hours (and if necessary brandy), and calomel ($\frac{1}{12}$ gr.–$\frac{1}{8}$ gr.) four-

hourly for 6 doses. If profuse diarrhœa continues unchecked by 3 doses of bismuth subnitrate at intervals of 3 hours, ¼ gr.–½ gr. Dover's powder must be given two-hourly till the symptom commences to improve. The recommencement of feeding must be extremely gradual.

51. (e) *Chronic gastric indigestion—chronic intestinal indigestion.*—When gastric symptoms predominate, mild cases may be successfully treated by attention to the general surroundings and careful correction of the diet. In more severe cases the most valuable treatment consists in washing out the stomach daily two hours after a feed. This treatment is of enormous benefit when associated with regulation of the amount and quality of the food at each feeding period. The majority of cases are, however, associated with more pronounced evidences of intestinal disorder, as is only to be expected when one considers the relative importance of gastric and of intestinal digestion in infants. Every effort must be made to discover the nature of the food element which is the original cause of the disorder, and for a definite opinion upon this point it is generally essential to wait for several days, to give during this time a simple dilute milk mixture, and to examine carefully the stools, vomit, if any, and the general condition. Sugar, fat, or protein may be the cause of the disturbance, or any abnormal element in the food: very frequently there is a combination of difficulty in the digestion of several elements: the commencement of dietetic treatment must consist in getting within the digestive ability, and gradually increasing the separate food elements as the condition permits. Upon the degree of severity of each case depends the weakness of the initial food. It is well to preface treatment with a purge; thereafter drugs should not be used.

52. (f) *Ileo-colitis—acute—chronic.*—Clinically this condition merges imperceptibly into conditions of many varieties of gastro-enteritis; pathologically it is associated with well-marked lesions of the lower part of the

ileum and the colon. In acute characteristic cases this region of the bowel is the site of numerous hæmorrhagic areas of marked general congestion and of diffuse ulceration. These lesions give the clue to the general symptoms. They are sudden onset, severe diarrhœa, with blood and much mucus in the stools, abdominal pain, tenesmus, high fever, and marked prostration. The characteristic stools are small, frequent, streaked with blood, and contain much mucus; after the condition has lasted two or three days blood, however, may be absent from most of the stools. In the most severe cases death rapidly supervenes, due to septic infection and exhaustion. In making a diagnosis it is extremely important to consider the possibility of intussusception.

53. When seen in the early acute stages these cases are to be treated as has been noted under the heading Summer Diarrhœa (Part IV., D, par. 47). In addition, irrigation of the colon must be undertaken twice daily with warm saline solution. Small doses of Dover's powder and large doses of bismuth are of great value in these cases after the initial purge has been allowed time to act. Brandy is invariably indicated, and should be given freely. Superintendence of the later dieting must be most careful; these cases are frequently most protracted and difficult to treat, and every possible indication must be sought for as to the most promising line of diet in each particular case.

E. Other Conditions

54. *Acute infective conditions.*—In all such conditions it is of vital importance to safeguard and nurse the digestive functions. In all a purge is to be given at the commencement, and sips of water permitted frequently. When there is no marked digestive difficulty, and a milk mixture is deemed permissible, it must be peptonised previous to administration during the period of high temperature, and the peptonisation gradually dispensed with afterwards. It may be necessary to feed frequently and with small amount

when weak nourishment only can be taken; and, on the other hand, when comparatively strong mixtures can be taken, the intervals between feeds may be lengthened. In many of these cases a form of eliminative diarrhœa occurs, which in its milder forms should not be checked, but which, when unduly profuse, must be treated with drugs, and the question of diet reconsidered with most scrupulous care.

55. *Anæmia.* — Infantile anæmia is commonly a symptom of indigestion and malnutrition. The original dietetic cause of the trouble must accordingly be sought for, and treatment conducted along the lines so indicated.

56. *Convulsions.*—Disorders of digestion and improper feeding not infrequently are the cause of convulsions. A brisk purge and care in the gradual recommencement of feeding are the remedies indicated.

57. *Nervous conditions.* — In the treatment of the vomiting in cases of brain lesion or of meningitis diet plays but little part. In such cases, however, very much may be effected by careful dieting and feeding in sustaining the general strength, and in securing for the infant a sufficiency of nourishment.

58. Social conditions and the nature of the nursing must always influence to a certain extent the ordering of the infant diet. In every case instructions must be exact, but in certain cases a specific allowance should be made for deviations from them which will ensure that the error, if it occur, will be on the safer side.

F. Various

59. (a) *Drugs.*—Brandy.—When you consider it advisable to give brandy, give it freely and well diluted. One drachm of brandy should be diluted with 1 ounce of water (ʒi in ℥i). In acute diarrhœal cases, and in all acute digestive disorders associated with collapse and alimentary intoxication, give a dessert-spoonful (ʒii) of this dilute brandy two-hourly, one-hourly, or more frequently if the initial doses benefit the condition. Do not cease its administration suddenly, but gradually

diminish the dose and lengthen the interval between doses.

60. Castor oil.—There are two correct methods of using this drug in infancy and a common incorrect method which consists in giving it regularly and continuously in comparatively large doses as a part of the treatment of chronic constipation. Give it in a purgative dose (ʒii and upwards) on a definite occasion, or as a means every two or three weeks of thoroughly clearing out the alimentary canal; or give it for intestinal disorders in minute doses (m. v) thrice daily for several days.

61. Calomel.—For infantile digestive disorders calomel is, as a rule, to be given in very small doses, frequently repeated ($\frac{1}{12}$ gr.–$\frac{1}{6}$ gr.). When calomel is given for a longer period than 48 hours it should not be given more frequently than thrice daily, or in larger doses than $\frac{1}{12}$ gr.–$\frac{1}{8}$ gr.

62. Bismuth.—This drug must always be administered in large doses, and preferably in powder form. To an infant during the first week of life 15 grains of bismuth subnitrate may be given thrice daily, and to older infants the dose should be 15 grains to 30 grains frequently repeated for a short time. It is only of marked value when administered in large doses, and such doses are associated with no danger. When a large amount of the drug has been taken for some days it occasionally happens that the infant becomes pale and of a peculiar ashen-grey cyanotic tint. When such an appearance is noted all bismuth must be stopped; the infant improves and no bad effects whatever are left behind.

63. Opium.—Do not fear to give opium to the infant in suitable cases. In acute digestive disorders it is a most valuable drug, and in doses of gr. $\frac{1}{6}$–gr. $\frac{1}{2}$ of Dover's powder administered under strict superintendence of the varying clinical condition, it frequently is of the utmost value. Do not permit prolonged administration, but cease its use as soon as the conditions *commence* to improve.

64. Carminatives.—Such drugs as dill water, cinnamon water, and fennel water are often most serviceable.

In cases of flatulence and colic due to slight irregularity of function in infants suitably fed, they often are of value in assisting digestion. One tablespoonful should be given immediately after each feed. In this connection, also, stress must be laid upon the great importance of preventing coldness of the feet in infants.

65. (b) *Stomach washing.*—This process is extremely easy, and, when conducted with ordinary care, entirely free from danger. Depress the tongue well with the left forefinger; do not hurry in passing the catheter; wait for a minute after the catheter is passed before introducing fluid; introduce the fluid slowly; continue washing till the contents are perfectly clear.

66. (c) *Nasal feeding.*—Food may be given by the stomach-tube or by a tube passed through the nose. Refrain from such a method of feeding whenever possible. In some cases of continued vomiting and cases of pyloric spasm it is, however, a valuable method of treatment.

67. (d) *Enemata.*—Where an immediate effect is desired, and in acute illness, a simple enema of soap and water, of oil and water, or of glycerine and water, is of great value. In chronic conditions of ill-health and of constipation, the employment of enemata is undesirable, but not infrequently essential, and is certainly preferable to treatment by drugs. The occasional use of a simple enema is often serviceable, and at times necessary, but the rational treatment of chronic constipation is primarily dietetic.

68. (e) *Continuous saline rectal injection.*—Very many cases of dangerous collapse in infants due to diarrhœa and vomiting are enormously benefited by this treatment. The procedure consists in passing a catheter well up the rectum and allowing normal saline solution at a temperature of 100° F. to flow from a beaker raised slightly above the level of the bed, very slowly or drop by drop, into the bowel.

69. (f) *Nursing.* — A reliable nurse is in many instances the determining factor in the success or failure of treatment. Scrupulous cleanliness is a vital necessity. Care and skill in feeding in an acute illness

may make the difference between the life and the death of the infant. It is incumbent on the physician to lay down strictly and definitely for the nurse rules for the treatment of the infant; it is equally incumbent on the nurse to carry out these rules faithfully.

70. (g) "*Mothering.*"—The natural maternal functions and inclinations are not limited to the process of suckling; the needs of the infant are not satisfied with occasional feeding and occasional tidying-up. The healthy infant demands from its mother constant attention, and the continuance of its good-health is very materially dependent upon the liberality with which these attentions are bestowed. The requirements of the sick infant are still greater; the benefits it derives from obtaining them are correspondingly marked. The function of suckling is a prerogative of a mother; the capability of "mothering" is common to all normal adult females, and, under skilled guidance and direction, is the most valuable aid in the treatment of infants.

APPENDICES

APPENDIX A

AN INVESTIGATION INTO THE COMPLICATIONS AND DISABILITIES OF PROLONGED LACTATION, WITH SPECIAL REFERENCE TO THE OCCURRENCE OF RICKETS IN INFANCY

(By the Author.)

(An extension of papers published in "The Lancet," 27th January 1906; "The British Medical Journal," 28th April 1906; and "The British Journal of Children's Diseases," July 1906.)

The social exigencies and the laborious strain and stress of modern civilisation conduce perforce, it is contended, to an unnatural and non-physiological life, to an ultra-development along certain lines, and to a correspondingly diminished power along others. The subtle, gradual, all-pervading process of evolution works its steady way, and draws to its inevitable conclusions, while the course is marked at varying intervals by alterations in the functions and bodily processes of the living matter of the genus "Man." A diminishing birth-rate, and the existence of an enormously high infantile mortality, engross the attention of men in all countries, and the conditions are such—whether induced by social and economic conditions, or dependent upon a variety of physiological factors conducing to a diminished capability of the function of maternity—as to engender a dread of the approaching spectre of national decay.

The conditions of physiological pregnancy and physiological lactation are still present amongst us, but on all hands it is

heard that, through the difficulties, disadvantages, and distractions which influence and overwhelm mothers at these periods, the conditions themselves tend ever to approach nearer the border-land of physiology and pathology, while the new life resulting is, from its inception, incompletely safeguarded from the multifarious dangers which incessantly threaten it. As a modest contribution to the existing knowledge of the very complicated processes of life in these periods, the following investigations are herewith recorded, the object with which they were undertaken being to obtain definite clinical information as to the prevalent methods of infant nourishment, and to note the commoner immediate effects resulting from the various methods employed.

As a matter of convenience, the subject-matter has been divided into remarks under the following four headings, viz. :—

1. Hyperlactation.
2. The return of menstruation during lactation.
3. The occurrence of pregnancy during lactation.
4. Rickets—a possible consequence of hyperlactation.

I. Hyperlactation

Lactation, the coping-stone of motherhood, is a function frequently impossible, frequently neglected, but also frequently exercised to excess.

In the higher grades of society the latter condition is practically unknown, but investigations among persons of the working class serve to show the very considerable extent to which this regrettable practice is indulged in. The normal duration of lactation, it may be contended, is a variable period, dependent on several factors, and consequently any definition of what composes hyperlactation must be a purely arbitrary one.

Undoubtedly this is so ; and in dealing with such a subject it is quite impossible to wholly eliminate a margin of error, although, from the definition I have made, it seems to me that this margin is narrowed to its extremest limits.

As hyperlactation I have considered those cases in which maternal nursing, wholly or mainly, has been indulged in for longer than twelve months after the birth of the infant.

This limit undoubtedly is on many occasions successfully

overstepped, and I am far from saying that a strong, healthy mother is doing wrong to nurse a weakly infant after twelve months, but I do say that the proportion of cases in the class of which I am speaking where this procedure is advisable, or even justifiable, is infinitesimally small, and that grave dangers are incurred by its adoption, both for mother and children. In the great majority of cases the condition is a vicious habit, bred of the belief that lactation ensures the avoidance of pregnancy, and it is indulged in solely as a means to avoid future financial burdens.

The infant frequently has never been entirely on the breast at all, and is kept on month after month, partly from economy and partly as a means of draining the maternal breasts, the while it indulges in many varieties of unsuitable food.

In determining the frequency of the practice, I have noted the cases of 645 children. Of these, 226 (35 per cent.) were bottle-fed or on the breast for less than six months, 280 (43 per cent.) were breast-fed wholly or mainly for six to twelve months, and 139 (22 per cent.) were cases of hyperlactation.

Hyperlactation, accordingly, far from being a hypothetical possibility, is a common procedure, and the condition, as affecting the mother, can be regarded in no other light than as a severe physical strain, more especially when, as in most of these cases, the general surroundings are those found in the none too salubrious poorer quarters of a large city, and when the available nourishment is too often poor and unsuitable in quality and scanty in quantity.

II. The Return of Menstruation during Lactation

Is amenorrhœa a physiological characteristic of normal lactation? By the vast majority of observers it is undoubtedly so regarded. Since the publication of my observations on the return of menstruation during lactation in *The Lancet*, a paper on this subject has been published by Heil, who studied the conditions of 200 nursing mothers, and gives voice to the belief, previously mooted, that the practice of menstruation, and not the condition of amenorrhœa, is the normal state during lactation. The very complicated

relations existing between the ovarian and uterine functions, and the somewhat problematical function of the corpora lutea during the period of lactation, are subjects of extreme interest, but subjects without the scope of my investigations.

My observations were conducted in the case of 100 mothers, from whom there were born 405 children (five cases of twins), and of these 400 deliveries there were 374 from which 376 infants survived at least two months. In 259 of these 374 deliveries (69 per cent.) the children were nursed on the breast, wholly or partially, for at least two months; and, therefore, in 259 cases there was a possibility of pregnancy or menstruation occurring during lactation. Of these cases, the average duration of suckling was ten months. In six cases the condition as regards the menses was not ascertained, and of the 253 lactations in which this point was determined, in 153 (60 per cent.) there was complete amenorrhœa, and in 100 (40 per cent.) menstruation occurred. Of these 100 occasions in which menstruation occurred during lactation, the date of the return of menstruation was:—

During the first two months after birth in					27	cases.
,,	third	month	,,	,,	7	,,
,,	fourth	,,	,,	,,	4	,,
,,	fifth	,,	,,	,,	11	,,
,,	sixth	,,	,,	,,	15	,,
,,	seventh	,,	,,	,,	9	,,
,,	eighth	,,	,,	,,	12	,,
,,	ninth	,,	,,	,,	7	,,
,,	tenth	,,	,,	,,	1	,,
,,	eleventh	,,	,,	,,	5	,,
,,	twelfth	,,	,,	,,	1	,,
,,	thirteenth	,,	,,	,,	1	,,

From which it is seen that in more than one-fourth, or 27 per cent., of these cases menstruation returned within two months of delivery, and in 92 per cent. of cases within nine months, figures closely agreeing with those of Mayer, who found that in 685 lactations menstruation returned in 25 per cent. of cases within the first six weeks after delivery.

Of the 253 cases of lactation, the position of the children in the family, and the condition as to amenorrhœa or menstruation during the lactation, with the average duration of lactation for the children of each position, were as follows:—

TABLE I.

Position of Child.	Number of Cases.	Amenorrhœa.	Menstruation.	Average Duration of Lactation.
1st	71	40	31 (44 per cent.)	9 months.
2nd	54	28	26 (48 ,,)	10 ,,
3rd	44	26	18 (40 ,,)	10½ ,,
4th	24	15	9 (38 ,,)	11½ ,,
5th	22	14	8 (36 ,,)	9½ ,,
6th	15	11	4 (27 ,,)	9½ ,,
7th	8	7	1 (13 ,,)	12 ,,
8th	7	5	2 (29 ,,)	9 ,,
9th	4	3	1 (25 ,,)	9½ ,,
10th	1	1	0	12 ,,
11th	1	1	0	12 ,,
12th	1	1	0	12 ,,
13th	...	...	...	...
14th	1	1	0	12 ,,

From these figures it would appear that menstruation during lactation is decidedly commoner with the early children than with the later. This, however, might be due to the fact that the earlier children were longer on the breast, but a glance at the last column of the foregoing table shows that with no child is the average duration of lactation shorter than with the first, and, consequently, that the increased frequency of the return of menstruation during lactation in the earlier lactations is not due to the greater length of the lactation period.

Heil considers this subject, and comes also to the conclusion that menstruation is less common in the later lactations. His figures are:—

During 188 1st lactations, menstruation occurred in 104 (55·3 p. cent.)
,, 135 2nd ,, ,, ,, 69 (51·1 ,,)
,, 73 3rd ,, ,, ,, 34 (46·5 ,,)
,, 46 4th ,, ,, ,, 14 (30·4 ,,)
,, 26 5th ,, ,, ,, 5 (19·2 ,,)
,, 17 6th ,, ,, ,, 4 (23·5 ,,)

As regards the date of the return of menstruation in the cases of the different children in the family, Table II. gives these dates, and also the percentage frequency of the return under two months after delivery and at the sixth month:—

TABLE II.

Position of Child.	Number of Cases.	Return of Menstruation.												Under 2 months.	At 6th month.
		Within 2nd month.	Within 3rd month.	Within 4th month.	Within 5th month.	Within 6th month.	Within 7th month.	Within 8th month.	Within 9th month.	Within 10th month.	Within 11th month.	Within 12th month.	Within 13th month.	%	%
1st	31	11	4	2	2	1	5	1	1	1	2	1	...	36	65
2nd	26	5	2	1	3	3	2	6	3	...	1	...	...	19	53
3rd	18	5	...	1	1	3	1	4	2	...	1	...	...	28	56
4th	9	2	...	...	2	3	...	1	...	...	...	...	1	22	89
5th	8	3	...	...	2	1	1	...	1	...	...	...	...	38	75
6th	4	...	...	...	1	2	...	...	...	...	1	...	...	0	75
7th	1	...	...	...	...	1	...	...	...	...	...	...	...	0	100
8th	2	...	1	...	...	1	...	...	...	...	...	...	...	0	100
9th	1	1	...	...	...	...	...	...	...	...	...	...	...	100	100

From the above it is seen that in a considerably greater proportion of cases does menstruation return within six months in the later children than in the earlier children; and as the average lactation period of the later children was as long as that of the earlier children, it appears that when menstruation occurs in later lactations it occurs early or not at all. Of the 100 mothers examined, 87 suckled a child for two months on at least one occasion, and of these 87 who suckled once or oftener, 47 experienced the return of menstruation during lactation; while of the 47, in 26 cases it occurred with every lactation. Menstruation during lactation was thus found to occur in nearly 1 in 2 of the subjects examined (Heil noted its occurrence in "about one-half of nursing mothers"), and in the great majority of the cases the return of the menses took place within nine months of delivery. That in no single instance was the suckling seriously affected is an important point, and the fact that the return of menstruation is commoner during the earlier than the later lactations would seem to indicate that its return is accelerated in the case of the younger and stronger

mothers. This condition, therefore, by no means necessarily serves as a contra-indication for the continuation of suckling, and a French author indeed—M. Gillet—goes so far as to recommend as a wet-nurse the woman who menstruates regularly during lactation, as this he considers to be a sign of robust health.

A brief summary of the facts above disclosed shows—

1st, That in 47 per cent. of mothers who nurse, menstruation during lactation at some period occurs.

2nd, That menstruation during lactation occurs in 40 per cent. of the cases in which suckling is performed, and in the great majority (92 per cent.) of cases where it occurs its return is within nine months of delivery.

3rd, That menstruation during lactation is commoner with the earlier than with the later lactations.

III. The Occurrence of Pregnancy during Lactation

The occurrence of pregnancy during lactation is a much more serious condition. Of my 259 cases where this was a possibility it occurred in 29, and the following Table summarises these cases (page 108).

Here it will be seen that, of the 100 mothers, in 24 per cent. pregnancy occurred during lactation, and in 29 out of 374 conceptions, *i.e.* 8 per cent. of conceptions, or in 11 per cent. of cases where the infant was reared for at least two months on the breast. Thus in 24 per cent., or nearly 1 in 4 of the mothers, there occurred at some period an overlapping of pregnancy and lactation, and in five cases this occurred twice, and this occurrence took place in 11 per cent. of the lactations.

From Table III. it is seen that the duration of the overlapping of pregnancy and lactation was:—

In	8	cases	1 month.
,,	7	,,	2 months.
,,	4	,,	3 ,,
,,	3	,,	4 ,,
,,	4	,,	5 ,,
,,	2	,,	6 ,,
,,	1	case	9 ,,
Total	29		

TABLE III.—SHOWING THE DURATION OF OVERLAPPING OF PREGNANCY AND LACTATION.

No.	Length of Lactation.	Date of Conception after Delivery.	Duration of Overlapping of Pregnancy and Lactation.	Position in Family of Fœtus Conceived.	Presence (+) or Absence (−) of Menstruation before Conception.	Age of Mother at Date of Conception.	Condition of Children at Date of Examination.		Number of Children in Family.
							Suckling.	Fœtus.	
1	11 months.	8 months.	3 months.	2nd	M −	21½ years.	Alive and well.	Alive and well.	4
2	12 ,,	7 ,,	5 ,,	,,	M −	29½ ,,	,, ,,	Died, aged 5 months.	11
3	15 ,,	10 ,,	5 ,,	,,	M+	25 ,,	,, ,,	Phthisical.	8 Same
4	12 ,,	8 ,,	4 ,,	3rd	M+	26½ ,,	Phthisical.	Delicate.	8 family.
5	12 ,,	9 ,,	3 ,,	,,	M+	21½ ,,	Alive and well.	Stillborn.	3
6	9 ,,	8 ,,	1 ,,	4th	M+	28 ,,	,, ,,	Miscarriage.	9
7	24 ,,	18 ,,	6 ,,	3rd	M −	30 ,,	Died, aged 2½ years.	Alive and well.	10 Same
8	24 ,,	18 ,,	6 ,,	4th	M −	32 ,,	Alive and well.	,, ,,	10 family.
9	11 ,,	10 ,,	1 ,,	2nd	M+	24½ ,,	,, ,,	,, ,,	3
10	13 ,,	11 ,,	2 ,,	,,	M −	20 ,,	,, ,,	Died, aged 10 months.	4
11	13 ,,	11 ,,	2 ,,	,,	M+	23 ,,	,, ,,	Alive and well.	6
12	11 ,,	6 ,,	5 ,,	,,	M −	27 ,,	,, ,,	,, ,,	9 Same
13	12 ,,	11 ,,	1 ,,	Twins, 4th and 5th	M+	30½ ,,	,, ,,	Premature twins; died.	9 family.
14	12 ,,	8 ,,	4 ,,	3rd	M −	24 ,,	,, ,,	Alive and well.	8
15	15 ,,	10 ,,	5 ,,	2nd	M −	28½ ,,	,, ,,	,, ,,	3
16	7 ,,	6 ,,	1 ,,	,,	M+	23 ,,	,, ,,	,, ,,	8 Same
17	7 ,,	6 ,,	1 ,,	3rd	M+	24½ ,,	,, ,,	,, ,,	8 family.
18	10 ,,	9 ,,	1 ,,	,,	M −	22½ ,,	,, ,,	Died, aged 6 months.	14
19	18 ,,	16 ,,	2 ,,	4th	M+	25 ,,	Delicate.	Miscarriage.	5
20	6 ,,	4 ,,	2 ,,	2nd	M+	20 ,,	Alive and well.	,,	5 Same
21	9 ,,	8 ,,	1 ,,	Twins, 4th and 5th	M+	21½ ,,	,, ,,	Twins; one died at birth, the other very delicate.	5 family.
22	15 ,,	6 ,,	9 ,,	3rd	M+	23½ ,,	Delicate.	Delicate.	9
23	9 ,,	5 ,,	4 ,,	2nd	M+	20 ,,	,,	Stillborn.	5
24	13 ,,	11 ,,	2 ,,	4th	M+	35 ,,	,,	Delicate.	6
25	13 ,,	10 ,,	3 ,,	,,	M −	32 ,,	Alive and well.	,,	5
26	10 ,,	9 ,,	1 ,,	2nd	M −	23 ,,	,, ,,	Alive and well.	12
27	14 ,,	12 ,,	2 ,,	3rd	M+	25½ ,,	,, ,,	,, ,,	8
28	9 ,,	7 ,,	2 ,,	2nd	M −	23 ,,	Died, aged 18 months.	,, ,,	10
29	11 ,,	8 ,,	3 ,,	,,	M+	24 ,,	Alive and well.	Delicate.	5

—and thus that in the majority of cases the period was a comparatively short one. The fœtus conceived during lactation was in 14 cases the second member of the family, in 8 cases the third, and in 7 cases the fourth; and in connection with later members of a family there was no such occurrence. It therefore certainly appears that this occurrence takes place most frequently in connection with the earlier children of a family, as might, perhaps, be expected, looking to the larger number of early children and the greater frequency of bottle-feeding among the later ones. This would not, however, seem entirely to explain the matter, or the entire absence of cases of overlapping among the later children, and it may safely be said that this condition of affairs is extremely uncommon. The average duration of lactation of those infants during whose suckling pregnancy occurred was twelve months, while of all the 259 lactations the average duration was ten months. In only two cases did conception occur prior to the sixth month after delivery, and the average date of conception was nine months after delivery, while the importance of the lengthened average period of lactation is observed from the fact that no fewer than 12 cases occurred at, or after, the tenth month. These figures largely bear out the statement of M'Cann that "the greater number of pregnancies during lactation commence after the eighth month."

In 17 cases (59 per cent.) menstruation occurred prior to conception, and in 12 cases (41 per cent.) there was no previous menstruation. Remfry, in the course of 900 lactations, found amenorrhœa in 503, or 57 per cent., and menstruation occurred in 388, or 43 per cent., and these figures correspond very closely with my own, which were 60 per cent. with amenorrhœa and 40 per cent. with menstruation. Of the 503 cases with amenorrhœa he found that pregnancy occurred 29 times (6 per cent. of cases) during lactation, while of the 388 cases with menstruation pregnancy occurred in 226 (60 per cent.) during lactation, and he therefore concludes that where menstruation returns during lactation, the chances of pregnancy occurring are ten times greater than where there is amenorrhœa. While in my cases it was also found that pregnancy was more common after the return of menstruation, the same marked disproportion between the two classes of cases was not obtained; and thus while in 153

lactations associated with amenorrhœa pregnancy occurred in 12 cases, or 8 per cent., in 100 cases associated with menstruation pregnancy occurred in 17 cases, or 17 per cent., pregnancy consequently occurring rather more than twice as frequently after the return of menstruation as where there was amenorrhœa.

As regards the condition of the children, those in fairly good health have been described as alive and well, while the weakly children have been described as delicate, the sucklings naturally being of greater age than the fœtuses, and therefore their lives having been exposed to greater dangers. Notwithstanding this, it is found that of the 29 sucklings 22 (76 per cent.) were alive and well at the date of examination, while of the 31 fœtuses 13 (42 per cent.) only were alive and well at this date. These figures appear to me to be somewhat striking. The works of Prochownick and Noël Paton, in human subjects and guinea-pigs respectively, have conclusively shown the remarkable effect of variations in maternal diet on the embryos; and one might, *a priori*, expect to find the infant of a poor woman, not too fully nourished, and for some period at least of her pregnancy engaged in the function of lactation, would start life severely handicapped. That this is so my figures show.

Jacobi, many years ago, stated that "lactation and pregnancy are incompatible," but this opinion of the condition would appear to have been anything but universally accepted, and in support of the contrary opinion Paquy reports 29 cases of pregnancy occurring during lactation, in none of which was any evil effect whatever noticed, and he refers to the well-known condition of affairs among domestic animals, an analogy which appears to me in many respects unsound. That the condition is by no means markedly uncommon has already been pointed out by Robertson and Church, and the cause of this is undoubtedly to be found in the widespread belief among the working classes that so long as lactation is continued, pregnancy will be avoided—a belief which leads inevitably to the undue protraction of breast-feeding. In such cases the importance of the condition is but ill-recognised, from the fact that the suckling probably continues well and thriving, while irrevocable injury is being done to the unseen fœtus, and consequently the greater need there is of emphasising the dangers of the position.

Consideration of the facts above stated leads me to the following conclusions, viz. :—

1. That the concurrence of pregnancy with lactation is comparatively common.

2. That conception is rare within the first six months of lactation, and uncommon before the eighth month.

3. That conception is more liable to occur after the return of menstruation.

4. That conception is more common during the earlier lactations.

5. That where pregnancy and lactation overlap, the fœtus is apt to suffer; its nutrition is entirely dependent on the mother, whereas extraneous assistance can be afforded the suckling.

IV. Rickets—A Possible Consequence of Hyperlactation

With the object of determining the relation of the incidence of rickets to the varying conditions under which the function of lactation is exercised, and to the duration of the exercise of this function, I have examined, irrespective of the cause which led the mother to seek advice, 200 children of different families, and aged from six months to three years. These children I have divided, according to their early feeding, into the following four categories :—

(*a*) "Breast-feeding," that is, children reared wholly or mainly on the breast for from eight to twelve months, and also children aged from six to eight months at the date of examination, who had up to that period been nursed wholly or mainly on the breast.

(*b*) "Hyperlactation," that is, children reared wholly or mainly on the breast for over twelve months.

(*c*) "Mixed-feeding," that is, children reared partly on the bottle and partly on the breast for from two to eight months, and also children reared wholly on the breast for from two to eight months.

(*d*) "Bottle-feeding," that is, children reared entirely on the bottle, or where breast nursing lasted less than two months.

This classification was adopted as being the most practical, although by using it one suffers under the obvious disadvantage of being unable to consider the conditions existing where the infants are strictly speaking breast-fed.

Marked physical signs alone were considered as definite evidences of rickets, and as such were taken marked beading of the ribs, enlarged epiphysis, wide fontanelle, and deformities of the thorax, limbs, and spine; while cases with slight beading of the ribs, late teething, marked head sweating, recurrent bronchitis, contracted chest, etc., were considered as slight cases of the disease.

Of these 200 cases, rickets was marked in 61,
" " rickets was slight in 55,
" " there was no rickets in 84,

—rickets accordingly occurring in 116 cases, or 58 per cent.

A classification according to age shows :—

Of infants aged—

From 6 to 12 months, rickets was present in 55 per cent.
" 12 to 18 " " " 63 "
" 18 to 24 " " " 65 "
" 24 to 36 " " " 52 "

TABLE IV.—SHOWING THE OCCURRENCE OF RICKETS IN THE CASES CLASSIFIED ACCORDING TO THE NATURE OF THE EARLY FEEDING.

	Rickets.		Total Rickets.	No Rickets.	Total Number of Cases.
	Marked.	Slight.			
(*a*) "Breast" . .	18	27	45	45	90
(*b*) "Hyperlactation"	10	8	18	13	31
(*c*) "Mixed" . .	5	5	10	5	15
(*d*) "Bottle" . .	28	15	43	21	64

From Table IV. it is seen that the amount of rickets among cases mixed-fed is approximately the same as among those bottle-fed, but differs in this respect, that whereas among the former the percentage number of marked cases

of rickets among those suffering from the disease was 50 per cent., in the latter it was 65·1 per cent.

TABLE V.—SHOWING THE RELATION OF THE INCIDENCE OF RICKETS TO THE POSITION IN THE FAMILY OF THE CHILD.

Position in Family of Child.	No. of Cases.	(*a*) Breast.		(*b*) Hyper-lactation.		(*c*) Mixed.		(*d*) Bottle.		Percentage Rickets.
		Rickets.	Nil.	Rickets.	Nil.	Rickets.	Nil.	Rickets.	Nil.	
First . .	39	5	15	1	1	3	1	9	4	46
Second . .	41	7	10	4	2	2	2	10	4	56
Third . .	33	11	8	2	6	...	...	5	1	55
After third .	87	22	12	11	4	5	2	19	12	66

In Table V. the most marked feature appears to me to be the steady increase in the amount of rickets with successive "breast-fed" children in the family. Of first children "breast-fed," 25 per cent. showed rickets; of second children, 41 per cent.; of third, 58 per cent.; and of those later, 65 per cent.; this gradual increase being probably in part accounted for by the later children getting a less plentiful supply of maternal milk than the earlier. Of children later than third in the family, however, the percentage of those with rickets among the "breast-fed" not only equals, but even exceeds, that of corresponding children bottle-fed; and, consequently, I was induced to consider the occurrence of rickets among the later children in relation to the previous general reproductive history of the mothers.

From the above figures it seems clear that bottle-feeding *per se* has no greater tendency to produce rickets among later children than among those earlier in the family.

The question accordingly arose: Can it be shown that rickety later children generally are born of mothers with an exceptional previous lactational strain, or do mothers of later "breast-fed" show greater previous strain than mothers of later "bottle-fed" infants? If the latter be the case, then the occurrence of rickets may be due to some fault in the maternal milk or to congenital weakness of the child.

Of the 161 children later than first in the family, in 146 cases the previous reproductive history of the mother since marriage was carefully investigated :—

Of these 146 cases, 40 were cases of second children.
" " 29 " third children.
" " 77 " children later than third.

The accompanying Tables show the early feeding in these cases :—

TABLE VI.—SHOWING THE PRESENCE OR ABSENCE OF RICKETS IN CHILDREN SECOND-BORN IN CONNECTION WITH THE EARLY FEEDING OF THESE CHILDREN, AND ALSO OF THOSE FIRST-BORN.

	Rickets.				Total Rickets.	No Rickets.				Total No Rickets.	Combined Total.
	"Breast-fed."	Hyperlactation.	Mixed Feeding.	Bottle.		"Breast-fed."	Hyperlactation.	Mixed Feeding.	Bottle.		
(*a*)	1	2	...	2	5	2	1	2	3	8	13
(*b*)	1	1	...	2	4	1	...	...	...	1	5
(*c*)	3	...	1	1	5	2	...	...	...	2	7
(*d*)	2	1	1	4	8	5	1	...	1	7	15
Total	7	4	2	9	22	10	2	2	4	18	40

(*a*) First-born child "breast-fed."
(*b*) " " hyperlactation.
(*c*) " " mixed feeding.
(*d*) " " bottle feeding.

In Table VI. the rachitic and non-rachitic second-born children have respectively been subdivided into four groups according to their early feeding. In addition, the antecedent lactational history of each case is noted by the position in the row (*a*), (*b*), (*c*), or (*d*).

From this Table it is seen that of 18 second-born children,

where the first-born child was either "breast-fed" or enjoyed hyperlactation—that is, cases in rows (*a*) and (*b*)—9 were rachitic, whereas of 22 where the first-born was either mixed-fed or bottle-fed—that is, cases in rows (*c*) and (*d*)—13 were rachitic, and, consequently, in these cases any previous lactational strain, which necessarily must be slight, has no necessary relation to the occurrence of rickets.

From a corresponding Table drawn up for children third in the family, I am also unable to distinguish any marked connection between lactational strain and the occurrence of rickets, with this notable exception, that of 7 children enjoying hyperlactation, 5 showed evidences of rickets.

TABLE VII.—SHOWING PRESENCE OR ABSENCE OF RICKETS IN CHILDREN LATER THAN THIRD IN THE FAMILY IN RELATION TO THE EARLY FEEDING OF THESE CHILDREN AND THE PREVIOUS OCCURRENCE OF MATERNAL LACTATIONAL STRAIN.

Previous Lactational History.	Rickets.				Total Rickets.	No Rickets.				Total No Rickets.	Combined Total.
	"Breast."	Hyperlactation.	Mixed.	Bottle.		"Breast."	Hyperlactation.	Mixed.	Bottle.		
(*a*) All previous children on bottle .	...	...	...	5	5	...	...	...	1	1	6
(*b*) No lactational strain . .	9	...	3	4	16	4	1	1	6	12	28
(*c*) Slight lactational strain . .	5	2	1	5	13	4	1	2	2	9	22
(*d*) Marked lactational strain . .	5	6	2	3	16	2	1	...	2	5	21
Total .	19	8	6	17	50	10	3	3	11	27	77

As lactational strain was considered: (1) the overlapping of pregnancy and lactation; (2) hyperlactation; (3) repeated rapidly succeeding pregnancies and lactations.

In Table VII., as in Table VI., the rachitic and non-rachitic children have been divided according to their early feeding, while their position in row (*a*), (*b*), (*c*), or (*d*) marks their relation to previous lactational strain. Consideration of this Table discloses the following facts :—

(1) Of the mothers of rachitic children previous lactational strain was present in 29 out of 50 cases, or 58 per cent.

Of the mothers of non-rachitic children previous lactational strain was present in 14 out of 27 cases, or 52 per cent., which apparently shows that previous lactational strain does to a slight extent produce a tendency to rickets in the child, a result at variance with that found in the case of second and third children in the family.

(2) Previous lactational strain was present in 16 out of 29 "breast-fed" infants, or 55 per cent., while in infants with hyperlactation it was present in 10 out of 11, or 91 per cent. ; these two classes combined showing 65 per cent. of cases in which there was previous strain.

In 12 out of 28 bottle-fed infants, or 43 per cent., this strain was present, and in 5 out of 9, or 56 per cent., mixed-fed infants ; these two classes combined showing its presence in 46 per cent. of cases. It is thus apparent that children born of mothers who had undergone previous lactational strain were in a considerable majority of cases nursed on the breast.

(3) Rickets occurred among "breast-fed" infants in 19 out of 29 cases, or 66 per cent.

Rickets occurred among infants with "hyperlactation" in 8 out of 11 cases, or 73 per cent. ; these two classes combined showing the presence of rickets in 68 per cent. of cases.

Rickets occurred among bottle-fed infants in 17 out of 28 cases, or 61 per cent.

Rickets occurred among mixed-fed infants in 6 out of 9 cases, or 67 per cent. ; these two classes combined showing the presence of rickets in 62 per cent. of cases.

Rickets accordingly was appreciably more marked among children "breast-fed" for over eight months (including those with hyperlactation) than among other children ; and as these "breast-fed" children were, in a large majority of cases, born of mothers who had undergone greater lactational strain, and as this lactational strain does only to a

slight extent predispose the infant to rickets, consequently one is forced to a consideration of the composition and fitness of the maternal milk in these cases.

In the literature on the subject of the changes, if any, taking place in maternal milk with advancing age and in successive lactations, systematic series unfortunately are by no means plentiful.

Personally, I am unable to record my results, owing to errors having occurred in the duration of the period of rest prior to the withdrawal of the milk. By very many observers it has been clearly shown that great variations exist in the normal composition of milk, not only in the milk of different mothers, but also in that of the same mother at different times. Thus it is found that in the course of one lactation the milk varies in composition according to the period of the lactation, the changes consisting in a fall in the amount of the proteids and salts, and a rise in the sugar and fat (Pfeiffer). Variations in the amount of proteid and fat present are wide, but whereas the fall in the amount of proteid is very distinct, the amount of fat varies but little according to the period of lactation, while the proportion of sugar is throughout very constant (Holt). Variations in the amount of fat occur with each nursing, the later milk being constantly found richer in fat than the earlier, and the proportion sinking again during the period of rest; while it has also been found that fat is more plentiful when the infant is only partially breast-fed than when it is entirely on the breast (Reyher). Holt states that the age of the mother has no constant influence on the composition of her milk, nor has the number of previous pregnancies, except such influence as results from the effect upon her general health. In this latter connection Sharples and Darling, as the result of 117 analyses of human milk, conclude that "during the first lactation the milk on the average is weaker in fat and proteids, but stronger in sugar, than in subsequent lactations. These differences may or may not be due to age."

That the exact changes, if any, produced in the composition of milk by advancing age and successive lactations have not, so far, been determined is clear; observers, however, agreeing that an unsatisfactory condition of maternal milk does exist, that the undue prolongation of lactation and rapidly succeeding pregnancies conduce to this condition,

and that this unsatisfactory condition can lay the foundation of rickets (Henoch, Holt, Thomson). The mothers of infants in the category I am now considering may be said to fall into this class, and the conclusion is arrived at that their milk was not in every case or in all respects a satisfactory food for the children.

To summarise briefly the foregoing observations, I would note—

1st, That the practice of hyperlactation is common.

2nd, That menstruation occurring during lactation, while offering no definite bar to the continuation of breast nursing, discloses an increased liability to the supervention of pregnancy.

3rd, That pregnancy occurs comparatively frequently during lactation, but not as a rule before the eighth month.

4th, That where pregnancy and lactation overlap, the fœtus is apt to suffer; its nutrition is entirely dependent on the mother, whereas extraneous assistance can be afforded the suckling.

5th, That lactational strain predisposes to rickets.

That every case must be judged on its own merits is a truism, but given fairly average conditions, a strong healthy suckling, and the prospect of intelligent hand feeding, the above facts point very strongly to the advantages to be derived from weaning in the eighth month.

While the disadvantages and insufficiencies of hand feeding are patent to the least skilled eye, the beneficent effects of maternal nursing are correspondingly striking. Every day we meet with weakly, ill-nourished women suckling a strong healthy infant, and the idea is fostered that from breast-nursing nothing but benefit to both mother and child accrues. Women of the working class who can and do nurse, very frequently nurse for a period of time altogether out of proportion to the needs of the infant. The number of such nursing mothers undoubtedly is distressingly small, but of those who do nurse, the number who do so excessively long is distressingly large. No one questions that, where practicable, maternal nursing, within limits, is the one and only procedure for the good of both mother and child; but in order to secure a continuance of this invaluable supply of nourishment it is imperative that it be utilised in moderation, with due consideration and avoidance of the undoubted evils resulting from its undue prolonga-

tion or the condition of an overlapping pregnancy, such conditions foreshadowing a diminished value of the milk in future lactations, and consequently forming a serious handicap in the natural nutrition of later infants.

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APPENDIX B

THE RELATION OF DIET TO THYROID ACTIVITY

(By the Author.)

(From "The British Medical Journal," 16th March 1907.)

As the result of a series of experiments conducted with a view to determine the effect of heat upon the nutritive value of milk, I have been led to a particular study of the thyroid glands of the animals experimented upon.

The prevailing custom at the present time of the pasteurisation of milk for infant feeding, and the very divergent views held regarding the advantages and disadvantages attendant on the custom, were, in the first place, the reasons which induced me to undertake these experiments. The results obtained as regards the respective value of plain milk, pasteurised milk, and sterilised milk as a food have proved inconclusive both positively and negatively.

Certain facts, however, concerning the structure of the thyroid gland in these animals would appear to be worthy of being placed on record, the variations in structure obtained being constant within narrow limits, and corresponding to the diet employed.

My experiments were conducted in the Physiological Laboratory of the University of Edinburgh, and to Professor Schäfer my warmest thanks are due. In all, the thyroid gland was examined in the case of 94 rats—5 of these being wild rats. The remaining 89 animals of 14 litters were dieted from the date of weaning (usually the twenty-first day) for periods varying up to sixty-seven days. Seventy-three of these rats from 11 litters were fed, thanks to the kindness of Dr Robertson, Medical Officer of Health, Leith,

upon modified milk obtained from the Leith Milk Depôt, while the remaining 16 rats of 3 litters were fed on ordinary dairy milk.

In the case of those rats reared in the laboratory, animals from the same litter were placed at the time of weaning on (1) bread and milk diet;[1] (2) fresh milk; (3) the same milk pasteurised; (4) the same milk boiled for thirty minutes.

In all cases an unlimited supply was given, no marked difference being noticed in the amount taken by rats on the three milk diets.

Rats of the various litters, when weaned, were weighed and divided as evenly as possible between the four diets, and thereafter were weighed every third day.

As regards increase in weight, practically no difference was noticeable between the various milk-fed animals, but in all milk-fed animals the increase was less than in corresponding bread-and-mild-fed rats. Clinically, all rats at the period of death appeared perfectly healthy, milk-fed rats being, however, in the majority of cases, somewhat softer and plumper than those fed on bread and milk.

The rats in all cases were killed with chloroform, and the tissues examined *post-mortem*. In all cases of milk-fed rats there was considerable deposition of general body fat. This increase of fat was most marked in the abdominal cavity, and was in some cases very excessive. In all milk-fed rats the thyroid glands were of a markedly paler colour than those of animals fed on bread and milk.

The organs and tissues were fixed in 5 per cent. formalin and stained with hæmatoxylin and eosin after, in the case of the bones, decalcification with Perenyi's fluid. The bones, spleen, liver, pancreas, kidney, suprarenal, thymus, and thyroid, in each case, were examined microscopically, and, apart from the thyroid gland, no constant marked differences were observed corresponding to the diets used. In the case of the thyroid gland, however, altogether different conditions were found when the rats were grouped under the three headings of (*a*) wild rats, (*b*) bread-and-milk-fed rats, (*c*) milk-fed rats.

As regards the thyroids of rats on the three varieties of milk food, in 80 per cent. of cases no distinct difference was

[1] Watson and Hunter, *Journ. of Physiology*, vol. xxxi., Nos. 1 and 2.

observable, while in the remaining 20 per cent. of cases the structure of the gland varied constantly according to the form of milk used, yet in all the characteristic features corresponded very closely with the general type of the remaining milk-fed animals.

The glands of all animals fed on bread and milk showed a constant picture within extremely narrow limits, while those from the wild rats (caught together at the same place

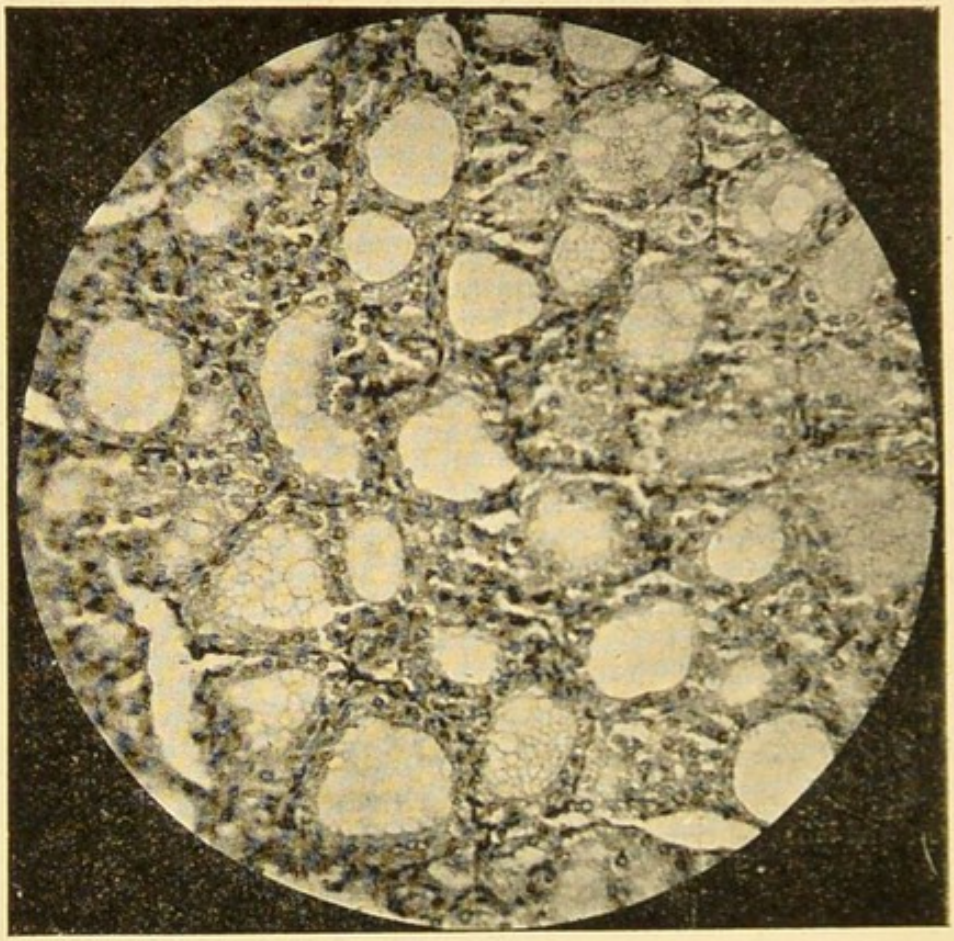


FIG. 1.—Rat, aged 10 weeks, weight 76 grams. *Plain milk.*

at the same time), though showing somewhat wider variations, yet in all cases displayed, in a greater or less degree, the same nature of differences from both the preceding types of gland.

Fig. 1 shows the form of gland in a milk-fed rat. In it the vesicles are large, well filled with colloid material, and the lining cells are small, with deeply-staining nuclei.

In fig. 2, the gland of a bread-and-milk-fed rat, the vesicles are seen to be very markedly smaller and the amount of colloid present very considerably less. Whereas, in the case of milk-fed rats, each vesicle consists of a large

lumen surrounded by a narrow ring of somewhat flattened cells, here it consists of a ring of columnar cells enclosing a minute lumen or lying apparently almost in contact.

Examination of the glands of wild rats (fig. 3) shows them to be of a more or less intermediate nature between those of milk-fed and those of bread-and-milk-fed animals. Compared with sections from bread-and-milk-fed animals, the vesicles appear distinctly larger, they contain consider-

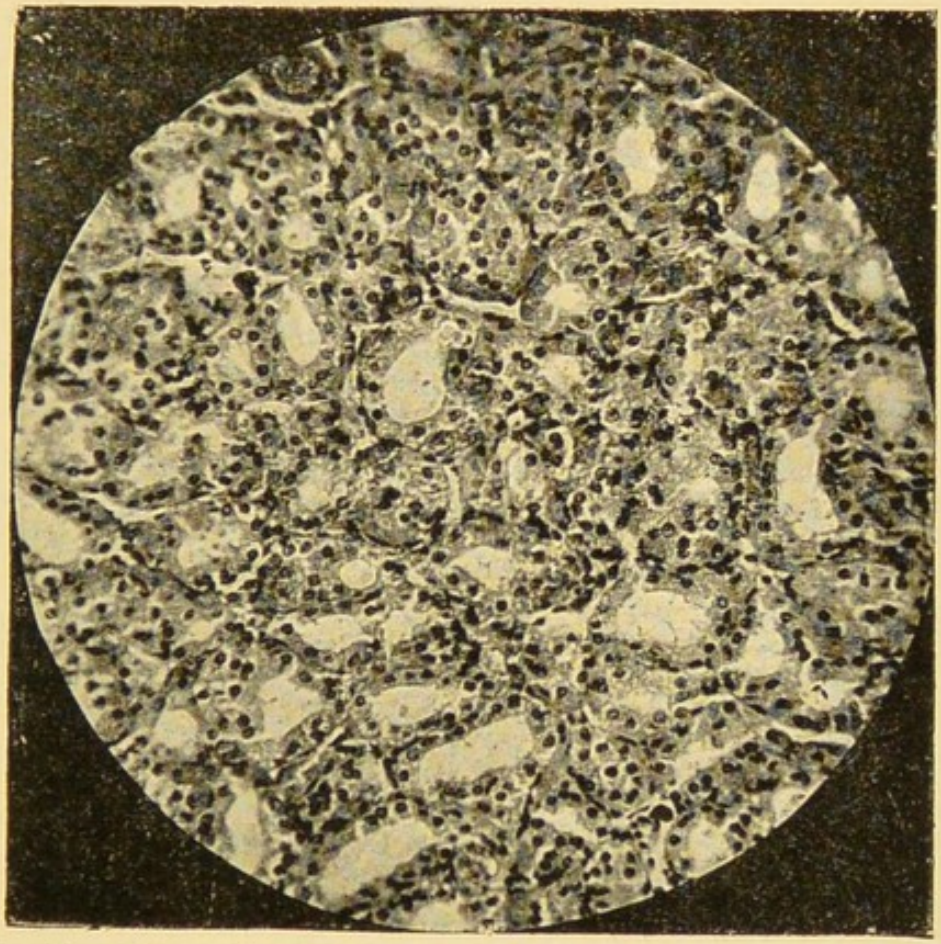


FIG. 2.—Rat, aged 10 weeks, weight 79 grams. *Bread and milk.*

ably more colloid material, and the lining cells show a greater variation in shape.

These glands, one and all, it must be remembered, were removed from animals clinically in perfect health; and, while the thyroid gland is an organ well known to be subject to considerable variations in structure, yet the interest in the present note rests in the fact that the variations in the series of glands examined corresponded with the differences in diet.

That the type of gland met with in each of the three

classes of cases was one of a variation within the limits compatible with a normal healthy animal seems certain. The thyroid gland of rats is obviously an organ extremely susceptible, and also extremely adaptable, to variations in diet, and in healthy animals the structure of the gland varies within fairly wide limits. But while this is undoubtedly the case, yet it is also equally apparent that along with varying types of sound health and of healthy thyroid

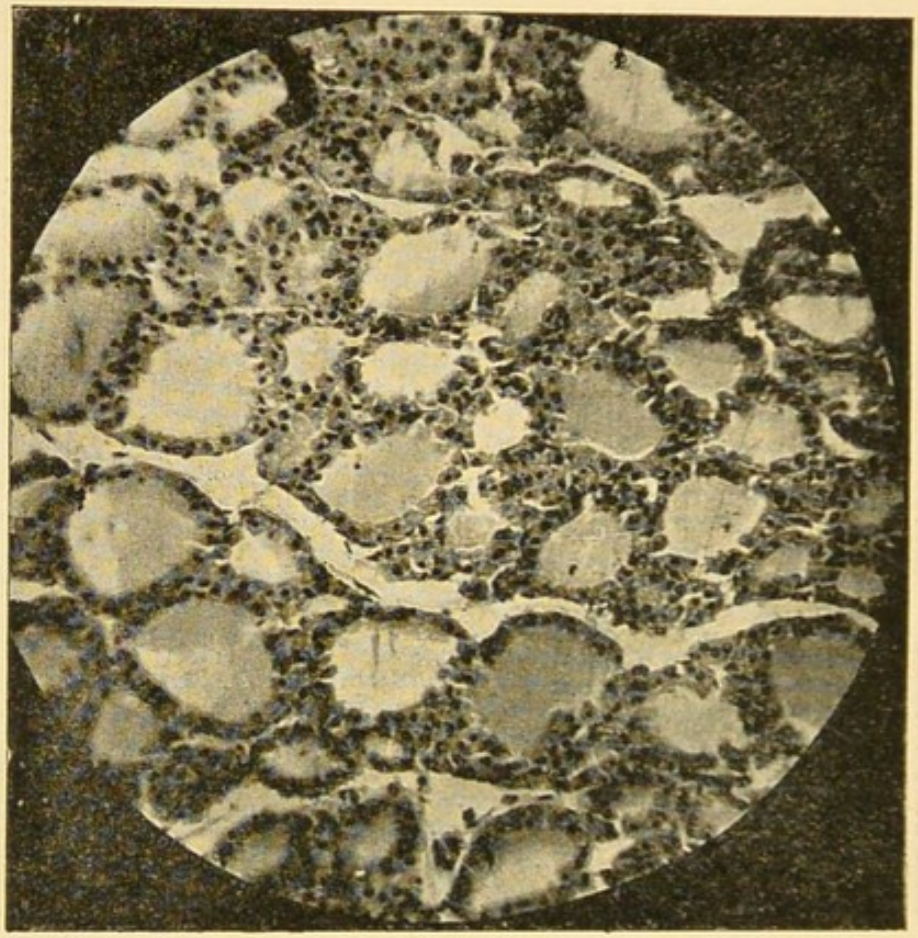


FIG. 3.—Rat aged (?), weight 92 grams. *Wild rat.*

glands are associated different degrees of activity of that gland. Normally the gland, within wide limits, responds readily to the diverse calls upon it, and, with a greater or less degree of activity, the normal condition is maintained. Should, however, the potential activity of the gland be, from any cause or in any manner, less than usual, obviously a healthy condition is only to be maintained by restricting the call upon it well within the normal limit; and, consequently, it is important to determine the relation of varying diets to the strain thrown upon the gland.

Swale Vincent and Jolly[1] affirm that no statement universally applicable throughout the animal kingdom can be made as to the importance of the thyroid and parathyroid glands, and the former author[2] states that in rats and guinea-pigs extirpation of both thyroids and parathyroids is never followed by myxœdema. The extreme difficulty of this operation of total extirpation—certainly in the case of rats—seems to warrant some hesitation in arriving at the conclusion that the function of the organs in these animals is so totally different from that found elsewhere throughout the animal kingdom.

It is certainly unjustifiable to presume that variations found in young rats will, in corresponding conditions, occur in young children, although it may be well to bear the possibility in mind; and in view of the statements of Richardson and others, which render it rational to suppose that cow's milk may call forth, in the processes of its digestion and assimilation, a greater effort on the part of the infant's thyroid than does human milk, and the favourable results obtained by Simpson in cases of "marasmic" children treated by thyroid extract, it appears worthy of consideration that the treatment of milk by heat may call for the production of varying degrees of energy by the thyroid gland in the processes of assimilation.

[1] *Journ. of Physiology*, vol. xxxii., 1904.
[2] *Lancet*, 18th August 1906.

APPENDIX C

LABORATORY RESULTS FROM THE ARTIFICIAL DIGESTION OF VARIETIES OF MILK

(By the Author.)

(From "The Scottish Medical and Surgical Journal," November 1907.)

In the choice of a food for the infant it is important to recognise not only the composition of the food but the nature of the reaction peculiar to this food which is likely to occur in the stomach through the admixture of the gastric juices. By artificial digestion in the laboratory it is obviously impossible to accurately reproduce the natural conditions, but such artificial digestion must be of considerable value in enabling us, at least roughly, to appreciate the difference between the results in the various cases.

In the following Table (page 128) I show the results which I have obtained by the artificial gastric digestion of various infant foods.

In all cases 5 c.c. of the milk or milk mixture were placed in a test-tube, and to this 5 drops of commercial essence of rennet were added. The contents of the test-tube were then thoroughly shaken up and the test-tube placed in the incubator at 38° C. for 25 minutes. On removal from the incubator the condition of the milk was noted, and into each test-tube were put 5 drops of 0·5 per cent. hydrochloric acid and 5 drops of a solution of pepsin. The solution of hydrochloric acid was prepared with distilled water. The pepsin employed was the pharmacopœial powder; it was dissolved in distilled water, and the same solution used in each case.

After the addition of the hydrochloric acid and the pepsin, the contents of each test-tube were thoroughly shaken up so as to cause a satisfactory mixture and thoroughly break down all curd when such was present, and the test-tubes

were then replaced in the incubator and kept there at a temperature of 38° C. for 3 hours. They were then removed and again examined.

By the term "liquid" is implied that in the test-tube on free movement no curding was visible.

In addition to the results given in this Table, in each case a second test-tube was also prepared, in which to the milk or milk mixture 5 drops of a 0·5 per cent. solution of lactic acid were added prior to the treatment with rennin. In every case in which the milk or milk mixture after treatment with rennet showed curd formation, the corresponding milk or milk mixture thus lactated showed a rather finer or slighter curd formation.

After further treatment with hydrochloric acid and pepsin, in no case but one was any distinction between the two recognisable, the exception being the case in which fresh milk was diluted with an equal amount of lime-water. In this case, in contradistinction to a very soft flocculent curd of $\frac{3}{4}$ bulk, the lactated mixture gave a solid curd of $\frac{1}{2}$ bulk.

In this Table it will be noticed that in the case of both raw buttermilk and buttermilk mixture it is stated that after each period of incubation the fluid was "liquid." By this term, in these two exceptional cases, I mean that the fluid showed no obvious difference after treatment; in neither, however, is the original fluid prior to treatment, strictly speaking, liquid.

Human milk under this treatment curds in such fine flocculi as to be invisible in the test-tube, the only other fluids (other than the buttermilks) which retain the same characteristics throughout the entire process being fresh cow's milk + sodium citrate in the proportion of 2 grains to each ounce, fresh cow's milk peptonised for 30 minutes, and Nestlé's milk (℥i in ℥iii water) + sodium citrate 1 grain to each ounce of the mixture.

By the application of heat to milk, curding with rennet is delayed—inappreciably in the case of pasteurisation, slightly in the case of boiling, and so markedly in the case of sterilisation as at the end of the period here chosen for rennet action to be quite invisible as compared with a solid curd in the case of fresh milk. After further digestion the positions are reversed, a condition which at first sight seems extremely unlikely, looking to the fact that, clinically, heated milk is, as a rule, more readily tolerated by the infant than raw milk.

No.	Milk or Milk Mixture.	Result of Incubation with Essence of Rennet.	Result of further Incubation with Hydrochloric Acid and Pepsin.
1	Human milk	Liquid	Liquid.
2	Fresh cow's milk	Solid curd	½ bulk solid curd.
3	Pasteurised cow's milk	,, ,,	,, ,,
4	Boiled ,, ,,	Solid curd, but rather softer than 2 or 3	Rather more than ½ bulk solid curd.
5	Sterilised ,, ,,	Liquid	Quite solid curd altogether.
6	Fresh cow's milk diluted with equal amount water	½ bulk solid curd	Distinctly less than ½ bulk solid curd.
7	Fresh cow's milk + Na Citr. 1 gr. to 1 ℥	Liquid	½ bulk soft curd.
8	Fresh cow's milk + Na Citr. 2 gr. to 1 ℥	,,	Liquid.
9	Sterilised cow's milk diluted with equal amount water	,,	Solid curd.
10	Sterilised cow's milk + Na Citr. 1 gr. to 1 ℥	,,	,, ,,
11	Fresh cow's milk diluted with equal amount lime-water	,,	¾ bulk very soft flocculent curd.
12	Fresh cow's milk diluted with equal amount barley-water	¾ bulk soft curd	⅓ bulk solid curd.
13	Peptogenic milk	Liquid	¾ bulk very soft flocculent curd.
14	Fresh cow's milk peptonised 10 minutes	,,	¾ bulk very soft flocculent curd.
15	Fresh cow's milk peptonised 20 minutes	,,	Only trace of very soft curd.
16	Fresh cow's milk peptonised 30 minutes	,,	Liquid.
17	Raw buttermilk	,,	,,
18	Buttermilk mixture boiled	,,	,,
19	Buddeised milk	Solid curd	Rather less than ½ bulk solid curd.
20	Nestlé's milk	Liquid	Complete soft curd.
21	Nestlé's milk + Na Citr. 1 gr. to 1 ℥	,,	Liquid.

Pasteurisation = heating milk 20 minutes at 70° C. Boiling = heating milk till it boils and then cooling rapidly. Sterilisation = keeping milk boiling for 20 minutes in open dish. (The same results were

The condition must, I think, be considered as due to the fact that the rennet action, though delayed, eventually takes place under suitable conditions, and gastric digestion is correspondingly delayed, while the clinical effects may be accounted for by a considerable transference of the still liquid uncurdled milk into the duodenum before the rennet action has fully taken place. In the stomach of an infant several months old the relatively free secretion of hydrochloric acid would suffice to inhibit the rennet action before marked curding occurred, but in the case of the very young infant in whose stomach the secretion of hydrochloric acid is extremely slight the above explanation must, I think, be accepted.

In the attempt to throw further light upon this point the following procedure was carried out:—

		Result.
1. Fresh milk, 5 c.c.	+ 5 minims essence of rennet. Incubated 3½ hours at 38° C.	Solid curd.
2. "Sterilised" milk, 5 c.c.		Solid curd.
3. Fresh milk, 5 c.c.	+ rennet, pepsin, hydrochloric acid. Incubated 3½ hours at 38° C.	½ bulk solid curd.
4. "Sterilised" milk, 5 c.c.		Solid curd.

From these results it would appear that the action of rennet, though delayed, eventually takes place; that the curd described as occurring after 3½ hours' digestion is a rennet curd; and that with delay in the curding occurs delay in gastric digestion.

An obvious fallacy is present, namely, the immobility of the fluid during the period of digestion, and consequently the possibility of the prevention of a softer curd in the case of the boiled milk.

None the less the results are, I think, instructive, more especially when we consider them along with the results in the case of other milks in which, notwithstanding the immobility, a very distinct soft curd is obtained. By the addition of sodium citrate to milk, rennet action is also delayed, and not only delayed but diminished in intensity.

obtained with milk kept at boiling point in Soxlet's apparatus for 40 minutes.) Peptogenic milk = milk treated with Fairchild's "Peptogenic Powder." Peptonised milk = milk treated with Fairchild's peptonising powder. Buttermilk mixture = 1 pint raw buttermilk, ½ ounce flour, and ¼ ounce lactose. Nestlé's milk = 1 teaspoon Nestlé's milk in 3 ounces of water.

Thus with 1 grain of sodium citrate to each ounce of milk while curding is delayed, in addition the curd when formed is much softer than that with non-citrated milk, raw or heated. By the addition of sodium citrate to milk in the proportion of 2 grains to each ounce the occurrence of a visible curd is entirely prevented.

For the thorough peptonisation of milk, and the consequent prevention of curding, it is to be noted that 30 minutes' treatment is essential.

It has been claimed for Buddeised milk that it is rather more readily tolerated by infants than fresh milk, and my results would seem to show that it is rather more readily affected by gastric digestion.

In the treatment of Nestlé's milk it was found that in the strength employed (1 ℥ in 3 ℥ water), 1 grain of sodium citrate to each ounce of the mixture entirely prevented curding.

APPENDIX D

EXAMINATION OF INFANTS' STOOLS AND STOMACH CONTENTS

(By the Author.)

(From "The Scottish Medical and Surgical Journal," December 1907.)

(A) *Examination of Stools.*—In forming conclusions from the examination of infant stools, four main factors influencing the constitution of the fæces have to be considered. These are—(1) the nature of the food ingested; (2) the effect of bacterial action in the alimentary canal; (3) the influence of the digestive secretions; and (4) the effect of treatment by drugs in cases where such remedies are being administered.

In the natural course of events such an examination forms but one link in the chain which is to lead us to our diagnosis and line of therapy, and obviously the result must always be regarded as merely a part of the whole. Towards its more accurate estimation we ourselves fortunately can contribute, and can more attentively and exactly consider each separate factor through the power we sway over points (1) and (4).

For clinical and practical purposes our methods of examination are markedly restricted in number, and in the main consist in accurate observation and simple chemical reactions. The intimate inter-relationship of the various factors concerned in producing the result which we examine naturally in many cases leads to very considerable difficulty in apprising, at even their approximate value, the part which each one plays, and no one factor obviously can act without influencing all the others, and in course of time leading to abnormality on their part. Thus in the great

majority of cases of infantile diarrhœa, when the patient is seen after the condition is well established, the stools show a great degree of similarity, they but infrequently permit of the exact definition of the primary cause of the condition, and they are the product of the disordered action of all the factors concerned.

In certain cases, by the delimitation of the factors concerned much information may be gained; in others, again, the purpose of examination may be obtained by simply noting the abnormal condition.

As a rough test of the absorptive power and the absorptive action presently occurring, such examination is essential, although by it we naturally gain no information as to the stage of hydrolysis at which the proteid has arrived when absorption occurred.

As a basis for the consideration of infants' stools the following Table, founded on the results of observations by Selter (*Fäcesuntersuchung*, 1904), is, I think, of practical value.

Normal	Breast—faintly acid Cow's milk—faintly alkaline	Light or brownish yellow	
Proteid disturbance	Strongly alkaline	Other colours, specially green, are abnormal. A normal stool may, however, become green on the surface (not in the interior) after exposure to the air	Crumbly stools and liquid cheesy stools.
Carbohydrate disturbance	Acid		Frothy loose motions with much mucus.
Fat disturbance	Acid	"Soapy gloss"	Greasy viscous stools.

In the case of a healthy breast-fed infant the stools are acid to litmus-paper owing to the presence of volatile fatty acids, and more especially to the presence of free lactic acid; when the infant is fed on cow's milk the reaction shows signs of a certain degree of proteid putrefaction. In cases

of feeding with buttermilk, unless there is much carbohydrate mixed with the milk, the reaction of the stools is naturally alkaline owing to the presence of ammonia. The yellowish colour of a "normal" stool is undoubtedly subject to considerable variation; it varies within the bounds of normality according to the composition of the milk or milk mixture employed as food, the amount and activity of the digestive juices, and on the degree of bacterial action which takes place during its progress through the alimentary canal.

Thus with a large amount of carbohydrate in the diet the stools tend to be brown; with an amount of fat bordering on the maximum "normal," or with a tendency to torpidity of hepatic activity, the colour becomes more grey; while with an excessive degree of proteid putrefaction and intestinal bacterial action the stools become green on exposure to the air. In cases where the stools are green, this colour is due to oxidation of the normal colouring matter of the fæces—bilirubin—into biliverdin; such a change is a very frequent accompaniment of various forms of food disturbance, and is very largely brought about by bacterial action. Along with the administration of calomel green stools are common, the explanation of this apparently being the increased alkalinity brought about in the upper bowel.

With various other drugs the colour of the fæces as in adults is also affected; of abnormal constituents blood is recognisable as in the case of adults. A small amount of mucus is common in the stools of healthy children, more especially where there is a tendency to constipation, or where the amount of ingested proteid material is greater than the digestive juices are capable of dealing with. Much mucus means irritation of the intestinal walls through the ingesta or bacteria; mucus is usually from the large intestine, but when it comes from the small intestine it occurs as small flakes in a liquid motion.

Shaw (*British Medical Journal*, October 13, 1906) states: "About 4 per cent. in nurselings and 5 per cent. in bottle-fed infants of the fat ingested appears in the fæces. This fat is, to a large extent, fat that has escaped digestion—it occurs as neutral fat, fatty acids, and soaps. The soaps are relatively increased in artificially-fed infants, in infants with a low percentage of fat in the food, and in infants with diarrhœa."

Fat in the stools occasionally occurs as greasy, opalescent

molecules, frequently more or less closely connected with true proteid curd, and thus gives to the casual observer an appearance of somewhat massive curds in the stools.

Southworth (*Medical Record*, vol. lxvii., March 4, 1905), discussing the work of Van Slyke and Hart, states: "If true tough curds are passed in the infant's stools it indicates that the milk has somehow been subjected to an excessive acidity, allowing the formation of too much tough acid curd of paracasein, which the pepsin secretion has not been equal to the task of digesting, and which was in a form unsuited for intestinal digestion. This may occur from—(*a*) excess of hydrochloric acid in the stomach; (*b*) milk slightly sour from formation of lactic acid before it was modified; (*c*) milk after modification kept too warm, and so slightly soured from the production of lactic acid as the result of bacterial growth; (*d*) lactic acid or other acids formed in the milk after reaching the stomach, when there is tardy digestion."

In fact, the conclusion come to seems to be that the presence of proteid curds in the stools implies the existence of undue acidity in the alimentary canal. I hardly think one can accept this explanation as applicable in every case, or at all events as the primary cause of the condition in many cases. The secretion of rennin by the infant stomach is one of the earliest, one of the most constant, and one of the most copious of the digestive secretions. On the other hand, excess of hydrochloric acid in the stomach is apparently very rare in infancy; by ordinary care acidity of the milk prior to administration can readily be prevented, and yet with no evidence of tardy digestion, with no considerable quantity of lactates discoverable in the stomach contents, and with no symptoms of gastro-intestinal disturbance, true curds appear in the stools.

Doubtless in every case acids must play their secondary part in acting on the formed curd, and where in excess they render it firmer and tougher.

But rennin action is the primary cause of the condition, and rennin action, quite exclusive of acid assistance, is competent to produce curds in the stools. The rennin secretion of an ordinary infant stomach appears capable of acting on a stomachful of milk in cases where the capacity for further digestion of the material is but partial. In such cases true curds appear in the stools, in the course

of time gastro-intestinal disturbance is undoubtedly set up, but in such cases reduction in the amount of proteid in the food, or it may be the addition to it of some material to delay the rennin action, serves to remedy the condition.

In the great majority of cases of ordinary infantile diarrhœa, when this diarrhœa is at all profuse the stools show the following characteristics:—They are acid to litmus-paper, green and watery in appearance and consistence; they contain numerous white solid curds, and there is constantly present a distinct amount of mucus, which, however, varies considerably in quantity. Such is the nature of the stools in a very large number of cases of well-established infantile diarrhœa, whatever the primary cause may have been. Towards the diagnosis of this primary cause they give consequently, I think, no assistance whatever; they indicate, on the other hand, disturbance of all digestive functions, and emphasise the necessity of digestive rest.

Another common type of stool is the following:—With an alkaline reaction to litmus-paper the consistence is semi-solid, and the whole forms a white, pasty or greyish-brown pultaceous mass, with little soft grey lumps throughout it, but with no definite curds and no mucus. Such stools, as a rule, occur in cases without marked diarrhœa; with vomiting it may be or with practically none; where there is no, or no appreciable, rise in the weight curve, and consequently where the general well-being of the infant is eminently unsatisfactory. In such cases the milk is to a considerable extent passing through the alimentary tract in an undigested condition. Very frequently the conditions are found in infants fed on a milk richer than they are capable of digesting, and consequently where, with a certain amount of proteid putrefaction, there is associated in addition inefficient pancreatic and hepatic action. These stools are usually alkaline; where they are acid, the condition, I think, is more serious, as here we have, in addition to the failure of digestion, the marked effects of intestinal sepsis.

It is in the process of treatment, however, and as a guide to our dietetic measures, that the examination of the stools is of the greatest value. By commencing well within the infant's digestive capacity, and by increasing one by one and gradually the several constituents of the milk, this examination helps us very considerably in determining the indications for the suitable alterations in the diet.

(B) *Examination of Stomach Contents.*—Since the year 1888 much careful work has been done on the subject of the examination of the stomach contents in healthy and unhealthy infants.

Careful and comprehensive though much of this work has been, however, the results of different observers have been widely divergent, and the conclusions arrived at have in many instances been extremely conflicting.

Leo (*Berlin. klin. Woch.*, No. 49, December 3, 1888) made the examination in the cases of 134 infants. Of these, 30 infants aged from 2 hours to 12 months were taken, so far as their digestion was concerned, as normal. He found that in healthy breast-fed babies during the first month of life the stomach was always empty 1½ hours after suckling. In older infants, and in those fed on cow's milk, there was frequently still some remnants of milk in the stomach more than 2 hours after drinking. When the contents were examined immediately after withdrawal from the stomach, the reaction in the case of breast milk was alkaline or neutral, in the case of cow's milk neutral or faintly acid. After standing for 15 minutes after withdrawal the contents in every case were acid.

Only in exceptional cases could free hydrochloric acid be detected in the contents, even when the withdrawal took place more than an hour after feeding, while with the contents of the fasting stomach it was practically always discovered.

This condition he accounts for by the reasoning that with a constant gastric secretion of hydrochloric acid there is, during the presence of milk in the stomach, an equally rapid combination taking place, and that consequently it is only in the absence of milk constituents that hydrochloric acid remains free in the stomach. Pepsin and rennin he found constantly present.

Of the 104 children examined who suffered from digestive disturbance, 60 are reported as suffering from "acute dyspepsia," 22 from "cholera infantum," 16 from "chronic gastric catarrh with atrophy," and 6 from "diarrhœa alone."

In all these cases the food remained much longer than usual in the stomach, and in many instances there was a large amount of mucus, and much gas escaped by the tube.

The reaction was always acid, owing to fatty acids, lactic acid, and hydrochloric acid. Rennin was always present, and pepsin also in the great majority of cases.

V. Jaksch (*Zeitschr. f. klin. Medicin.*, Bd. 17, 1890), on the other hand, found free hydrochloric acid in the stomach contents ¼ hour after feeding, and notes its diminution in cases of dyspepsia and gastric catarrh; while Heubner (*Jahrb. f. Kinderheilk.*, 32, 1891), in partial agreement with Leo, found free hydrochloric acid but rarely. Wohlmann (*Jahrb. f. Kinderheilk.*, 32, 1891), again, states that free hydrochloric acid is constantly present in the stomach contents of healthy breast-fed infants 1½ to 2 hours after suckling.

Wolf and Friedjung (*Archiv f. Kinderheilk.*, 25, 1898) note the great divergence of results obtained on this subject, and their own observations were conducted in the cases of 97 children aged from 10 days to 21 months. They found that "the secretion of the 'normal' digestive ferments of the stomach in infancy is subject to considerably greater variations than is the case in later life, and in these variations may be included 'entire absence,' on which condition great diagnostic value cannot be placed, as it may be entirely physiological. Motor insufficiency is the only certain pathological sign; along with it occur increased period of gastric digestion and lactic acid fermentation, and probably also the presence of free fatty acids."

Bauer and Deutsch (*Jahrb. f. Kinderheilk.*, 48, 1898) found in the gastric contents of children suffering from gastro-intestinal disturbance that "free hydrochloric acid could never be detected, and the combined salt only in those cases in which the pathological condition was limited to the large intestine."

Meyer (*Archiv f. Kinderheilk.*, 35, 1903), as the result of careful and numerous examinations in the cases of 38 infants, concludes that "examination of the stomach contents of infants plays at present no useful part in clinical examination, as usually in abnormal conditions no greater variations are found than occur daily in the healthy condition owing to unknown nervous influences."

He notes a want of hydrochloric acid secretion in certain cases of acute diarrhœa without fever, and possibly an increase in "spastic pyloric stenosis"; while Hamburger and Sperk (*Jahrb. f. Kinderheilk.*, 62, 1905), in their examina-

tions of new-born babies, found free hydrochloric acid present in 33 per cent. of the cases examined 1½ hours after food.

The results of observations on this subject are, therefore, to say the least of it, not very enlightening.[1] Thus, as

[1] I have quoted the literature on the subject very shortly for the reason that the results obtained are so very conflicting; this divergence is so readily recognised by all writers, and the value of the various observations is consequently such a negative one, that it seems unnecessary to dilate at any length on the work. Beneath I give a reference to some of the more important publications on the subject:—

1. Leo. *Berlin. klin. Woch.*, No. 49. 1888. "Ueber die function des normalen und kranken Magens und die therapeutischen Erfolge der Magenauspülung im Säuglingsalter."

2. Escherich. *Jahrb. f. Kinderh.*, Bd. 27. 1888. "Die normale Milchverdauung des Säuglings."

3. V. Jaksch. *Zeitschr. f. klin. Medicin.*, Bd. 17, v. 1890. "Beiträge zur Kenntniss der Salzsäuresecretion des verdauenden Magens."

4. Heubner. *Jahrb. f. Kinderh.*, 32. 1891. "Ueber das Verhalten der Säuren während der Magen-verdauung des Säuglings." (Gives results of examination in 40 cases of healthy and unhealthy infants.)

5. Wohlmann. *Jahrb. f. Kinderh.*, 32. 1891. "Ueber die Salzsäureproduction des Säuglingsmagens im gesunden und kranken Zustande."

6. Toch. *Arch. f. Kinderh.*, Bd. 16. 1891. "Ueber Peptonbilding im Säuglingsmagen."

7. Müller. *Jahrb. f. Kinderh.*, 34. 1892. "Zur Kenntniss des Verhaltens von Milch und Casein zur Salzsäure." (Fresh cow's milk has a greater combining power with hydrochloric acid than has old cow's milk. The combining power with hydrochloric acid of mother's milk is about ⅓ to ½ that of cow's milk.)

8. Bauer and Deutsch. *Jahrb. f. Kinderh.*, 48. 1898. "Das Verhalten der Magensäure, Motilität und Resorption bei Säuglingen und Kindern unter physiologischen und pathologischen Verhältnissen." (A lengthy and very comprehensive article.)

9. Wolf and Friedjung. *Archiv f. Kinderh.*, 25. 1898. "Zur Würdigung der Magenverdauung in Säuglingsalter." (Also a very complete study.)

10. Volhard. *Munch. med. Woch.*, Nos. 5 and 6. 1900. "Ueber Resorption und Fettspaltung im Magen."

11. Volhard. *Zeitschr. f. klin. Medicin.*, Bd. 42 and 43. 1901. "Ueber das fettspaltende Ferment des Magens."

12. Meyer. *Archiv f. Kinderheilk.*, 35. 1903. "Zur Kenntniss der Magensaftsecretion der Säuglinge." (A lengthy communication, with an excellent bibliography.)

13. Hamburger and Sperk. *Jahrb. f. Kinderheilk.*, 62. 1905. "Untersuchungen über die Magenverdauung bei neugeborenen Brustkindern."

14. Langstein. *Jahrb. f. Kinderheilk.*, 64. 1906. "Die Eiweissverdauung im Magen des Säuglings."

15. Schütz. *Wien klin. Woch.*, No. 44. 1907. "Ueber Pepsinverdauung bei Abwesenheit 'freier Salzsäure.'"

regards acidity in digestive disorders, Leo found hyperacidity, Wohlmann diminished acidity, Bauer and Deutsch absence of acidity, Pipping no abnormality. In the healthy condition some authors never found free hydrochloric acid, others usually found neither free nor combined hydrochloric acid, and others often found free hydrochloric acid. The same variations are found in the results concerning lactic acid and other secretions. The substance most constantly noted as present by all observers is rennin, and in but few cases is it recorded as absent.

In considering these results, it has of course to be borne in mind that the preparation of the child, the method of withdrawal of the gastric contents, the tests employed, and the procedure generally, varied very greatly in the hands of different observers.

Thus, by some observers, the stomach was washed out, a measured quantity of fluid given at a definite interval afterwards, and the gastric contents subsequently withdrawn; by others no preliminary stomach washing was undertaken, and by some no definite intervals between the two feeds was observed. In some cases milk was the fluid employed for the test, in others milk mixtures, in others Nestlé's milk, albumen water, or barley water.

In certain cases (Wolf and Friedjung) a measured quantity of sterile water was injected into the stomach prior to the withdrawal of the contents in order to ensure the withdrawal of a sufficient quantity to test; in the majority of cases this was not done.

The tests employed were many and varied. As a rule, Congo red was used for the detection of free acid, Gunzberg's test for free hydrochloric acid, and Uffelman's reagent for lactic acid. One is almost inclined to suspect that in certain cases examination of the contents cannot have taken place immediately after withdrawal, a point of no inconsiderable importance when dealing with such a substance as milk, which has so high a combining power with hydrochloric acid. Practically, therefore, at the present day, the examination of the infantile gastric contents in the case of the ordinary digestive disturbances is of but the most problematical value in assisting us to a diagnosis.

My own observations on the subject are too few in number to permit me to hold any decided opinion. I cannot but

believe, however—comparatively valueless though the procedure has been pronounced as an aid to a correct diagnosis—that by means of this examination we may gain important information from time to time in each case as to the suitability or otherwise of our dietetic régime, and an additional guide to our future line of procedure.

APPENDIX E

STATISTICS OF INFANTILE MORTALITY IN GREAT BRITAIN

I. England and Wales.

(From a paper by J. W. Forster presented at the Second International Congress of the Gouttes de Lait, Brussels, September 1907.)

The following information and tables are extracted mainly from the Registrar-General's returns for the year 1905.

The deaths of infants under one year of age were in the proportion of 128 per 1000 births in the year 1905 (the latest for which returns are available), as compared with 145 in the year immediately preceding, and 150 the mean proportion in the ten years 1895–1904. The proportion in 1905 is the lowest hitherto recorded. Proportions closely approximating to this have, however, been previously recorded, notably 130 per 1000 in 1881, and 133 and 132 per 1000 in 1902 and 1903 respectively.

In each quarter of the year 1905 infantile mortality was below the average, especially so during the second and fourth quarters. The following table exemplifies the well-known fact that the greatest loss of infantile life occurs most frequently in the third quarter of the year. It also shows that large variations in the rate of infantile mortality are confined almost exclusively to the third quarter, excessive mortality in this quarter being associated generally with high temperature and deficient rainfall (see Table, next page).

From these figures it appears that in 10 of the 36 years under review the meteorological conditions in the third quarter of the year, viz. low temperature and excessive rainfall, were conducive to low rates of infantile mortality,

while the high temperature and deficient rainfall that prevailed in four of the years increased the loss of infant life in the third quarter by more than 60 per cent.

ENGLAND AND WALES—AVERAGE INFANTILE MORTALITY, 1870–1905.

Deaths of Children under 1 Year to 1000 Births.					Meteorology at Greenwich.	
Proportions in Complete Years ranging from	Average Proportions in				Mean Temperature of Earth at Depth of 3 ft. 2 ins. Third Quarter.	Mean Rainfall, Third Quarter.
	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.		Inches.
128 to 138 (10 years)	141	122	136	140	60·6	8·1
141 to 159 (22 years)	147	128	180	147	62·0	6·5
160 to 163 (4 years)	147	126	220	151	62·5	4·7

As in previous years, the ratio of infantile mortality varied considerably in different counties, being highest as a rule in those which are urban and industrial in character, and lowest in those which are rural.

The improvement in the rate of infantile mortality during the year was shared by nearly all parts of the country.

That urban life is not *per se* incompatible with a low rate of infantile mortality would appear from the fact that of the 217 chief towns of England with populations exceeding 20,000 each at the last census, 32 were credited during 1905 with proportions of infantile mortality below 100 per 1000 births. On the other hand, there were 34 towns, mostly mining or industrial centres, in which the rate exceeded 160 per 1000. In no fewer than five towns, one out of every five children did not survive the first year of life, and in one of them the average mortality in the three preceding years reached the high rate of 228 per 1000 births, which exceeds the total mortality in the first five years of life in the country as a whole.

ANNUAL MORTALITY OF INFANTS UNDER ONE YEAR OF AGE TO 1000 BIRTHS. ENGLAND AND WALES.

Groups of Years.

1838–1842 (five years)	152	1871–1880 . .	149
1843–1850 (eight years)	154	1881–1890 . .	142
1851–1860	154	1891–1900 . .	154
1861–1870	154	1901–1905 . .	138

ANNUAL MORTALITY OF INFANTS UNDER ONE YEAR OF AGE TO 1000 BIRTHS. LONDON.

Groups of Years.

1841–1850 . .	157	1881–1890 . .	152
1851–1860 . .	155	1891–1900 . .	160
1861–1870 . .	162	1901–1906 . .	138
1871–1880 . .	158		

Since 1888 the Registrar-General has furnished returns of infant deaths in three periods of the first and second three months and the last six months of the first year, which give the following results :—

Years.	England and Wales.				London.			
	Months 0–3.	Months 3–6.	Months 6–12.	One Year.	Months 0–3.	Months 3–6.	Months 6–12.	One Year.
1888–1892	70·5	29·5	45·4	145·4	69·1	31·6	50·7	151·4
1893–1897	73·7	32·0	47·7	153·4	73·5	33·8	51·3	158·6
1898–1901	75·3	31·2	48·0	154·5	74·5	34·9	51·6	161·0

Dr Newman remarks that these tables show that the fatal incidence fell upon the first months in ever-increasing proportion. The last published returns, however, give the following results :—

Years.	England and Wales.			
	Months 0–3.	Months 3–6.	Months 6–12.	One Year.
1901–1904	70·39	28·52	41·30	140·21
1905 . .	66·56	24·76	36·83	128·15

II. Scotland.

(By the Author.)

In his most recently published report the Registrar-General for Scotland sets forth the vital statistics of the country for the year 1905.

During that year the births of 131,410 living children were registered in Scotland, and the birth-rate per 1000 of the estimated population was 28·10, which is the lowest rate which has so far been recorded in that office (*i.e.* during the past fifty years).

In considering the birth- and death-rates of the country, occasion is taken to divide the population into five groups of registration districts.

Thus we have to deal with the following districts:—

1. Principal towns = towns of over 30,000 inhabitants;
2. Large towns = towns of from 10,000 to 30,000;
3. Small towns = towns of from 2000 to 10,000;
4. Mainland rural = remaining mainland registration districts;
5. Insular rural = remaining insular registration districts.

Birth-rate in Scotland and in its Groups of Registration Districts in 1905.

Districts.	Births.	Birth-rate per 1000 of Population.	Birth-rate per 1000 of women aged 15 to 45.
Scotland . . .	131,410	28·10	116·4
Principal towns . .	60,493	28·88	111·6
Large towns . .	18,451	30·42	127·8
Small towns . .	27,131	28·85	124·7
Mainland rural . .	22,960	24·93	114·7
Insular rural . .	2,375	20·85	96·4

Infantile Death-rate in Scotland and in its Groups of Registration Districts in 1905.

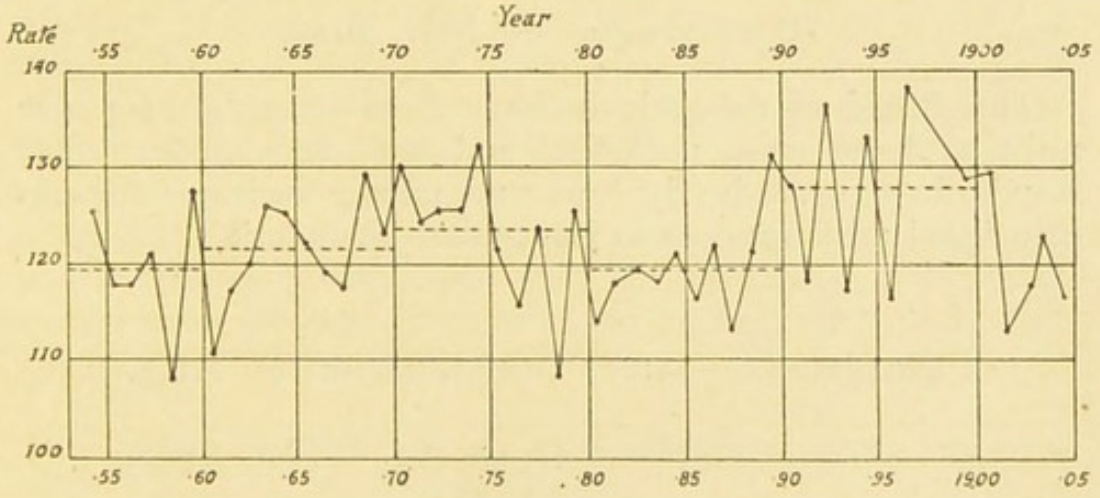
Districts.	Deaths under 1 Year.	Death-rate per 1000 Births.
Scotland . . .	15,275	116·2
Principal towns . .	7,729	127·8
Large towns . . .	2,217	120·2
Small towns . . .	3,038	112·0
Mainland rural . .	2,099	91·4
Insular rural . . .	192	80·8

From these tables we see that both the birth-rate and death-rate of infants under 1 year is lower in rural than in urban districts.

INFANTILE MORTALITY IN SCOTLAND, 1855–1905.

Year.	Death-rate of Infants under 1 Year per 1000 Births.					
	Scotland.	Principal Towns.	Large Towns.	Small Towns.	Mainland Rural.	Insular Rural.
Average.						
1855–60	119·6	157·5		94·8		88·8
1861–70	121·1	151·2		99·6		83·1
1871–80	122·7	149·8	133·9	118·1	90·6	81·0
1881–90	119·0	140·3	127·2	111·9	88·7	72·4
1891–1900	127·9	147·4	133·6	121·4	95·3	75·7
1901	129·4	148·9	133·2	122·9	92·8	60·6
1902	113·4	127·1	113·9	106·5	88·5	85·5
1903	117·5	135·2	114·5	109·2	87·6	72·2
1904	123·1	141·5	129·9	111·6	89·0	71·5
1905	116·2	127·8	120·2	112·0	91·4	80·8

INFANTILE MORTALITY, RATE PER 1000 BIRTHS, 1855 TO 1905.
Decennial averages are represented by the dotted line.



APPENDIX F

THE PRODUCTION AND DISTRIBUTION OF MILK IN GREAT BRITAIN AND IRELAND, TOGETHER WITH THE REGULATIONS IN FORCE

(*The summary of a paper presented by Dr George Carpenter at the Second International Congress of the "Gouttes de Lait," Brussels, September 1907.*)

Summary.

Various Acts of Parliament, Orders, and Regulations have been framed by Governments, Privy Councils, the Board of Agriculture, and Local Sanitary Authorities in the United Kingdom of Great Britain and Ireland to ensure the production and distribution of unadulterated and wholesome cow's milk.

Constitution of New Milk.

The Board of Agriculture have fixed a standard for new milk at 3 per cent. milk fats and 8·5 other solids. This standard is exceedingly low, and affords facilities for unprincipled milk-vendors to manipulate their milk.

Precautions Against Adulteration of Milk.

The Sale of Food and Drugs Act, 1875 *to* 1899.

The principal Act of Parliament in force is that of 1875; the remaining Acts are supplemental. The 1875 Act repealed all previous Acts relating to food adulteration.

Offences.—The principal offences under the 1875 Act are—

1. (*a*) Mixing injurious ingredients with food or drugs sold or intended to be sold.

(*b*) Selling any article so mixed.

2. (*a*) Selling any article of food or drug which is not of the nature, substance, and quality demanded by the purchaser.

(*b*) The abstraction from any article of food sold or intended to be sold, of any part of it, so as to affect injuriously its nature, substance, or quality, without making disclosure of the alteration.

(*c*) The selling of any article so altered. There are also subsidiary offences under these Acts.

3. (*a*) Refusing to sell to an officer charged with the execution of the Acts.

(*b*) Obstructing an officer in the execution of his duties.

(*c*) Giving a false warranty.

(*d*) Using a milk cart or can not bearing the name of the owner. The penalties for the main offences under the Acts are £20 for the first offence, £50 the second, and £100 for the third or any subsequent offence. Provision is also made for the magistrates to commit the offender to imprisonment without the option of a fine.

Under the Act of 1899, Sanitary Authorities are now compelled to cause samples of food to be taken in their district for the purpose of analysis. Should the Sanitary Authorities fail in their duties, Inspectors from the Local Government Board and Board of Agriculture can obtain the samples and charge the costs to the defaulting Sanitary Authorities. Samples of milk are divided into three parts. One part is returned to the vendor, one part of the sample is submitted to the Public Analyst for the purpose of analysis, the third part is retained by the purchaser. Each part of these samples is marked in such a way as to be known only to the Inspector, and sealed with the official seal. Provision is also made for obtaining samples of milk in transit from the producer to the distributor.

Regulations.

Regulations for prescribing and regulating the Lighting, Cleansing, Ventilation, Drainage, and Water-supply of the Cowsheds, Dairies, and Milkshops in the occupation of

persons following the trade of Cow-keepers, Dairymen, or Purveyors of Milk are made by the various Local Authorities of England, Scotland, and Wales under the Dairies, Cowsheds, and Milkshops Order of 1885.

In Ireland these regulations are made under the Dairies and Milkshops (Ireland) Orders of August 1879, July 1866, and the Dairies, Cowsheds, and Milkshops Amending Order of 1894. Copies of the regulations in force in many towns and districts of England, Ireland, Scotland, and Wales have been obtained, and the various regulations have been found to be very similar in character. Some Local Authorities issue recommendations supplemental to the regulations. The regulations in force in Beckenham, a very healthy town of some 33,000 inhabitants eight miles from London, in the county of Kent, of which the writer of the paper is the Medical Officer of Health, are given as a specimen of prevailing regulations. There still remain, however, urgent needs for reform and the better administration of existing regulations.

The largest and most up-to-date dairies in London and its environs are not as particular as they profess to be in looking after their sources of supply. The farms at which the milk is produced are frequently found to be in a most insanitary condition. The cows are huddled together in ill-ventilated and dingy sheds; others are confined in pitch-dark buildings, breathing a foul atmosphere and soiled with their own excrement. In some of the poor districts of London the milk is supplied by small general shops, at which a variety of odoriferous commodities are dispensed.

Municipal Milk Establishments.

Milk depôts have been established in many of the towns of England and Scotland; particulars relating to the Battersea Milk Depôt are given in detail. The authorities of these towns have been seriously hampered owing to the fact that auditors have surcharged them with expenses incurred in connection with these establishments which have been held by them to be illegal under existing laws. There is, however, a Bill before Parliament which when it becomes law will legalise the establishment of milk depôts by Local Authorities.

Milk for Feeding Infants.

Milk in this country is prepared in a variety of ways by competing dairy companies and others to attract customers. Bottles and jars containing "Humanised," "Pasteurised," "Sterilised," "Peptonised," "Humanoid," and other milks can be purchased. Milk in the form of dry powders can also be obtained from dairymen, grocers, chemists, and proprietary food vendors. There are also other proprietary foods sold which are preparations of milk. In addition to cow's milk, the milk of goats, mares, and asses can be obtained for infants and invalids. The employment of private veterinary surgeons by wealthy dairy companies is no guarantee to the general public. The only safeguards under existing conditions are the Medical Officers of Health and Sanitary Inspectors, and then only when they assiduously and conscientiously attend to their duties.

Action taken by the United Hospitals of London.

A conference on the subject of milk supply was held at Great Ormond Street Children's Hospital, London, in April of the present year, at which representatives from the London Children's Hospitals were present. A resolution was passed recommending that milk supplied to these hospitals should be clean, pure, genuine, with all its cream, and absolutely free from any kind of adulteration and preservatives. The standard of 3·5 per cent. of butter fat was fixed. No pronouncement was made in regard to the necessity for testing milch cows by tuberculin.

Tuberculosis.

Many of the cows in the United Kingdon are tuberculous, and the amount of tuberculous milk consumed by the public is very large—far larger than is commonly supposed. In one of the healthiest cowsheds in the country, amongst a herd of 100 cattle, no less than 21 reacted upon the tuberculin test being applied, although no traces of tubercle in the teats and udders were found. Larger powers for dealing with tuberculous cattle are needed by Sanitary Authorities.

APPENDIX G

THE CARE OF MILK FOR INFANTS

(a) *On the Continent of Europe.*

For a very full account of the existing conditions in the different countries, reference is given to the following papers which were presented at the Second International Congress of the "Gouttes de Lait," held at Brussels in September 1907:—

2. "Exposé critique des législations des différents pays sur le contrôle de la production et de la vente du lait. Les rapports feront surtout ressortir les mesures générales prises, ainsi que les règlements particuliers de certaines villes en ce qui concerne le lait destiné aux nourrissons."

3*a*. "Description des œuvres et institutions érigées dans les différents pays pour lutter contre la mortalité infantile."

Germany	2.	Dr Arthur Keller.
	3*a*.	Dr Ad. Würtz.
France	2.	Dr Léon Dufour.
	3*a*.	Dr Paul Grasset.
Holland	2.	Dr D.-L. Van Wely.
	3*a*.	Dr Plantenga.
Belgium	2.	Mr René Henry.
	3*a*.	Dr Marchandise.
Sweden	2.	Dr Axel. Johannessen.
	3*a*.	Dr Axel. Johannessen.
		Dr Z. M. Spolverini.
		Dr Wilh. Wernstedt.
Austria	2.	Dr Siegfried Weiss.
Italy		
	3*a*.	Dr Joseph Pezzetti.

Hungary	2.	Dr Ernö Deutsch.
	3*a*.	Dr Ernö Deutsch.
Spain	2.	Dr Borobio Diaz.
	3*a*.	Dr Avelino Benavenuti.
Denmark	2.	Dr Lunddahl.
Russia	2.	Mr Ottocar d'Aderkass.
Switzerland	2.	Dr Champendal.
	3*a*.	Dr Feyler.

It is sufficient here to state that the conditions are perhaps most satisfactory in Denmark. There special regulations apply to the sale of milk for infant use,—"Bórnemaelk." Whoever wishes to sell milk under this denomination must apply to the Local Health Committee, and must fulfil definite requirements concerning the quality and the treatment of the milk, must furnish proof of the health of the cows, and must accede to strict demands as to the method of sale (*e.g.* in bottles of transparent glass), all in addition to the regulations concerning ordinary milk.

Of late years there has been formed in Austria a committee of physicians, farmers, dairymen, and bacteriologists —Milchwirtschaftliches Comité—which has submitted to the authorities a plan of legislation, and among the regulations suggested a large number deal with milk for infant use.

(b) *In the United States of America.*

The following extract from the book by Dr C. G. Kerley, of New York, on "The Treatment of the Diseases of Children," gives some idea of the great care taken in the United States of America in connection with the milk used as food for the infant.

Dr Kerley says:—

Certified Milk.—The best grade of milk, and the one which should be used in feeding infants whenever possible, is known as "certified milk," and is produced under the direction of what is known as a "Milk Commission." The establishing of Milk Commissions in different cities throughout the country has been the means of securing a much better milk-supply than was formerly possible, and has doubtless been instrumental in saving many lives. To Dr H. L. Coit, of Newark, N.J., is due the credit of organising the first Milk Commission.

Certified milk must conform to certain standards as to its nutritional value, and as to the number of bacteria per cubic centimetre. These standards are established by a committee of medical men who compose the Milk Commission, and who have complete control of the dairy and its entire output.

The Milk Commission of the New York County Medical Society required a standard of milk not exceeding 30,000 bacteria in a cubic centimetre. When a dairyman has shown to the satisfaction of the commission that he can produce a milk up to the required standard, he is allowed to attach to his bottles of milk, labels furnished by the Commission certifying to that fact. Milk thus "certified" is taken from the delivery wagons from time to time and subjected to examination by their bacteriologist in order to determine whether it conforms to the requirements of the Commission. In order to show the care and supervision necessary for the production of certified milk, the requirements of the Milk Commission of the New York County Medical Society for the production of certified milk are given in full.[1]

"The most practicable standard for the estimation of cleanliness in the handling and care of milk is its relative freedom from bacteria. The Commission has tentatively fixed upon a maximum of 30,000 germs of all kinds per cubic centimetre of milk, which must not be exceeded in order to obtain the endorsement of the Commission. This standard must be attained solely by measures directed toward scrupulous cleanliness, proper cooling, and prompt delivery. The milk certified by the Commission must contain not less than four per cent. of butter fat on the average, and must possess all the other characteristics of pure, wholesome milk.

"In order that dealers who incur the expense and take the precautions necessary to furnish a truly clean and wholesome milk may have some suitable means of bringing these facts before the public, the Commission offers them the right to use caps on their milk-jars stamped with the words 'Certified by the New York County Medical Society Milk Commission.'

"*Rules for the Producer.*—1. The Barnyard.—The barnyard should be free from manure and well drained, so that it may not harbour stagnant water. The manure which collects each day should not be piled close to the barn, but should be taken several hundred feet away. If these rules are observed, not only will the barnyard be free from objectionable

[1] Chapin, *Infant Feeding.*

smell, which is always an injury to the milk, but the number of flies in summer will be considerably diminished. These flies, in themselves, are an element of danger; for they are fond of both filth and milk, and are liable to get into the milk after having soiled their bodies and legs in recently visited filth, thus carrying it into the milk. Flies also irritate cows, and by making them nervous, reduce the amount of their milk.

"2. The Stable.—In the stable, the principles of cleanliness must be strictly observed. The room in which the cows are milked should have no storage loft above it; where this is not feasible, the floor of the loft should be tight to prevent the sifting of dust into the stable beneath. The stable should be well ventilated, lighted, and drained, and should have tight floors, preferably of cement. They should be whitewashed inside at least twice a year, and the air should always be fresh and without bad odour. A sufficient number of lanterns should be provided to enable the necessary work to be properly done during dark hours. There should be an adequate water-supply, and the necessary wash-basins, soap, and towels. The manure should be removed from the stalls twice daily, except when the cows are outside in the fields the entire time between morning and afternoon milkings. The manure gutter must be kept in a sanitary condition, and all sweeping and cleaning must be finished at least twenty minutes before milking, so that at that time the air may be free from dust.

"3. Water-supply.—The whole premises used for dairy purposes, as well as the barn, must have a supply of water absolutely free from any danger of pollution with animal matter, sufficiently abundant for all purposes, and easy of access.

"4. The Cows.—The cows should be examined at least twice a year by a skilled veterinarian. Any animal suspected of being in bad health must be promptly removed from the herd and her milk rejected. Never add an animal to the herd until it has been tested for tuberculosis, and it is certain that it is free from disease. Do not allow the cows to be excited by hard driving, abuse, loud talking, or any unnecessary disturbance. Do not allow any strongly flavoured food, like garlic, which will affect the flavour of the milk, to be eaten by the cows.

"Groom the entire body of the cow daily. Before each milking wipe the udder with a clean, damp cloth, and, when necessary, wash it with soap and clean water, and wipe it dry

with a clean towel. Never leave the udder wet, and be sure that the water and towel used are clean. If the hair in the region of the udder is long and not easily kept clean, it should be clipped. The cows must not be allowed to lie down after being cleaned for milking until the milking is finished. A chain or rope must be stretched under the neck to prevent this.

"All milk from cows sixty days before and ten days after calving must be rejected.

"5. The Milkers.—The milker should be personally clean. He should neither have nor come in contact with any contagious disease while employed in milking or handling milk. In case of any such illness in the person or family of any employee in the dairy, such employee must absent himself from the dairy until a physician certifies that it is safe for him to return.

"Before milking, the hands should be thoroughly washed in warm water with soap and a nail-brush, and well dried with a clean towel. On no account should the hands be wet during the milking.

"The milking should be done regularly at the same hour morning and evening, and in a quiet, thorough manner. Light-coloured washable outer garments should be worn during milking. They should be clean and dry, and when not in use for this purpose should be kept in a clean place, protected from dust. Milking-stools must be kept clean. Iron stools, painted white, are recommended.

"6. Helpers other than Milkers.—All persons engaged in the stable and dairy should be reliable and intelligent. Children under twelve years should not be allowed in the stable during milking, since in their ignorance they may do harm, and from their liability to contagious diseases they are more apt than older persons to transmit them through the milk.

"7. Small Animals.—Cats and dogs must be excluded from the stable during the time of milking.

"8. The Milk.—The first few streams from each teat should be discarded, in order to free the milk-ducts from milk that has remained in them for some time, and in which bacteria are sure to have multiplied greatly. If, in any milking, a part of the milk is bloody or stringy, or unnatural in appearance, the whole quantity of milk yielded by that animal must be rejected. If any accident occurs by which the milk in a pail becomes dirty, do not try to remove the dirt by straining, but reject all the milk and cleanse the pail.

The milk-pails used should have an opening not exceeding eight inches in diameter.

"Remove the milk of each cow from the stable immediately after it is obtained to a clean room, and strain it through a sterilised strainer.

"The rapid cooling of milk is a matter of great importance. The milk should be cooled to 45° F. within an hour. Aeration of pure milk beyond that obtained in milking is unnecessary.

"All dairy utensils, including bottles, must be thoroughly cleansed and sterilised. This can be done by first thoroughly rinsing in warm water, then washing with a brush and soap or other alkaline cleansing material and hot water, and thoroughly rinsing. After this cleansing, they should be sterilised with boiling water or steam, and then kept inverted in a place free from dust.

"9. The Dairy.—The room or rooms where the bottles, milk-pails, strainers, and other utensils are cleaned and sterilised should be separated somewhat from the house, or, when this is impossible, have at least a separate entrance, and be used only for dairy purposes, so as to lessen the danger of transmitting through the milk contagious diseases which may occur in the home.

"Bottles, after filling, must be closed with sterilised discs and capped so as to keep all dirt and dust from the inner surface of the neck and mouth of the bottle.

"10. Examination of the Milk, and Dairy Inspection.—In order that the dealers and the Commission may be kept informed of the character of the milk, specimens taken at random from the day's supply must be sent weekly to the Research Laboratory of the Health Department, where examinations will be made by experts for the Commission, the Health Department having given the use of its laboratories for this purpose.

"The Commission reserves to itself the right to make inspections of certified farms at any time, and to take specimens of milk for examination. It also reserves the right to change its standards in any reasonable manner upon due notice being given the dealers."

Naturally, milk produced in this way is more expensive than when little or no care is used; more help is required, and help of a more expensive type. Certified milk, or its equivalent, is sold in New York city at prices ranging from twelve to eighteen cents a quart.

APPENDIX H

APPROXIMATE PERCENTAGE COMPOSITION OF GRUELS

(*H. D. Chapin, M.D., "Medical Record," 18th February 1905.*)

	Pearl Barley.		Barley Flour.		Wheat Flour.		Rolled Oats.	
	Protein.	Carbo-hydrate.	Protein.	Carbo-hydrate.	Protein.	Carbo-hydrate.	Protein.	Carbo-hydrate.
1 oz. to quart	0·14	1·34	0·195	2·093	0·331	2·161	0·262	1·669
2 ,, ,,	0·28	2·68	0·390	4·186	0·662	4·322	0·524	3·338
3 ,, ,,	...	...	0·585	6·279	0·993	6·483	0·786	5·007
4 ,, ,,	...	...	0·780	8·372	1·324	8·644	1·048	6·676
5 ,, ,,	...	...	0·975	10·465	1·655	10·805	1·310	8·345
6 ,, ,,	...	...	1·170	10·558	1·986	12·966	1·572	10·014
7 ,, ,,	...	...	1·365	14·651	2·317	15·127	1·834	11·683
8 ,, ,,	...	...	1·560	16·744	2·648	17·288	2·096	13·352

Plain gruels cannot be made much stronger than 2 ounces to the quart.
Dextrinised gruels may be made up to as high as 8 ounces to the quart.

APPENDIX I

THE COMPOSITION OF PROPRIETARY FOODS FOR INFANTS

The following analyses of foods for infants are taken from the book by Dr Robert Hutchison on "Food and the Principles of Dietetics."

He divides the foods into the following groups :—

"*Group* 1. Foods prepared from cow's milk, with various additions or alterations, and requiring the addition of water only to be ready for use.

"*Group* 2. The second group consists of farinaceous foods prepared from cereals (usually wheat), of which the starch has been partly or wholly transformed into soluble substances (dextrins or malt sugar), and which require the addition of milk to fit them for use. The group may be subdivided into two classes :—

Class (*a*). Those in which the starch has been transformed before reaching the consumer.

Class (*b*). Those which contain malt or pancreatic ferment, which convert the starch when the food is mixed.

"*Group* 3. The third group includes farinaceous foods in which the starch has not been predigested."

COMPOSITION OF INFANT FOODS.

Food.	Water.	Proteid.[1]	Fat.	Carbo-hydrate.	Mineral Matter.	General Description and Remarks.
Dried Human Milk.	...	*12·2*	*26·4*	*52·4*	*2·1*	*The standard of composition to which artificial substitutes should conform.*
GROUP I.						
Allenbury No. 1 (for children below 3 months)	5·7	9·7	14·0	66·85	3·75	Desiccated cow's milk, from which the excess of casein has been removed, and a certain proportion of soluble vegetable albumen, milk, sugar, and cream added. No starch present. ½ ounce in 3 ounces of water for a child of 3 months.
Allenbury No. 2 (for children of from 3 to 6 months)	3·9	9·2	12·3	72·1	3·50	Resembles the above, but contains some malted flour in addition. No starch present. 1 ounce in 6 of water for a child of 6 months.
Horlick's Malted Milk	3·7	13·8	3·0	76·8	2·70	A mixture of desiccated milk (50 per cent.), wheat flour (26¼ per cent.), barley malt (23 per cent.), and bicarbonate of soda (¾ per cent.). Contains no unaltered starch when mixed. 3 teaspoonfuls (=22 grammes) in 4 ounces of water for a child of 3 months.

Carnrick's Soluble Food	5·5	13·6	2·5	76·2	2·20	A mixture of desiccated milk (37½ per cent.), malted wheat flour (37½ per cent.), and milk-sugar (25 per cent.). When prepared according to directions, the casein is partially digested, but a considerable amount of unchanged starch is left. 1 part to be mixed with 9 of water and boiled for a few minutes.
Nestlé's Milk Food	5·5	11·0	4·8	77·4	1·30	A mixture of desiccated Swiss milk, baked wheat flour, and cane sugar (30 per cent.). More than a third of the total amount of carbohydrate is in the form of starch. 1 ounce to be mixed with 5 ounces of water.
Manhu Infant Food	8·8	8·7	5·6	75·9	1·0	A mixture of desiccated milk and malted cereals. When prepared according to directions, contains a good deal of unaltered starch. A dessert-spoonful (=13 grammes) to be mixed with 2½ ounces of water.
GROUP II.						
Class A.						
Mellin's Food	6·3	7·9	trace	82·0	3·8	A completely malted food. All the carbohydrate in a soluble form. May be regarded as a desiccated malt extract. ½ tablespoonful (about 5 grammes), ¼ pint milk, and ¼ pint water for a child under 3 months.

[1] Calculated from total N by factor 5·7.

COMPOSITION OF INFANT FOODS—*continued.*

Food.	Water.	Proteid.	Fat.	Carbo-hydrate.	Mineral Matter.	General Description and Remarks.
Class B.						
Savory & Moore's Food	4·5	10·3	1·4	83·2	0·6	Composed of wheat flour, with the addition of malt. When prepared according to the directions, most, but not all, of the starch is converted into soluble forms (chiefly dextrins). 1 or 2 tablespoonfuls (=1 to 2 ounces) to be mixed with 2 or 3 tablespoonfuls of cold milk, or milk and water, and ⅓ pint of boiling milk, or milk and water, added.
Benger's Food	8·3	10·2	1·2	79·5	0·8	A mixture of wheat flour and pancreatic extract. When prepared according to the directions, most, but not all, of the starch is converted into soluble forms. The proteid is also partially digested, as well as that of the milk used in mixing it. Take 1 tablespoonful (about an ounce) and 4 of cold milk, then add ½ pint of boiling milk and water; set aside in a warm place for fifteen minutes, then bring to the boil.

Allenbury Malted Food	6·5	9·2	1·0	82·8	0·5	A mixture of wheat flour and malt. When prepared according to the directions, still contains some unaltered starch. Designed for children above 6 months. 1 tablespoonful (about an ounce), 1 teaspoonful of sugar, and 3 tablespoonfuls cold water; mix and add ½ pint boiling milk and water (equal parts).
Diastased Farina	8·3	8·3	1·3	81·0	1·1	A malted farinaceous food. When prepared according to the directions, practically all the starch is converted into soluble forms. 1 ounce of food, ½ pint of cold milk, and 2 ounces water. Heat slowly till it boils; boil three minutes and sweeten if desired.
Coomb's Malted Food	7·9	12·1	2·8	76·8	0·4	A malted farinaceous food. When prepared according to the directions, still contains much unaltered starch.
Nutroa Food	6·8	15·9	10·3	66·0	1·0	A mixture of cereals with the addition of a certain proportion of peanut flour, from which the somewhat bitter taste of the food and its high proportion of fat are derived. It is a self-digesting food, but when prepared according to the directions only part of the starch is converted. 1 ounce of the food to be mixed with 1 ounce of cold water, and ½ pint boiling milk and water (equal parts) to be added.

COMPOSITION OF INFANT FOODS—*continued.*

Food.	Water.	Proteid.	Fat.	Carbo-hydrate.	Mineral Matter.	General Description and Remarks.
Albany Food	8·6	9·5	2·1	79·4	0·4	A self-digesting farinaceous food for infants and invalids. To be used with equal parts of milk and water according to directions. Starch not all changed.
Worth's Perfect Food	2·4	11·1	2·0	83·5	0·5	A tablespoonful to be mixed with ½ pint of cold milk or milk and water, and boiled five or ten minutes. When prepared according to directions, still contains unaltered starch.
GROUP III.						
Ridge's Food	7·9	9·2	1·0	81·2	0·7	A baked flour, containing only 3 per cent. of soluble carbohydrates, the remainder being starch. Recommended to be made with milk *or* water. Made with water alone is not a sufficient food.
Neave's Food	6·5	10·5	1·0	80·4	1·6	Resembles the above, but recommended to be made with milk and water.
Frame Food Diet	5·0	13·4	1·2	79·4	1·0	A thoroughly baked flour, to which has been added cane sugar and some extract of bran. It is *not* specially rich in mineral ingredients, but nitrogenous matters are abundant, and it contains much unaltered starch. ½ ounce to be mixed with a breakfast-cupful of milk and water (1 of milk to 2 of water).

Opmus Food	10·9	9·1	1·0	78·6	0·4	A granulated wheat food. 1 teaspoonful to ½ pint of milk. Starch unaltered.
Falona	7·0	8·4	3·5	79·9	1·2	A mixture of cereals (oats, barley, and wheat) with a ground, fat-containing bean. The food is thoroughly baked, but contains a considerable proportion of unaltered starch. A teaspoonful to ½ pint of boiling milk *or* water, or half milk and half water.
Robinson's Groats	10·4	11·3	1·6	75·0	1·7	Ground oats from which husk has been removed. Rich in proteid and mineral matter.
Robinson's Patent Barley	10·1	5·1	0·9	82·0	1·9	Ground pearl barley, and of the same nutritive value as the latter.
Chapman's Whole Flour	8·4	9·4	2·0	79·3	0·9	A finely ground whole-wheat flour. Not much superior in nutritive value to ordinary "household" flour. Starch entirely unaltered.
Scott's Oat Flour	5·8	9·7	5·0	78·2	1·3	A fine oat flour. Starch unaltered.
Nichol's Food of Health	11·9	7·7	1·7	76·9	1·75	To be used with equal quantities of boiling milk and water for making infant gruel.
Triticumina Food	8·6	12·5	2·2	75·7	1·0	To be made with equal parts of milk and water, with the addition of sugar.
"I and I" Food	5·5	10·3	2·3	80·5	1·4	An infants' and invalids' food. To be made with water only, or half and half water and milk, and sweetened to taste.
Muffler's Food	4·7	13·8	5·0	74·1	2·4	Prepared from milk, wheat flour, and eggs; sterilised *in vacuo*. To be used with water or milk.

APPENDIX J

THE VALUE OF THE TUBERCULIN TEST IN CATTLE

THERE has recently been issued from the Hygienic Laboratory of the Public Health and Marine-Hospital Service of the United States a most valuable compendium by various authors entitled *Milk, and its Relation to the Public Health.*

In it there appears a paper on "Conditions and Diseases of the Cow injuriously affecting the Milk," by John R. Mohler, A.M., V.M.D., Chief of the Pathological Division, Bureau of Animal Industry, and from it I quote the following :—

VALUE OF THE TUBERCULIN TEST

The symptoms of tuberculosis in cattle are not sufficiently prominent except in advanced stages, or when superficially located, to enable one to diagnose this disease by the ordinary methods of physical examination. And cattle may, without showing any clinical symptoms, be in such a stage of tuberculosis as to render them capable of spreading disease. Indeed an animal may be fat and sleek, eat and milk well, have a bright, glossy coat, and be apparently in the pink of condition, and still be passing tubercle bacilli through the fæces or by an occasional cough, and thus endanger all the healthy cattle in the herd. Consequently, such adventitious aids to diagnosis as animal inoculation, biological test, serum agglutination reaction, and the tuberculin test, are made use of in arriving at a definite opinion relative to the presence or absence of this disease. The value of all but the last of these is discounted by the technique required and their impracticability, while the tuberculin test is most satisfactory, and is the best diagnostic agent known for the disease.

Tuberculin was invented by Koch in 1890, and was first used experimentally in treating tuberculosis in man. In these cases it was observed that its injection was followed by a rise of temperature, which led veterinarians to apply tuberculin to suspected animals to see if a similar reaction resulted. Numerous experiments showed this to be the case, and since 1891 the use of tuberculin as a diagnostic agent for tuberculosis of cattle has been almost universally adopted in all parts of the civilised world. No one thinks of accepting tuberculin as an absolutely infallible agent. but it is immeasurably more dependable than any other method that has ever been used.

Tuberculin is the sterilised and filtered glycerin extract of cultures of tubercle bacilli. It contains the cooked products of the growth of these bacilli, but not the bacilli themselves. Consequently, when this substance is injected under the skin of an animal it is absolutely unable to produce the disease, cause abortion, or otherwise injure the animal. In case the injected animal is normal there is no more effect upon the system than would be expected from the injection of sterile water. However, if the animal is tuberculous, a decided rise of temperature will follow the use of tuberculin. In practice the tuberculin test is applied by first taking a sufficient number of temperatures at intervals of two hours to ascertain the normal variation of temperature of the animal to be tested. The tuberculin is then injected hypodermically between 8 and 10 p.m. on the day of taking the preliminary temperatures. On the following day the "after" temperatures are recorded every two hours, beginning at 6 a.m., and continuing until twenty hours following the injection. As a result of this method an accurate diagnosis may be established in over 97 per cent. of the cases tested. The relatively few failures in diagnosis are included among two classes of cattle. The first class contains those that are tuberculous, but which do not react, either because of the slight effect of an ordinary-sized dose of tuberculin on an advanced case of the disease with so much natural tuberculin already in the system, or on account of a recent previous test with tuberculin which produces a tolerance to this material lasting for about six weeks. The second class includes those that are not tuberculous, but which show an elevation of temperature as a result of (*a*) advanced pregnancy ; (*b*) the excitement of œstrum ; (*c*) concurrent diseases,

as inflammation of the lungs, intestines, uterus, udder, or other parts, abortion, retention of after-birth, indigestion, etc.; (*d*) inclosure in a hot, stuffy stable, especially in summer, or exposure to cold draughts or rains; (*e*) any change in the method of feeding, watering, or stabling of the animal during the test. Notwithstanding all these possibilities of error, the results of thousands of tests show that in less than 3 per cent. of the cases tested do these failures actually occur. In class one the chances of error are decidedly reduced by the skilled veterinarian by making careful physical examination and diagnosing clinically these advanced cases, and by the injection of double or triple doses into all recently tested cattle, with the taking of the after-temperatures, beginning two hours following the injection and continuing hourly for twenty hours. In class two, errors are avoided by eliminating those cases from the test that are nearing parturition or are in heat, or show evidence of the previously mentioned diseases, or exhibit temperatures sufficiently high to make them unreliable for use as normal. Then, in reading after-temperatures, it is advisable not to recognise as a reaction an elevation of temperature less than 2° Fahrenheit, and which at the same time must go above 103·8° F., and the temperature reaction must likewise have the characteristic rainbow curve. (Those cases which approximate but do not reach this standard should be considered as suspicious, and held for a re-test six weeks later.) In addition, a satisfactory tuberculin must be used, also an accurate thermometer and a reliable syringe, in order that a sufficient dose of tuberculin may be given. Finally, the number of apparent errors of the tuberculin test will be greatly diminished if a careful *post-mortem* examination is made, giving especial attention to the lymph glands. This low percentage of failures being the case, cattle-owners should welcome the tuberculin test, not only for their own interest, but for the welfare of the public as well. Where this method of diagnosing the disease has been adopted, tuberculosis is gradually being eradicated, while it is spreading rapidly and becoming widely disseminated in those districts where the tuberculin test has not been employed. Without its use the disease cannot be controlled, and the cattle-owner is confronted with serious and continuous losses; with its use the disease can be eradicated from the herd, a clean herd established, and the danger of its spread to man removed. Tuberculin may

therefore be considered a most beneficial discovery for the stock-raiser. Strange to say, many of these men have been incredulous, antagonistic, or prejudiced against the tuberculin test by misinterpreting published statements, by incorrect, unsubstantiated, or exaggerated reports, and by alleged injurious effects to healthy cattle.

Law has clearly stated the question when he says :—

"Many stock-owners still entertain an ignorant and unwarranted dread of the tuberculin test. It is true that when recklessly used by ignorant and careless people it may be made a root of evil, yet, as employed by the intelligent and careful expert, it is not only perfectly safe, but it is the only known means of ascertaining approximately the actual number affected in a given herd. In most infected herds, living under what are in other respects good hygienic conditions, two-thirds or three-fourths are not to be detected without its aid, so that in clearing a herd from tuberculosis, and placing both herd and products above suspicion, the test becomes essential. . . . In skilled hands the tuberculin test will show at least nine-tenths of all cases of tuberculosis when other methods of diagnosis will not detect one-tenth."

It is perfectly natural that there should be objection to its use among those who are not acquainted with its method of preparation or its properties, but it is difficult to explain the antagonism of farmers who are familiar with the facts connected with the manufacture and use of tuberculin. Probably the most popular objection to tuberculin is that it is too searching, since it discovers cases in which the lesions are small and obscure. While this fact is admitted, it should also be borne in mind that such a small lesion to-day may break down and become widely disseminated in a relatively short period. Therefore any cow affected with tuberculosis, even to a slight degree, must be considered as dangerous, not only to the other animals in the herd, but also to the consumer of her products. Furthermore, tuberculin must be considered as harmless for healthy animals in view of the results revealed by numerous tests, covering vast numbers of animals. And it has also been clearly demonstrated that tuberculin interferes in no way with the milking function in healthy cattle ; neither in the quantity of milk nor in butter-fat value has any variation been detected.

Nocard and Leclainche state :—

"Direct experiments and observations collected by

thousands show that the tuberculin injections have no unfavourable effect. With healthy animals the system is indifferent to the inoculation; with tuberculous animals it causes only slight changes, which are not at all serious."

Most of the objections to tuberculin would probably be removed if some method of compensation for the reacting animals could be devised. Thus, in Pennsylvania, where tuberculosis is being eradicated with more success than in any other State, and where there are usually three times as many voluntary requests on file for the application of the test as can be made, all reacting animals are paid for by the State. As the suppression of tuberculosis is a public health measure, it would appear perfectly logical for the State governments to appropriately reimburse cattle-owners for the animals condemned and slaughtered.

Provision could be made to pay 70 per cent. of the appraised value of the condemned animals, not to exceed $30 per head for common stock, or $60 for registered stock. Such legislation should also include a requirement for the testing of all cattle coming into the State.

All tuberculous animals should be slaughtered in abattoirs having Federal inspection, and the money obtained from carcasses which are inspected and passed for food, and from the hide and offal of those carcasses condemned as unfit for food, should be applied as part-payment on the indemnity for their respective owners. The payment of indemnity for tuberculous animals is a good business policy, and would do more toward making the tuberculin test popular with cattle-owners than any other possible action. And as a corollary of the latter, more testing would be performed, and more tuberculous cattle would be discovered at the start, but the gradual suppression of the disease would soon be manifest, as has been noted in Pennsylvania and Denmark. Furthermore, as Stiles has mentioned, if tuberculosis can be eradicated from dairy herds with but slight loss to the owner, the increase in the price of milk would naturally be inhibited, and the children of poor families would consequently be in less danger of having this very important article of their diet decreased.

As a result of the careful study of the tuberculin test, Salmon draws the following conclusions:—

1. That the tuberculin test is a wonderfully accurate method of determining whether an animal is affected with tuberculosis.

(2) That by the use of tuberculin the animals diseased with tuberculosis may be detected and removed from the herd, thereby eradicating the disease.

(3) That tuberculin has no injurious effect upon healthy cattle.

(4) That the comparatively small number of cattle which have aborted, suffered in health, or fallen off in condition after the tuberculin test, were either diseased before the test was made, or were affected by some cause other than the tuberculin.

APPENDIX K

THE PERCENTAGE COMPOSITION OF EDINBURGH MILKS

(By the Author.)

From "The Edinburgh Medical Journal," September 1908.

THE "percentage" system of feeding infants has in recent years developed so many intricacies, and become, withal, professedly a system of such accuracy, that it has seemed to me interesting to observe to what extent accuracy is readily obtainable in everyday routine practice in Edinburgh, and to note if some simple standard can be obtained.

To this end I have examined a sample of the morning milk (obtained at 10 a.m. to 11 a.m.) and a sample of the evening milk (obtained about 5 P.M.) from twenty-five of the more outstanding dairies in Edinburgh and Leith. The amount of fat in this milk I have estimated by the method of Gerber—which consists in reading the volume of fat brought into the graduated neck of a bottle by centrifuging, after dissolving everything in the milk but fat by strong sulphuric acid, with the addition of a little amyl alcohol to help the fat to separate. The amount of solids other than fat was calculated from the specific gravity and the amount of fat.

The following results were obtained :—

	Morning Milk.		Evening Milk.	
	Fat.	Solids not Fat.	Fat.	Solids not Fat.
1.	2·2 per cent.	8·83 per cent.	4·4 per cent.	7·39 per cent.
2.	4·0 ,,	8·44 ,,	6·2 ,,	7·38 ,,
3.	2·2 ,,	8·08 ,,	3·3 ,,	7·55 ,,
4.	3·3 ,,	8·30 ,,	3·9 ,,	7·92 ,,
5.	3·3 ,,	7·80 ,,	4·5 ,,	10·89 ,,
6.	3·0 ,,	8·24 ,,	5·3 ,,	10·95 ,,
7.	3·7 ,,	9·13 ,,	3·5 ,,	9·84 ,,
8.	2·5 ,,	8·89 ,,	3·7 ,,	9·63 ,,
9.	3·4 ,,	8·32 ,,	2·7 ,,	10·68 ,,
10.	3·1 ,,	8·26 ,,	3·6 ,,	9·86 ,,
11.	2·7 ,,	8·18 ,,	4·4 ,,	10·26 ,,
12.	3·6 ,,	8·61 ,,	2·7 ,,	10·68 ,,
13.	3·3 ,,	9·05 ,,	3·9 ,,	9·42 ,,
14.	3·6 ,,	7·86 ,,	3·6 ,,	8·36 ,,
15.	5·0 ,,	8·64 ,,	3·2 ,,	8·78 ,,
16.	3·5 ,,	8·34 ,,	3·5 ,,	8·34 ,,
17.	4·7 ,,	8·44 ,,	4·5 ,,	8·29 ,,
18.	2·7 ,,	8·68 ,,	3·4 ,,	7·82 ,,
19.	3·7 ,,	8·38 ,,	3·4 ,,	7·82 ,,
20.	3·4 ,,	8·82 ,,	3·8 ,,	9·90 ,,
21.	2·8 ,,	8·45 ,,	3·5 ,,	8·09 ,,
22.	1·9 ,,	7·52 ,,	3·2 ,,	9·53 ,,
23.	1·8 ,,	6·25 ,,	3·4 ,,	9·07 ,,
24.	3·2 ,,	8·53 ,,	3·9 ,,	9·40 ,,
25.	2·8 ,,	8·45 ,,	4·4 ,,	8·02 ,,
Average	3·2 ,,	8·34 ,,	3·84 ,,	9·0 ,,

Average over all—Fat, 3·5 per cent. ; Solids not fat, 8·7 per cent.

From these figures it is at once apparent that the variations in the percentage amounts of fat and of solids not fat are considerable. Milk bought in the evening is, as a rule, richer than that which is bought in the morning.

The percentage amount of fat was in one case as low as 1·8 per cent., and in one case as high as 6·2 per cent., while the amount of the solids other than fat varied from 6·25 per cent. to 10·95 per cent.

It is consequently not readily practicable to estimate accurately the constituent value of any given milk.

As regards a simple standard which may be of practical utility, I think that such may be obtained by calculating the daily milk from a good Edinburgh dairy

to contain 4 per cent. fat, 4 per cent. protein, and 4 per cent. sugar.

This calculation is obviously incorrect, but the value of it is, that by employing it we know—speaking generally—what our error is.

As an accurate standard is a sheer impossibility, mathematical minutiæ are entirely out of place.

The amount of sugar in cow's milk has by all observers been noted as very constant at rather over 4 per cent.

The average of my figures reads—fat, 3·5 per cent., solids not fat, 8·7 per cent.; and by accepting the formula, fat 4 per cent., protein 4 per cent., sugar 4 per cent., we know that, as a rule, we are calculating upon rather too much fat and rather too little sugar in the milk.

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