The infant: nutrition and management / by Eric Pritchard.

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PREFACE

This little volume is founded on a series of lectures which, from time to time, I have given to students attending at courses held by the Queen's Hospital for Children, the Medical Graduates' College and Polyclinic, the National Association for the Prevention of Infant Mortality, and other medical societies. Some of these lectures have already been published in part, or in whole, in medical journals, and for permission to republish I have to thank the editors of *The Lancet*, *The Practitioner*, *The Medical Press and Record*, *The Clinical Journal*, *The American Practitioner*, *American Medicine*, *Pediatrics*, *Archives of Pediatrics*, and *The British Journal of Children's Diseases*.

In preparing these lectures in book form, it has been necessary to edit somewhat freely, for the same ideas recur over and over again in different lectures. Even in their revised form I am afraid there is some repetition; this is owing to the fact that I deal more with general principles than with details, and these principles apply, with slight varia-

tions, to a large number of different conditions in connection with which they are here employed.

Those who read this little book in the expectation of finding a full description of the methods of feeding infants will be disappointed, for according to the views herein set forth each case must be regarded as an individual problem which is to be solved by the practical application of certain general principles.

I believe one of the chief reasons why fixed methods of feeding babies so often fail is because the manner in which any particular baby responds to any particular line of treatment depends more on its past experiences than on any other factor, and each infant has its own past.

This work is not intended to take the place of more ambitious textbooks or handbooks on the subject of infant management ; it contains views which, in many cases, are still regarded as unorthodox and revolutionary. Tradition and authority have, however, so narrowly circumscribed our methods in the past, and one book has so closely followed on the lines dictated by those which have preceded it, that a little breaking away from precedent, even if it is not in all cases an improvement, may perhaps broaden our ideas.

E. P.

Harley Street, W.,
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THE INFANT

CHAPTER I

The Establishment of Lactation and the Management of Breast-Feeding

If one tithe of the human ingenuity, which of recent years has been lavished on the artificial method, had been bestowed on studying improvements in the breast-feeding of infants, I believe that comparatively few infants would even now, in these so-called degenerate days, be relegated to the bottle.

It is most gratifying to me personally, in view of the efforts I have made to extend the educational influences of infant consultations, to realize that many of the improvements in the natural method of feeding infants which have been introduced of late years, are directly due to the energies of those who are engaged in this particular branch of preventive medicine.

In this connection I would more particularly refer to the work of Dr. Ronald Carter[1] in Kensington,

[1] "Breast-Feeding and the Value of the Test-Feed," *The Lancet*, September 2, 1911.

of Dr. Jessie G. Duncan[1] in Birmingham, of Dr. Ella Webb[2] in Dublin, and of Drs. A. E. Naish and Lucy Naish[3] in Sheffield.

Unfortunately, at our infant consultations we gain more experience in the general management of breast-feeding than we acquire of that most important phase known as the "establishment of lactation," for we are seldom called upon to advise on the care of infants under three weeks of age.

The obstetric physician, who has unrivalled opportunities for studying the early phases of lactation, is as a rule too closely concerned with the interests of the mother to pay much regard to those of the infant, or to the practical details connected with the establishment of the milk flow. On the other hand, the children's specialist is seldom consulted until breast-feeding has already proved a failure, or until the infant has been weaned and relegated to the bottle. The consequence is that the study of this important stage of breast-feeding falls between two stools—between the apathy of the obstetrician and the want of opportunity on the part of the children's specialist.

[1] Report on Infant Mortality in St. George's and St. Stephen's Wards. Birmingham, 1913. Printers: Hudson and Son.

[2] "Breast-Feeding of Infants," *Medical Press and Circular*, July 2, 1913.

[3] "Breast-Feeding: Its Management and Mismanagement," *The Lancet*, June 14, 1913, p. 1657.

One of the great difficulties with which those who are interested in the problems of infant mortality have to contend is the early and unnecessary weaning of quite young infants. Dr. Ella Webb, to whose work in Dublin I have already referred, has published an analysis of the causes of premature weaning of 200 infants who were brought to her infant consultations. The following is a résumé of her results:

	Cases.
1. Insufficient milk	93
2. Illness of the mother	35
3. Disagreement of milk with infant	22
4. Sore breasts	16
5. Mother going out to work	13
6. Advised by nurse or friend to wean	8
7. Child refusing breast	5
8. Death of mother	6
9. Hare-lip	1
10. Accidental illness of child causing great fatigue to the mother through watchful nights	1
Total	200

I find that my own experience closely coincides with that of Dr. Webb, except for the fact that I meet with fewer instances of illness in the mother and more cases in which the milk is said to have disagreed with the infant. I should also have to include a larger number of cases in Group 6.

Unfortunately Dr. Webb does not tell us at what dates these infants were taken off the breast. Speaking from my own experience, I find that of all

cases of early weaning no less than 33 per cent. are deprived of the breast during the puerperium, a proportion which in my opinion can be justified by no possible combination of circumstances.

A very large number of infants are weaned during the first three weeks of life owing to the advice of doctors, nurses, and friends, on very slender evidence that the breast itself is at fault. Troubles there often are connected with the establishment of the motor and digestive functions of the stomach and bowel in infants, which may make it appear that the milk is responsible; but exactly the same troubles, only in an aggravated form, may ensue when resort is made to artificial feeding.

It is quite impossible to determine at first whether a young mother—and more particularly a primipara —will eventually prove a good nurse or not. I have known many most unpromising cases turn out complete successes after a few weeks of patient effort.

During the puerperal period we must be prepared for accidents in connection with the establishment of lactation; but, because our first efforts are not successful, we are not necessarily justified in relinquishing all further attempts to keep the infant at the breast.

The nervous and glandular mechanisms concerned in the secretion of milk are extremely complicated, and most of the difficulties which arise in connection with breast-feeding are concerned with setting the

machinery as a whole in motion. I believe that it is never justifiable to wean an infant during the first three weeks of life simply on the ground that the breast remains dry. I have known many instances in which the breasts have remained refractory for three weeks or longer, and then have afforded satisfactory supplies of milk. The following experience illustrates this point:

A primipara was confined at full time in a maternity institution. The infant was perfectly healthy, and was put regularly to the breast for the first three days. On the fourth day as no milk appeared in the breast, the baby was given cow's milk in a bottle, and was permanently weaned on the seventh day. Contrary to instruction, however, the mother secretly put the infant to the breast at night in the hope that the milk might come at a later date, and that the inconveniences of a second pregnancy might thereby be averted. On the fourteenth day the mother left the institution and returned to her home still feeding the infant during the day on the bottle, and giving it the breast at night. When the infant was ten weeks old, the mother brought it to my infant consultations, and gave me the details as already described. On examining the baby, I found it much under weight, and in a very poor condition of nutrition. On further inquiry I elicited the fact that, although the mother put the infant to the breast at night with

the object already stated, she was under no delusions that the infant derived any benefit from the proceeding, or that her breast contained any milk. Feeling convinced, however, that the infant would not acquiesce in the conspiracy unless it received some reward for its efforts, I examined the mother's breasts, and found, as I expected, that both contained a small quantity of milk. So I straightway ordered a test-feed to be given, and much to the mother's surprise, demonstrated the fact that the baby extracted 3½ ounces of milk. In consequence of this discovery, I ordered the infant to continue at the breast, and with the exercise of a little care and encouragement, succeeded in postponing artificial feeding until the end of the seventh month.

I have little doubt that a large proportion of the cases which are relegated at an early date to the bottle might be saved from the dangers incidental to this proceeding by the exercise of the same degree of patience as that which was displayed, in a less worthy cause, by this poor woman.

The following are the particulars of another case which illustrates the value of patience in bringing about a satisfactory secretion of milk under most unpromising circumstances:

A woman was confined of her first baby on January 4, 1907, at a maternity hospital. The infant weighed 7 pounds 10 ounces, and was quite healthy at birth. During the twelve days the mother stayed

at the hospital, the infant was put regularly to the breast, and nothing was noticed amiss with him except that there was obstinate constipation. On January 17 the baby was brought to my infant consultations, chiefly because of this symptom, and also because he was losing weight. On being placed on the scales, he was found to have lost 10 ounces since birth. Owing to the loss of weight, constipation, and oliguria, I thought it was extremely likely that the infant was suffering from inanition. So I ordered a test-feed, and found that the quantity of milk which the infant extracted from the breast was only a few teaspoonfuls. I therefore ordered a small quantity of whey and cream to be given to the infant in addition to the breast, hoping that by keeping the infant hungry and allowing him also to apply stimulus to the breast, the latter would ultimately become functionally active. During the following week the infant showed unmistakable signs of improvement in his general condition, but repeated test-feeds proved that this result was not due to any increase in the quantity of the breast-milk.

During this week the child recovered 6 ounces of the weight he had previously lost. On January 28 the infant was again weighed and found to have gained 8 ounces in weight, although the test-feeds still proved that the breasts were nearly dry. By February 4 there was a further gain in weight, and

every indication that the glands were beginning to secrete normally. By February 6 the mother felt "the draught" when the child was put to the breast, and from that time forward it was possible to remit the artificial feedings, and the infant made uninterrupted progress on the breast. The points of interest in this case are—Firstly, that it was practically one month before lactation was fully established, and that during the last fortnight the infant was kept in a good condition of nutrition by very small quantities of artificial food (6 ounces of whey and cream in the twenty-four hours). The second point of interest is that the cause of inanition from which the infant was suffering was not detected in the maternity institute in which the infant was born, although the baby presented all the classical symptoms of starvation—*i.e.*, constipation, loss of weight, and oliguria.

Although I shall again refer to these points in greater detail, I would at the outstart emphasize the fact that the establishment of lactation is dependent on the fulfilment of the following conditions: Firstly, the nipple must be stimulated by the sucking of the infant; secondly, the nerve centres which control the functions of secretion and the vascular supply must be in a condition of adequate excitability; and, thirdly, the blood itself must contain a sufficiency of the raw material out of which the mammary secretion can be elaborated.

On purely hypothetical grounds we should naturally assume that the stimulus afforded by the sucking of the infant itself would be more effective in bringing about the reflex activity of the glands than any other form of excitation; it is, however, satisfactory to know that this theoretical assumption has been substantiated by the practical observations of Dr. Jessie G. Duncan.[1] In a series of experiments carried out in Birmingham, Dr. Duncan was able to prove that the amount of milk which the pump was capable of extracting from the breast was in all cases considerably less than that which was obtained by the natural efforts of the infant.

Further, we have ample evidence from the experiences of the late Pierre Budin[2] that the total quantity of milk secreted by a nursing-woman is directly proportional to the intensity of the stimulus applied. A weakling baby, with feeble powers of sucking, extracts only a small quantity of milk, whereas a strong, lusty baby secures as a rule a good meal. In his book, *The Nursling*, he supplies the protocols of the actual amounts of milk supplied by a number of wet-nurses employed in his clinics. Some of the women acted as foster-mothers to two, three, four, or more infants, and the tables show that the greater the demand the greater was

[1] Report on Infant Mortality. Birmingham, 1913. Printers: Hudson and Son.

[2] *The Nursling*, Pierre Budin. English translation, first edition, p. 37.

the supply. In certain cases of multiple feeding the total amount of milk supplied to the infants in twenty-four hours was surprisingly large.

The intensity of the stimulus afforded by the infant will naturally depend on a variety of conditions—for instance, on the strength of the infant, and its degree of hunger; also on the shape of the nipple and the sensibility of its tactile nerve-endings.

An appreciation of these facts will necessarily suggest a number of practical expedients to promote the activity of the secretory apparatus. For instance, in anticipation of possible difficulties in nursing, the nipples should be drawn out and prepared for their duties for some considerable time before the date of the expected confinement. This is particularly desirable in the case of the primipara. The best method of drawing out the nipples is to invert over them the bowl of a long-stemmed clay pipe (churchwarden), and then to induce a vacuum by means of suction applied to the mouthpiece. The patient can easily carry out this devise for herself, and she should be instructed to commence doing so for some weeks before the confinement. The rim of the bowl should be well greased with vaseline in order that it may adhere to the surface of the skin, and enable a good vacuum to be produced. It may here be mentioned that quite probably the chief cause of depressed nipples is a pre-existing mastitis, in some cases caused by the

so-called "*dispersion*" of the milk in new-born infants by massage or other improper treatment. The usual plan of hardening and preparing the nipples by treating them with astringents is not to be recommended, for such applications not only dull the sensibility of the tactile sense, but they also tend at a later date to indurate the tissues and to produce cracks and fissures of the epidermis, especially if the infant is rough in its method of seizing the nipple. The indications are not so much to render the superficial epithelium hard and cornified as to make it thoroughly supple and elastic, and to accustom it to the sort of treatment to which it will be exposed when the infant is put to the breast. The best means of preparing the surface of the nipple is to massage it daily with lanoline or some other emollient. It is further desirable to remove all crusts from the surface of the nipples, for such crusts not only tend to form if there is any oozing of secretion towards the end of pregnancy, but after removal by the lips of the infant they leave the underlying epithelium tender and liable to maceration. All these are small matters, but from the point of view of successful nursing they are not without their importance. It is, of course, needless to say that at the end of each feeding the nipples should be most carefully cleaned with boracic lotion, which should be applied with cotton-wool, and that they should be subsequently

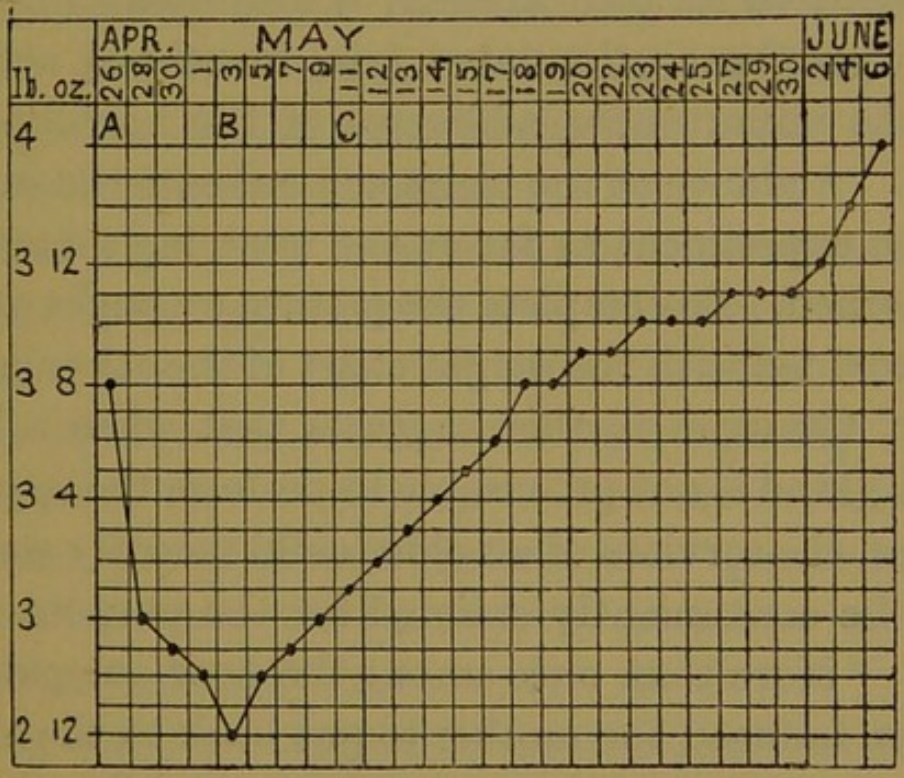
thoroughly dried with lint or some other soft material.

In order that the infant may apply adequate stimulation to the nipple, it is necessary that it should itself be actuated by the most potent of all incentives—namely, by hunger and thirst. For this reason the humane instincts of doctor and nurse to relieve the supposed wants of the infants by potations of water or other fluids should be sternly resisted. It not infrequently happens, however, that despite our best endeavours, the infant will not apply the desired stimulus to the breast.

Under such conditions we must be prepared to resort to other expedients, and to coax the infant to play its part in the establishment of the mammary functions. Sometimes the smearing of the nipples with a little glycerine, honey, or even condensed milk, may tempt the infant to apply his lips; at other times a temporary exchange of babies may effect the desired object. Unfortunately, it is not always possible to find, at the required moment, a baby to perform the function of an artificial pump, and considerations of possible infection with syphilis or other disease may damp our ardour, for no one would willingly accept responsibilities of this kind unless the need is commensurate with the risks. In maternity wards, however, there is usually one infant at least which can safely be employed for this purpose, and by employing one in this way a double

purpose is served—the dry breasts of the woman who cannot nurse are stimulated into activity, and the weakly baby can be nourished into life by being placed at the active breast of the other mother.

Dr. H. C. Cameron[1] describes an interesting case in which such a substitution was effected with the most happy results. The accompanying chart



represents the weight curve of a premature infant, which was born in Guy's Hospital, and fed by an accommodating foster-mother in the manner described.

On the eighth day of life the weight of the baby had fallen 14 ounces, and it was obvious that it would soon die if not provided with some better

[1] H. C. Cameron, *The Lancet*, September 27, 1913, p. 911.

form of nourishment than that supplied by the mother. The woman in the next bed happened to have a vigorous baby fourteen days old, and weighing 8 pounds, and as she consented for the time being to play the part of foster-mother to the premature infant, an exchange of babies was immediately effected. Eight days later the premature baby was returned to its own mother, whose breasts by this time had been stimulated into functional activity by the importunate addresses of the borrowed infant. A glance at the chart will indicate the success of the experiment as far as the weakling infant was concerned. To complete the picture we ought also to be provided with the weight chart of the other infant.

Dr. Cameron further suggests that when a baby of this kind is not procurable to perform the required duties, the services of an older child recently weaned may be conveniently enlisted for the purpose. He says: "More than once among the poor out-patients I have induced the mother to put back to the breast a child which has been recently weaned."

Opportunities to employ this ingenious expedient must be comparatively rare, for women seldom nurse their infants during pregnancy, and therefore can seldom have a recently weaned child at hand when the next one is born. In this connection it may be mentioned that cows usually supply excellent milk almost up to the date of arrival of the next calf.

The physiological activity of the mammary glands

is dependent on a very complicated nervous mechanism, in which mental and psychological factors are closely concerned in addition to the direct centripetal influences. It would be difficult to define accurately the origins or paths of these mental impressions which reinforce the effect of the direct reflex stimulus. We know, however, that emotions and emotional states can sensitize or activate local nerve centres, so that otherwise subnormal stimuli reaching them through the direct reflex route, can cause normal or even exaggerated results.

There is a very close relationship between the specific secretory functions of a gland and the vascular supply. The two sets of centres, in fact, act as if they were in anatomical continuity. The influence of the emotions on the vaso-motor functions explains the dominant influence of psychological impressions on the secretory functions of the mammary glands.

That curious complex of emotions known as the maternal *instinct* has an undoubtedly favourable influence on the secretion of milk, just as fear, anxiety, hatred, and anger have a reverse effect.

Most women who have nursed infants successfully are familiar with the phenomenon known as "the draught"—a feeling of fulness that takes place in the breasts when the infant begins to suck.

This phenomenon has probably little to do with the sudden resolution of the substance of the gland

cells into milk as is generally supposed; it rather represents a sudden engorgement of the blood-vessels, and a flushing of the breast in consequence of vaso-dilator influences.

This vaso-motor phenomenon can manifest itself with the same rhythmical and automatic periodicity that is familiar in the case of certain other organic functions, for it is one of the properties of nerve centres, such as those which subserve the mammary activities, to acquire rhythmical habits when the stimuli which first evoke the functions follow one another in regular and orderly sequence. If, therefore, the infant is given the breast at absolutely regular intervals during the first few days of life, there is a reasonable probability that the receptive and impressionable nerve centres which control the functions of mammary secretion will acquire a rhythm and automatism which can be made to subserve most useful purposes, and promote the chances of successful breast-feeding.

The usual practice in maternity institutions is to feed the infant three times during the first twenty-four hours, four times during the second or third day, and, finally, when the functions of lactation have become permanently established, to give the baby the breast every two hours.

For the reason already stated, I do not regard this plan as well designed to promote successful breast-feeding and the establishment of rhythm. The

frequent changes in the intervals of feeding must interfere with the assumption by the nerve cells of periodic habits at the very moment when such habits are most easily induced.

If advantage is taken of this opportunity to impress a habit of regular activity on the nerve centres, the breasts may be induced to assume such a regular periodicity, that the times of feeding, as they come round, can be recognized by the arrival of "the draught."

Mrs. Lucy Naish[1], whose opinion on matters connected with breast-feeding deserves the fullest attention, advises against the practice of putting the infant to the breast more than three times during the first few days after the confinement, on the grounds that nursing exhausts the mother, and that the nipples are liable to become sore and excoriated if they are exposed too frequently to the friction of the infant's lips. I cannot agree with these objections because I consider that the physiological and the psychological influences of suckling altogether outweigh the other disadvantage that nursing may cause to the mother, and because I believe that if the nipples have been properly prepared before the confinement, there need be no soreness due to suckling.

Provided that both breasts are in a state of functional activity, "the draught" occurs on both sides simultaneously. Of this associated action advantage may be taken in several ways. For instance,

[1] *The Lancet*, June 14, 1913, p. 1657.

it is sometimes of importance to obtain breast-milk for infants who are themselves unable to extract it from the breast. In such cases the breast-pump is usually employed, but, as I have already mentioned, the quantity that can be obtained by this means is less than that which is extracted by the infant; but if a strong infant is put to one breast and the pump is applied to the other, the physiological stimulus afforded by the infant promotes a more abundant flow into the receiver of the pump, and this milk, whether from the infant's own mother or from some other nursing-woman, may be instrumental in saving life. Indeed, it has been claimed that this method may be employed as a modified form of test-feed; that is to say, the amount of milk extracted by the pump from one breast may be an accurate gauge of the quantity obtained by the infant from the other.

During the summer of 1913 two twins were brought to my consultations: one of them was strong and lusty, the other small and feeble. We gave each of them a test-feed, one being put to the left breast and, subsequently, the other to the right. The amount the strong baby secured was apparently adequate for his requirements, whereas the weakling obtained an insufficient quantity. Believing that the weakling was suffering from inanition due to his feeble attempts at sucking, I instructed the mother to feed both of the twins simultaneously, holding one to the right breast and the other to the left. I

also instructed her to be prepared to feed them in this way on the next occasion she attended at the dispensary. On the following week we found that the smaller of the twins had improved considerably in condition, and that he had put on more weight than his brother. The mother further told me that since she had adopted this double method of feeding "the milk seemed to pour into the small baby's mouth without his doing any work at all," evidence which the test-feed confirmed in the weighing-room at the dispensary.

Reverting once again to the question of the times of feeding and the acquisition of rhythmical habits, I would insist on the great advantage conferred on the mother as well as on the child by the adoption of the three-hourly method of feeding. In Germany there is a tendency to make the intervals even longer than this, and to allow four hours' rest between two consecutive feedings. On the whole I do not think this plan answers very well in the case of English nursing-mothers, and even in Germany, with extended experience, it seems that most infants obtain more milk and put on more weight when they are fed eight times than when they are fed five times during the twenty-four hours.

Professor Hans Reitchel,[1] who has paid attention to this question, comes to the conclusion that we cannot lay down hard-and-fast rules. Each case must

[1] Professor Hans Reitchel, *Lehrbuch f. Kinderheilk.*, April, 1912, p. 403.

be treated on its own merits, and the number of feedings must be determined by the prevailing conditions. In the case of first children his inquiries indicate that four-hourly feeding is seldom a success, at least for the first few weeks of life.

Whatever arguments may be urged against limitation to five feeds in the twenty-four hours, little can be said in favour of the two-hour system, for in so short an interval the stomach cannot be completely emptied except in quite rare instances, and it is essential that this important digestive organ should have time to recover after one period of activity before it enters upon another. It is unfortunate that the two-hourly method of feeding has been sanctioned by English custom, and that it has so many attractions for the impatient mother.

Notwithstanding the arguments I have already cited in favour of the establishment of rhythm in the times of feeding, I see the advantages of longer intervals at night in order that a prolonged period of sleep may be secured. The value both to the mother and to the child of one long uninterrupted spell of sleep cannot be exaggerated, and the earlier this habit is induced the better it is for both. Habits of sleep are very easily acquired, especially when advantage is taken of the quiet and darkness of the night. On the other hand, when once the infant has formed a habit of waking up in the night to be fed, it is very difficult to induce it to dispense with these attentions. It is not so difficult as is supposed to

train an infant to sleep right through the night, say, from 9 p.m. to 6 a.m. if the room is kept quite dark and quiet, but it is very difficult to persuade any mother that it can be good for an infant to be kept without food for so long a time. Provided, however, that an infant obtains a sufficient amount of food in the twenty-four hours to satisfy its physiological requirements, it is a very distinct gain that there should be one long interval of rest such as this. As a counsel of perfection I believe that the best hours for feeding an infant are six, nine, twelve, three, six, nine—that is to say, six feedings during the day and an interval of nine hours during the night for sleep. Although an infant will, perhaps, require to "be changed" or held out during this long night interval, the function of micturition can be made so automatic that it soon becomes a reflex habit and the child does not wake up.

The establishment of a broken rhythm of this kind is not so irrational as might be imagined. All of us can acquire such periodicities, but infants acquire them more easily than older individuals.

It is quite a mistake to suppose that young infants —that is to say, infants under one month of age—normally derive much nourishment from their mother's breasts. During the colostrum period, which usually lasts three or four days, the amount of secretion is quite insignificant, and even after the establishment of lactation, the quantity of milk obtained is far less than is usually supposed. Judg-

ing by the statements which appear in textbooks on the subject of infant-feeding, one would imagine that, by the end of the first week of life, the majority of infants extract about a pint of milk from the breasts.

TABLE I.

Day.	Total Quantity of Milk taken in 24 Hours.	Average Number of Feeds Each Day.	Average Quantity of Each Feed.	Average Daily Weight.
	Oz. Dr.		Dr.	Lb. Oz.
1st ..	0 9	3·23	2·28	7 1
2nd ..	1 15	5·00	5·23	7 1
3rd ..	4 12	8·88	8·19	6 10
4th ..	6 4	9·24	9·98	6 15
5th ..	6 11	9·33	11·70	6 15
6th ..	7 3	9·22	12·39	7 1
7th ..	7 9	9·53	12·43	6 15
8th ..	7 13	9·44	13·29	7 3
9th ..	8 1	9·43	13·80	7 2
10th ..	8 4	9·11	13·93	7 2
11th ..	7 14	9·40	13·36	7 0
12th ..	8 8	9·38	14·88	7 4
13th ..	8 13	9·23	14·69	7 4
14th ..	8 11	9·48	14·70	7 9
15th ..	9 3	9·29	15·70	7 3
16th ..	9 8	9·52	15·95	7 7
17th ..	9 4	9·54	15·94	7 6
18th ..	9 10	9·58	16·08	7 4
19th ..	9 12	9·69	16·07	7 3
20th ..	10 4	9·00	18·43	7 4
21st ..	11 5	8·00	18·10	7 9
22nd ..	10 6	9·28	18·40	8 1
23rd ..	11 7	10·00	18·30	7 8
24th ..	12 2	10·00	19·40	7 6

This table shows the average amount of breast-milk secured by sixty-one infants in twenty-four hours, and at each feeding. It also shows (column 4) the average weight of the infants and the number of feeds (column 2) in the twenty-four hours. It is to be noted that in columns 1, 3, and 4 the figures refer to avoirdupois and not apothecaries' weights.

The evidence on which this belief is based is that which has been afforded by a comparatively small number of test-feeds conducted in maternity institutions in Germany. For instance, Camerer's figures, which constitute the usually accepted standard, are derived from six cases only, and Freer's estimates are based on a similar number. Repeating these experiments at my suggestion, on a much larger scale—namely in the case of sixty-one infants—Dr. W. O. Pitt[1] was able to show that the average amount of milk secured by London mothers confined in a maternity institute (the St. Marylebone Workhouse) was very much lower than the German standards. Dr. Pitt's results are given in Table I. (p. 22).

In Table II. Dr. Pitt's results are placed side by side with those of Camerer and Freer.

TABLE II.

AVERAGE NUMBER OF OUNCES OF MILK CONSUMED BY NURSLINGS DURING THE FIRST TEN DAYS OF LIFE IN TWENTY-FOUR HOURS.

	Day of Life.									
	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th.	10th.
Dr. Pitt's 61 cases ..	½	1⅛	4⅛	6½	6	7¼	8	7	8	8½
Freer's 6 cases	—	½	5¾	11¼	15	16½	20	18½	21	20
Camerer's 6 cases ..	¾	2½	6	11½	12½	13	16	16½	16	15¾

It will be noticed that Camerer estimates that the amount of milk obtained by infants on the seventh

[1] *The Lancet*, September 2, 1911.

day of life is on an average 16 ounces and Freer 20 ounces, whereas Dr. Pitt's figures for the corresponding day amount to only 7 ounces.

I call attention to these figures because it is generally supposed that infants are being starved if during the early days of life they do not obtain amounts of food which conform to the textbook standards. Such a belief is quite unjustified; the infants in Dr. Pitt's series of cases (see column 4 of Table I.) showed quite normal progress and average gains in weight in spite of the small quantity of milk they obtained. Any unwarrantable interference with Nature's supply by supplementary feeding during the early days of life, until lactation is fully established, is extremely likely to interfere with the ultimate success of nursing.

If the foregoing explanations of the factors on which successful breast-feeding depends are understood, it will be realized that the usual expedients adopted to secure the establishment of lactation are little calculated to promote the desired object.

A short time ago I asked a class of experienced midwives what was the most important factor to attend to in the establishment of lactation. They all seemed to think that the feeding of the mother was the most important consideration.

If what I have already said on this subject is physiologically and substantially correct, it is quite clear that gruel, or Benger's food, or nursing-stout,

can have no influence in the matter. The conditions on which the establishment of lactation depend are normal stimulation of the nipples, normal conduction of the nerve impulse, and normal reflexion of the impulse by the nerve cells in the centres concerned; that is to say, the normal behaviour of a normal reflex arc controls the vascular supply and the secretory functions of normal glands. You cannot force these glands to activity by saturating the blood with nutritive material.

It is, of course, essential that the blood should contain the raw elements required for the manufacture of milk, and, further, if a large quantity of any manufactured article is required, a large quantity of raw material must be supplied. But for the mere establishment of the function of lactation it is not only unnecessary, but even harmful to attempt to overfeed the patient, for the blood always contains an ample quantity of nutriment.

Of recent years a good deal has been written and said on the subject of galactogogues, and several preparations have been largely advertised as being capable of influencing the supply of milk. As far as I am aware, no specific galactogogue has yet been discovered, neither linseed-oil, nor cottonseed-oil, nor any of their derivatives can be regarded as galactogogues in the proper acceptation of the term. They are foods just as cod-liver oil or olive-oil are foods, and they can serve as the raw material out of which

certain of the constituents of milk can be manufactured; but they cannot influence the establishment or the non-establishment of lactation, although many poor people are induced to purchase these preparations and to take them under the belief that the money is well expended, and that they have some specific charm in the secretory powers of the mammary glands.

An examination of the factors on which the establishment of lactation depends emphasizes the importance of the following points:

To set the secretory mechanism in motion it is necessary that the liberating stimulus received from the nipple should be adequate in intensity to evoke the required response from the controlling nerve centres. The responsiveness of these centres can be materially promoted by the favourable co-operation of the higher centres which subserve psychic and emotional activities; they are, in fact, activated and reinforced by the concentrated fire of nerve energy which can be directed upon them by the psychic batteries of the higher brain. There is reason to believe that internal secretions, or hormones, circulating in the blood can also reinforce the activities of these centres or of the gland cells. There are, however, no grounds for believing that foods or so-called galactogogues can have any influence in setting in action the nervous mechanism of secretion, although if a large amount of milk is required, the mother must be well fed to prevent exhaustion.

I have already dealt somewhat fully with the details concerned in the "establishment of lactation." I now propose to consider other matters connected with its subsequent maintenance and the general management of breast-feeding up till the time of weaning.

It will be unnecessary for me to allude further to the necessity for long intervals between feeding and for giving an extended period of rest during the night, but I would refer to some very interesting observations made by Dr. Maynard Ladd[1] of Harvard, which show that the stomach requires even a longer period than is usually supposed to become completely empty, sometimes as long as six hours.

The management of the quantity of milk supplied is a matter of prime importance, not so much during the first few weeks of life, when the chief desideratum is the establishment of the normal functions of digestion, as from the end of the first month onwards, when considerations of nutrition should occupy our attention.

There is a very general belief that, as the infant grows older and larger, there is a corresponding increase in the amount of breast-milk consumed. This is by no means an invariable rule, as my own observations[2] on a large number of infants of the poorer

[1] "The Influence of Variations of Diet upon Gastric Mobility in Infants," *Archives of Pediatrics*, 1913, p. 740.

[2] *The British Manual of Children's Diseases*, February, 1914, vol. xi., pp. 49-62.

class very clearly prove. There is, indeed, a serious risk of breast-fed infants being underfed during the later months unless precautions are taken to prevent this catastrophe.

I imagine I do not overstate the case when I say that of all the factors in the environment which make or mar the development of the infant, food or feeding is the most important. Even in breast cases the feeding requires management, both as regards quality and quantity. It is very difficult to influence the quality of breast-milk—this is for the most part beyond our control—but we can manage the quantity or, at least, we can, with very little trouble, make ourselves acquainted with the exact quantity of food consumed, especially when we are dealing with infants of well-to-do parents. For many years past I have estimated, by means of the test-feed, in many cases repeatedly performed, the amount of milk consumed by all breast-fed infants brought to my clinics, both at the Queen's Hospital and at the St. Marylebone General Dispensary, and by this means I have gained some experience of the quantitative variations in the milk-supply of different women. These variations are so bewildering and often so unexpected that it is merely playing with an important matter to attempt to treat breast-fed infants for nutritional and other disturbances until this primary element in the diagnosis has been settled. I have, indeed, had some very strange experiences, which all go to show how

utterly futile it is to attempt to estimate the quantity of food an infant is obtaining without the confirmatory evidence of the test-feed. Many times have I thought that the infant was being starved when in reality it was being "overfed," and often I have thought that "overfeeding" was the trouble when events have proved that the symptoms were due to starvation. There are, indeed, certain clinical tests by which we may distinguish between underfeeding and overfeeding, and I do not hesitate to refer to these very obvious indications, because I notice that they are often ignored.

The cardinal symptoms of underfeeding are—

1. Loss of, or at least a failure to gain, weight at the normal rate.

2. Constipation, or in case of extreme starvation the passage of small mucous stools.

3. A limited excretion of urine (oliguria).

Whereas the cardinal symptoms of overfeeding are—

1. At first unduly large increments in weight succeeded by a period of stationary or falling weight.

2. The passage of large bulky stools and the presence of redness of the buttocks. Constipation sometimes develops, but the motions are large when passed.

3. The passage of a large quantity of water (polyuria).

4. Sweating and vascular dilatation of the capillaries of the face.

5. Rapid breathing.

In addition to these cardinal symptoms there are other means by which we may distinguish between starvation and superalimentation—for instance, the condition of the mother's breasts conveys very important information. Breasts which are full and large before feeding, and small and flaccid after feeding, presumably afford a good supply, whereas small breasts which do not perceptibly diminish in size after feeding as a rule cannot be credited with a liberal secretion; but no matter how carefully we piece together such fragments of diagnostic evidence, it is impossible to rely on any other evidence than that of the test-feed.

To show how very misleading the subjective sensations of the mother may be, and how utterly worthless her own opinions as to the amount of milk she may supply, I herewith give the particulars of two interesting and illustrative cases:

Case 1.—A male infant, two months old, was brought to the Queen's Hospital, February 10, 1913, for continuous screaming. The weight at birth was not noted, but the baby was reported to have been of average size; the weight on being brought to the hospital was 10 pounds. So presumably the infant had increased in weight some 2 or 3 pounds in the two months, and therefore could not have been systematically starved. For some days past the infant had been constipated, and had passed a very small quantity of water. The mother's breasts were of normal size and appeared well developed, but

milk could only be expressed with difficulty. I gave the mother instructions when she next came to see me not to feed the infant for three hours before attending at the hospital. In the meantime, feeling fairly confident from the symptoms that the infant was now being starved, whatever might have been the case at an earlier date, I told the mother to give the infant one teaspoonful of condensed milk and two tablespoonfuls of water after each breast-feeding. Owing to a mistake on the part of the mother, it was not possible to give a test-feed when the infant was brought to the hospital a week later, but in the interval the infant had gained 2 pounds 4½ ounces in weight, the largest increment I have ever seen registered in one week—in fact, no infant could possibly show such an increment unless it had been very seriously starved for some time previously. I have no doubt that the infant's tissues were very dry and that this extraordinary increase in weight was chiefly due to their rehydration. Two days later a proper test-feed was given, but this showed that the infant weighed the same after the feeding as it did before it was put to the breast—a result which was confirmed in the following week by means of a second test-feed.

It is interesting to note that on the occasion of each of these test-feeds the mother told me, in answer to my inquiry, that the infant had had a good feed, and that she felt sure it obtained quite as much as it had during the early days of life when the whole history of the case proves that it must have been making good progress.

Seven days later another test-feed was given,

but the result still proved that the breasts were quite dry. In the interim, however, the infant had gained further weight and was now 13 pounds 4 ounces. The mother was apparently so satisfied with the result of the artificial feeding that she ceased her attendance at the hospital, and I have not seen the infant since.

This result illustrates one of the great dangers of supplementary feeding with condensed milk. Owing to the sweetness of the milk, infants take so kindly to the food that they do not seem to apply much energy to the task of obtaining milk from a relatively dry breast; moreover, the mothers are so pleased with the immediate results that they are only too glad to relinquish breast-feeding, with all its attendant troubles and disappointments. I have very little doubt that the infant above referred to grew into a fat, contented, flabby, and unhealthy baby, like the rest of its kind who are fed on this most unsatisfactory food.

I have great faith in condensed milk as an easy stepping-stone to better things, but as a permanent bridge between the period of early weaning and the solid food stage, it is full of temptations and dangers. The three main defects in condensed milk, at any rate the ordinary sweetened variety, are—(1) That it contains a great excess of sugar, (2) that it is too easily digested and does not develop the functions of digestion, and (3) that it is a dead food which contains no antiscorbutic elements (vitamines).

The following case illustrates the value of the test-feed from a totally different point of view:

Case 2.—W. W.—A male infant six months old and weighing 16 pounds 6 ounces was brought to the Queen's Hospital for constipation and glands in the neck. The infant was fed every two hours, and the mother was under the impression that she had not sufficient milk. I gathered from the mother's account of the condition of the napkins that the infant passed a large quantity of water, and from the appearance of the breasts and the ease with which milk could be expressed, I felt convinced that from whatever else the infant might be suffering, its present condition was not due to want of milk. I gave the mother the usual instructions, and two days later a test-feed was given at the hospital. This proved that the amount of milk which the infant extracted from the breast was very nearly 7 ounces, a quantity which in my experience of hospital practice in the East End of London is almost unique, and it suggested a diagnosis of overfeeding, and, on reflection, the symptoms appeared by no means inconsistent with this explanation. Constipation is not an uncommon accompaniment of super-alimentation, but in this particular case, as I subsequently discovered, the constipation was due to the abuse of soap-and-water enemata. There are, on my experience, few more aggravating causes of constipation in infants than the early dislocation of the normal rectal reflex by the administration of enemata, glycerine suppositories, and powerful aperients. I treated this case by extending the intervals

between feeding, by reducing the amount of clothing, and by promoting the physiological demand for food in the many ways I have already mentioned. Thus were overcome the consequences of overfeeding, and the infant soon improved in condition. It at once increased in weight, and was in perfectly good health when the mother ceased attending at the hospital.

I could easily multiply instances both of overfeeding and of underfeeding which have been revealed and cured owing to the instrumentality of the test-feed, but no degree of repetition would be so convincing as a short experience of the method in an infant clinic. Personally, I cannot understand how anyone can expect to treat breast-fed infants successfully unless he or she first takes the precaution of becoming acquainted with the amount of food the infant consumes.

I imagine that the two really important factors in the infant's environment are the quantity and the quality of the food. It is very difficult to obtain accurate information with respect to the quality of breast-milk, for chemical analysis shows us but little; but it is quite easy to obtain precise information with respect to the quantity, and I consider that any physician who fails to take this precaution, does himself an injustice.

Although for the last ten years I have practically never omitted to gauge as accurately as I have been able the amount of milk which has been consumed by every breast-fed infant concerning whom I have

been consulted, I freely admit that even with the experience I have thus gained I am unable to form a reliable estimation of the quantity obtained by any particular nursling by any clinical test with which I am acquainted other than the test-feed.

I have elsewhere explained that, within certain wide limits, the supply of breast-milk is correlated to the demands of the infant; that is to say, other things being equal, the more hungry and lusty the infant, the larger will be the amount of milk afforded by the breasts. In other words, there is some parallelism in this particular secretory function between the intensity of the stimulation applied and the reflex response elicited. But this physiological correlation does not obtain under all conditions; its fulfilment demands the existence of normal conditions in the secretory apparatus and its nervous mechanisms. For instance, the casual presence of a crack in the nipple may induce painful impressions, and these may suppress rather than excite secretion in the mammary glands; on the other hand, psychological disturbances in the mother may interfere with the normal liberation of the reflex response. Again, the infant itself is, like the mother, subject to psychological disturbances, and for some quite unforeseen reason may refuse to suck and apply the required stimulus. Suggestion plays a most important part in the actions of an infant. For instance, one or two disappointments at the breast may shake the infant'

faith, and it may refuse to make any further efforts. Sometimes the effort of sucking may initiate painful sensations in the abdomen, due to contraction of sphincters, to enterospasms, or to other forms of incoordinated peristalsis; and when once the infant associates such experiences with the act of taking the breast, it may resolutely refuse to make any further attempt. The truth is that breast-feeding requires a great deal of management if it is to be a comp'ete success. It is a mistake to underrate its difficulties or to exaggerate its merits.

One of the most important matters in connection with breast-feeding is to know when and how to supplement an inadequate supply with artificial feedings. In this connection two factors must be considered—firstly, how much food ought any particular infant to receive in the twenty-four hours; and, secondly, how much does it actually derive from the mother's breasts. As regards the first factor, I must refer the reader to Chapter III., which treats of the food requirements of infants. If it is found by means of the test-feed that the quantity of milk supplied by the mother falls materially short of this amount, then the deficit must be made good by supplementary feedings. It is very difficult to increase the natural supply by any practical expedient.

Galactogogues which directly stimulate the flow are unknown, and food makes very little impression. Starving women afford quite a good supply, as we know from the experiences of the siege of Paris in

1870, and the great cotton famine in Lancashire some years prior to this date. During these times of trouble and deprivation the infant mortality was peculiarly low, and the infants did not seem to suffer in health from the starvation of the mothers. I had quite recently an interesting illustration of the insignificant influence of starvation on the mother's milk, when a woman, whom I had known for some years, came to my infant consultation with a three-months-old baby whom she was suckling. This woman was suffering seriously from the effects of inanition, and yet the baby was plump and well, increasing normally in weight, and appearing quite well in all other respects. The test-feed showed that the amount of milk obtained at a feeding was ample. Dr. Leslie Duncan[1] has made some interesting observations on the influence of dinners supplied to necessitous nursing-mothers in Birmingham. The extra food supplied in this way to half-starved women had a distinct influence on the fat content of the milk, but in no other way appeared to influence its quality, although the nutrition of the mothers materially improved in consequence of the extra food.

This has been my own experience also, although I have not had an opportunity of confirming my clinical experience by many actual analyses of the milk.

On the other hand, if a nursing-mother is already obtaining a sufficiency of food, no good purpose will be served by amplifying her already adequate

[1] Report on Infant Mortality. Birmingham, 1913. Printers: Hudson and Son.

dietary. Nursing-stout, gruel, and cod-liver oil often do more harm than good by making the mother bilious and thus upsetting the general bodily equilibrium on which a good mammary secretion so largely depends. I would, however, say one word in favour of iron as an adjuvant to the nutrition of the nursing-mother; it is certainly a drug which may improve the quality of the milk. At the best of times breast-milk is none too rich in iron, and it may show a noticeable deficiency if the mother has been depleted of it by hæmorrhages or other conditions which dispose to anæmia. Infants very soon show the effects of iron starvation, and their general condition of nutrition may under certain circumstances greatly improve when it is administered to the mothers. I make a common practice of supplying nursing-mothers with 15 to 60 grains of carbonate of iron in the twenty-four hours, and I generally notice that the quality of the milk—as estimated by the nutrition of the infants—improves. Seeing that by ordinary means we cannot increase the quantity of the natural supply, we must compensate for a shortage of breast-milk by giving supplementary feedings; and it is certainly my experience that some of the best results in breast-feeding which I have seen have been in the case of infants fed by the combined method. The supplementary feedings can be given in various ways, either at the beginning or at the end of a breast-feeding, or as an occasional substitute for it—that is to say, by alternating breast- and bottle-

feedings, or by substituting one, two, three, or more, bottles for the breast.

I would not like to lay down any hard-and-fast rules. Each case must be judged on its own merits. Sometimes on inquiry, or on the evidence of a test-feed, we find that at one particular hour in the day the mother's milk materially fails. If this is so, this hour should be chosen for the supplementary bottle. I find from experience that the late afternoon feeds are the poorest in quantity, just as the first morning feed, after the long rest at night, is usually the largest.

Sometimes I find it an excellent plan to give a small supplementary feed at the end of each feeding. I have had some very extraordinary cases both at the Queen's Hospital and at the St. Marylebone General Dispensary, in which the addition of an insignificant quantity of extra food has produced a quite disproportionate change in the infant. Infants whose weight may have been stationary for weeks or months may increase a pound or more in weight in quite a short time by the addition of a few ounces of cow's milk in the twenty-four hours.

It is naturally of some importance to supply the right food in the right amount when recourse is had to supplementary feedings. The amount of food to be given by hand will depend on the quantity of breast-milk already taken by the infant. It is unwise to augment the quantity too suddenly or too drastically. The danger of overloading an unprepared stomach is very great.

If an infant obtains, say, 15 ounces of breast-milk from the mother in the twenty-four hours, when, according to ordinary estimation, the amount should be at least 25 ounces, we must consider in what way to supply the deficiency. If we find, after giving a few test-feeds, that sometimes the infant obtains a large quantity and sometimes a small, it may be quite safe to give the supplementary food in comparatively large quantities, say, in doses of 3, 4, or 5 ounces. On the other hand, if the infant appears to obtain its total supply in small and constantly regular quantities, it may be better to distribute the supplementary food in the form of small and increasing addendums to each feed; but, as I say, there is no rule, and each problem must be solved by a full consideration of the individual difficulties.

I find among the poor that the simplest and most practical method of supplementing a defective breast-supply is to order a quarter, a half, or a whole teaspoonful of condensed milk to be given after each breast-feeding, the food to be given in a spoon without any previous dilution. This obviates the possible danger of overdistending a stomach already full of a thin and poor milk, for it must be remembered that infants are often underfed, owing to the poor quality of the milk, although its quantity may be ample. This is especially the case towards the end of lactation, when the mother has become exhausted from prolonged suckling.

CHAPTER II

Some Physiological Principles concerned in the Nutrition of Infants

When we speak of the state of nutrition of an animal or of a human being, I imagine that few of us conjure up a very clear picture of the exact meaning of the term we employ. We are apt, for instance, to regard the popular expression "to be well nourished" as synonymous with "being in a condition of good nutrition." As a matter of fact, "to be well nourished," in the more usual acceptation of the expression, is to be fat and sleek—to be in the sort of condition in which prize cattle and babies are when they are sent to shows—a very different thing from being in a sound condition of health. I should find myself in a very difficult position if I were asked to define shortly what I myself understand by the term "good nutrition." It certainly has very little to do with reserve stores of fat or glycogen, and it certainly has a great deal to do with the functional efficiency or "fitness" of the individual.

When an organism as a whole is said to be in a condition of good functional efficiency or good nutri-

tion, such a statement implies that the individual organs or elements that make up the sum total of its anatomy are also in a condition of functional efficiency. We ought therefore to judge the condition of nutrition of a baby, for instance, by the standard of its functional efficiency rather than by that of its outward appearance. There is truth in the statement that no one can judge of the time-keeping qualities of a watch by a mere inspection of its mechanism, and for the same reason there is truth in the view that there are few people who can judge of the physiological efficiency of the human baby by a simple examination of its exterior characteristics. There are, however, a large number of physiological functions which betray their merits or defects by visible and objective manifestations. For instance, if the liver does not play its part efficiently in the destruction or combustion of the products of intestinal putrefaction, the individual will be unduly pigmented or muddy of complexion; or, again, if the kidneys are diseased or incompetent, the tissues may be œdematous or the complexion bloated. It requires, however, a very shrewd observer to judge at all accurately of the condition of nutrition of any particular individual by an examination of externals. He must judge by performance, and not by appearances.

In order that any organ or tissue may be in a condition of good nutrition or good functional efficiency,

certain conditions are essential. In the first place, good nutrition postulates that the organs or tissues themselves must possess normal qualities, qualities which will enable them to perform the duties demanded of them. Secondly, they must be provided with the food or nutritive material which is required for their normal metabolic processes. And, thirdly, they must be in connection with a normally constituted nervous arc.

The soundness and integrity of this nervous arc is of paramount importance for the nutrition of the highly complex organs of which our bodies are composed.

Let me take, for instance, such an example as the biceps muscle. For this muscle to be in a condition of functional efficiency, it must constantly exercise its function, or it will assuredly atrophy. The functions of this muscle are not only exercised when it becomes mechanically shortened and it performs external work, but its activities are in constant operation in the mere maintenance of "tone." "Tone," however, ceases to exist the moment the integrity of the reflex arc is damaged or destroyed. A never-failing stream of sensory or centripetal impulses constantly impinges on the nerve cell, which controls the administrative functions of the reflex arc. These centripetal impulses are interpreted by the nerve cell and transmitted to the muscle in the form of an endless succession of trophic or tone-giving stimuli. The moment these

centripetal impulses are cut off, as by severance of sensory nerves, or the moment the functions of the nerve cell are dislocated, that moment does the muscle cell lose its tone, or, in other words, fail in nutrition.

Whether, therefore, we take the case of a single muscle or of the body as an aggregate of many organs, we can see, in the light of these fundamental conceptions, that nutrition depends on a large number of factors, chief and foremost among which is the integrity or efficiency of the nervous arc.

Now, bearing these facts in mind, I would ask you to turn your attention for a moment to a consideration of the first of the factors which I have already enumerated as requisite for nutrition—namely, the food or nutritive supply. In order that nutrition may be maintained, certain food requirements must be observed. The food must contain all the elements required by the various organs for the performance of their functions, and in adequate amounts. If the supply falls short, or is excessive in amount, the organism suffers. But, owing to the vast reserve powers of the body, there must be a large excess or a serious shortage to produce any material damage.

The human body has aptly been compared to a community of citizens, in which economy and efficiency have been secured by a strict adherence to the principles of the division of labour. The cells of the body, like the various professions or classes

in a community of individuals, are differentiated into systems or groups for the performance of certain definite and often highly specialized functions. Thus, in the digestive tract we find segregated together cells whose special duties are to render soluble and suitable for the nutrition of the other members of the community, those solid and crude articles of diet which are consumed as food. Again, we find in the liver a vast assemblage of cells whose special function it is to sort the good from the bad, and to destroy or oxidize those waste and superfluous products which, together with the necessary and useful products, are absorbed from the alimentary tract, and are passed through this great scavenging system. Highly organized cells, such as those of the nervous or muscular systems, could not perform their specialized duties with the required efficiency if their energies were diverted for such base and commonplace purposes as the digestion and preparation of their own food.

It is the special duty of the cells concerned in the processes of digestion and assimilation to reduce the many varieties of food, consumed by the host, to some common denomination, or to some uniform standard capable of fulfilling the required conditions. The blood contains, or should contain, all the nutritive material required for the growth and maintenance of the many varieties of tissue cells represented in the body, and in a form at once available for

utilization. The composition of the blood remains singularly constant and uniform, no matter what may be the nature of the food consumed. Chemically and physically, the blood is most accurately adjusted to the requirements of the tissue cells, so that the latter always receive nutritive material, which is adjusted both quantitatively and qualitatively to their specific needs. It would greatly interfere with the efficiency of their work if these cells were to be constantly confronted with changes in the character of their food, for such variations would necessitate corresponding adjustments in the disposition of their molecular structure. It is, therefore, impossible to insist too strongly that one of the most important mechanisms in the animal body is that which is concerned in maintaining the uniformity, or specificity, of the circulating nutrient media.

The blood contains, or should contain, every one of the essential elements required for the synthesis or building up of the many varieties of tissue cells contained in the body; for this purpose, proteins, carbohydrates, fats, salts, and a great number of other colloidal or crystalloid bodies are required. Every provision is made for maintaining these necessary substances at a uniform strength and of specific quality, and for eliminating from the circulation all those which are not required. Any gross departure from the required standards may

cause considerable dislocation of the machinery of the body, and interfere with the health of the organism as a whole. For this reason, the blood of one animal cannot be transfused into the circulation of another without risk. The more closely the animal whose blood is transfused into the circulation of another is allied by the ties of consanguinity or habit to the animal into which it is injected, the less serious are likely to be the disturbances provoked.

Even the blood of two members of the same family, of two brothers for instance, is not exactly identical, and cannot be substituted without some disturbance of organic equilibrium. The blood of the mother is practically identical with that of the fœtus in her womb, and so is the blood of one dicephalous twin with that of the other; but the blood of the infant ceases to be identical with that of the mother the moment the placental connections are severed.

The maintenance of the specificity and uniformity of the blood is so important to each individual that it is not without interest to inquire by what mechanism or mechanisms these conditions are fulfilled. Most of us are quite familiar with the resources at the disposal of the organism for maintaining the quantitative constancy of the blood. Thus, we all know that, as regards the carbohydrate content of the blood, the required percentage is maintained by elaborate systems of extra-circulatory storage, and

by elimination from the body; the same is true, to a greater or less extent, with respect to the nitrogenous and saline constituents of the blood. These matters are so familiar that I feel my time will be employed better in confining myself to the manner in which the qualitative constancy of the blood is insured.

To a certain extent, similar mechanisms and methods are employed to maintain the qualitative constancy of all the essential constituents of the blood; but inasmuch as the specificity of the protein content transcends in importance the specificity of all the other constituents combined, I shall confine myself to this side of the question, although *mutatis mutandis* the details are practically the same for all the other nutritive elements in the blood.

Thanks to the brilliant work of Emil Fischer, Emil Abderhalden, and other organic chemists working in the same school, we now have more exact information of the molecular constitution of protein bodies than we had, let us say, ten years ago. We know, for instance, that these complex bodies consist of long chains of relatively simple atomic-complexes, such as fatty acids and amido-acids, linked or combined together in ester groupings or piperazine rings. Further, we know the exact chemical constitution of the amido-acids which take part in these syntheses, and can recognize their presence by chemical tests. At least twenty separate and independent amino-acids have thus been isolated,

and recognized as taking part in the specific " make-up " of the various protein bodies. The number of combinations of amino-acids is, however, possibly greater than the number of combinations of letters into words, for, however sesquipedalian may be the character of the latter, their length is as nothing in comparison with the possible length of the chains of amino-acids which constitute the huge molecules of which proteins consist.

Thus, although it is quite easy to separate the various classes of proteins into groups or classes, such as serum-albumins, globulins, nucleo-albumins, caseinogens, albumoses, peptones, or collagens, it is quite possible, or, indeed, almost certain, that there are slight specific differences in the " make-up " of each representative of each class, although the distinction between these various representatives is at present indistinguishable by ordinary chemical tests. These specific differences unquestionably depend on the number and the grouping of the component amido-acids. We know, in fact, that the serum-albumins or globulins of no two animals are exactly identical when put to the test of the biochemical reaction; if, for instance, the serum of a horse is transfused into the blood-stream of a human being, it acts as a foreign body, and leads to the production of specific precipitins. This phenomenon has a most important bearing on certain phases of infant feeding, for we know that, under given con-

ditions, unaltered proteins[1] are absorbed from the alimentary tract into the circulation without previous digestion; further, we know that such absorption can be followed by untoward consequences, as, for instance, by the development of extensive urticarial rashes.

Immediately after birth, and before the processes of digestion are established, if soluble proteins are introduced into the stomach of the infant, a certain proportion will be absorbed; if these proteids are foreign, such, for instance, as those contained in cow's milk or in white of egg, they will excite biochemical reactions, and lead to the production of specific precipitation in the blood, and therefore they will not subserve the functions of ordinary nutrition, and consequently are not only useless, but may be actually dangerous. On the other hand, if proteins, as, for instance, those contained in the colostrum of the child's mother, are introduced into the system of the infant and happen to be identical with its own specific circulating proteins, the case is quite different; such proteins are not foreign bodies, and are available for the purposes of nutrition. A consideration of these facts emphasizes the importance of maternal feeding. Even the colostrum of a wet-nurse does not contain exactly the same proteins as the colostrum of the mother,

[1] Van Alstyne and Grant, *Journ. of Med. Research*, 1911, vol. xxv., p. 399.

and consequently is not exactly suited to the requirements of the infant. It may be safer to feed the new-born infant with the colostrum of a wet-nurse than with the milk of some foreign species of animal, the cow, for instance; but there are dangers attaching even to this procedure, and wet-nursing should not be attempted during the first few days of life.

The important purpose of digestion is not so much to bring about the solution of solid articles of food as for the purpose of splitting up foreign material into its component elements. For instance, foreign proteins are split up by the processes of gastric and intestinal digestion into their constituent amino-acids, sometimes into chains of amino-acids of varying length and varying degree of complexity, sometimes into individual amino-acids, and out of these fragmentary particles new proteins are built up by synthetic processes on an entirely new architectural plan, and of a type which is suited to the specific requirements of the individual in whom they circulate.

I have already referred to the fact that in the "make-up" of the various protein bodies there are quantitative as well as qualitative variations; thus, egg-albumin does not contain among its constituent amino-acids, representatives of the glycocoll group, while gliadin, a vegetable protein, does not contain lysin, nor does gelatine contain tyrosin or trypto-

phane. On the quantitative side, egg-albumin has been shown to contain only 8 per cent. of glutaminic acid, while in gliadin it is represented to the extent of 33 per cent.

In the light of this knowledge, it is easy to understand that when one proteid is built up, so to speak, out of the ashes of another, there may be synthetic difficulties owing to the absence or relative deficiency of some particular amino-acid, or of some atomic grouping, or, indeed, there may be excess of certain amino-acids which must be disposed of. For instance, we cannot expect the organism to build up its own specific serum-albumin out of gelatine or out of a vegetable protein such as gliadin, for the former contains no tyrosin or tryptophane, and the latter no lysin, all of which amino-acids are required for the "make-up" of serum-albumin; but we could well imagine, as, indeed, is the case, that the organism might maintain nutrition on a diet of gelatine to which the missing amino-acids, tyrosin and tryptophane, had been added, or on a diet of gliadin plus the requisite quantity of lysin. A knowledge of these facts explains why calf's-foot jelly, at one time so greatly valued as an invalid food, and subsequently held in such scientific contempt, can be an excellent food in combination with beef-tea, and yet of little nutritive value as an exclusive food; it also explains the advantages of a mixed diet.

The whole question of the resolution of foreign pro-

teins into their component elements, or amino-acids, is of immense importance in infant dietetics, for unless foreign proteins can be so resolved in the processes of digestion, they cannot be utilized for the purposes of synthetically compounding the specific proteins, which are essential for the nutrition of the growing baby.

Young infants are not at first possessed of these digestive powers, although they soon acquire them under suitable conditions of training. The protein foods usually provided for the infant consist largely of caseinogen, a substance which is converted into an insoluble casein by the ferment rennin contained in the stomach; it is then further acted upon by lactic acid, or hydrochloric acid and pepsin, and converted into albumoses and peptoses. Although these soluble and diffusible bodies may be taken up into the system, it is a question to what extent they can subserve the purposes of nutrition. If they are really to be useful, they must be broken down still further into shorter chains of amido-acids by the processes of pancreatic digestion. If pancreatic digestion is carried far enough, a very complete resolution of the protein molecule into its component amino-acids occurs, and out of these individual acids, or from short chains of acids, the new proteids are built up by the organism, either *in situ* in the wall of the intestine, or locally in each organ. When it is remembered how many different kinds of proteins exist in the animal body, it is

hardly remarkable that the specific albumin of the blood of each individual has complicated functions to perform, for out of its own molecular structure must be supplied the required building material for the make-up of such very differently constituted bodies as the myosin of the muscles, the histone of the thymus, the collagen and elastin of the connective tissues, the keratine of the hair and nails, and the nucleo-proteins of the nervous system.

The circulating proteins of the blood must, in fact, represent the least common multiple of all the prime factors into which the various tissue proteins can be resolved, although this analogy need not be taken too literally nor pressed too far.

It is quite easy to understand that, when through monotony or defects in the dietary, the specific " make-up " of the circulating proteins is not exactly adjusted to the requirements of the organism, complications and disturbances of development may occur. Such a disease as scurvy, for instance, may possibly depend on the absence of simple atomic groupings which are required for the specific " make-up " of some nucleo-protein; indeed, there is good evidence that the disease does depend on the continued absence of certain derivatives of nucleic acid known as *vitamines*, which are present in fresh foods, but are more or less destroyed when the fresh foods are disintegrated by heat or prolonged keeping.

We know that the reserve powers of the animal

organism, both as regards compensation, metastasis of function, and excretion of waste products, are so great that ordinary degrees of excess or deficiency with respect to any particular food element do not greatly disturb the general equilibrium. At the same time the best results in nutrition are obtained when these reserve forces are least strained.

The practical deductions to be drawn from these arguments are mainly concerned with the new-born infant, and it follows from what has been already stated that it is quite useless, or even dangerous, to supply the new-born infant with any variety of foreign proteid, unless or until the digestive functions have been established. It is possible that a great number of the troubles of digestion and nutrition in infants and young children can be traced to the improper administration of cow's milk before the gastric and pancreatic functions have been developed.

The common practice of greatly diluting cow's milk does not necessarily enhance its suitability as a food for infants. If it can be digested by the gastric and intestinal ferments, and broken up into its constituent molecular fragments, well and good ; but if it cannot be so broken up and rendered suitable for synthetic purposes, no degree of dilution will make it a suitable medium for nutrition. I cannot help thinking that in our attempts to make cow's milk digestible we often dilute it too much.

As I have already indicated, the digestive functions of the infant are not developed at the time of birth, and it may be days, weeks, or months, before the gastric or intestinal functions become sufficiently developed to deal satisfactorily with diluted cow's milk; the time will be more or less dependent on the experiences to which the digestive functions are submitted. If an infant is deprived of the educational experiences to which it is entitled—namely, the gradual metamorphosis of its mother's colostrum into the ordinary milk of full lactation—it is quite clear to my mind that some other means of education should be found. If an infant cannot digest or break up foreign food into those elementary fragments out of which it can synthesize its own specific nutritive material, we ought, wholly or in part, to perform its digestive functions for it. In other words, we ought to pre-digest any artificial food which is given to the new-born baby.

Now, it is very clear that foreign proteins cannot be broken up completely into their component amino-acids by any perfunctory or superficial act of artificial digestion. If *in vitro* we digest milk with pepsin or pancreatic extract for a period of twenty minutes, the time usually recommended, we hardly begin to digest the food. By such a procedure we only convert a tithe of the proteins into albumoses or peptones. If we wish to disintegrate the greater proportion of the casein and

whey-proteins into their component amino-acids, or even into comparatively short chains of amino-acids, it is necessary to pancreatize (pepsin is useless for this purpose) for twenty hours, not for twenty minutes. The necessity for the prolonged pre-digestion of proteins has been well pointed out by A. Rendle-Short and H. W. Bywaters in their article on the preparation of nutrient enemata.[1]

It is quite a mistake to think that milk completely digested in this way is too nauseating and bitter for infant consumption, for new-born infants will swallow most liquids with complete indifference, no matter how disagreeable adults may think them. Although, from the theoretical point of view, it may be desirable to pre-digest milk for twenty hours, if it is desired to convert all the proteins into amino-acids, from the practical standpoint six hours' pre-digestion, at a suitable temperature and with a liberal supply of pancreatic extract, is sufficient.

But milk which is pancreatized for this prolonged period is apt to become contaminated and nauseating to the taste by the simultaneous development of putrefactive bacteria; for this reason, it is very necessary to sterilize the milk thoroughly before commencing the operation, and to boil it again at the end of the proceeding, or even during the period of digestion.

It is further necessary to remember that the

[1] *The Lancet*, June 28, 1913, p. 361.

infant should gradually be taught to digest its own food. For this reason the milk, which at first should be very thoroughly digested, should be pancreatized less and less with each succeeding day. I generally advise that the milk should be pre-digested for six hours at first, and for ten minutes less every day, so that in thirty-six days from the time of commencement, the infant will be taking completely undigested milk. By this method, most excellent and reliable results can be obtained; it is, however, important to insure that the pancreatic extract is active, that the amount of food given at each feeding and the intervals between feeding are adjusted to the physiological requirements of the case.

For many years past, clinicians have argued as to the respective merits of boiled milk, unboiled milk, milk scientifically modified, or milk diluted haphazard, as a food for infants; but now, thanks to the researches of the modern physiologist, we know that all of them can be good foods or bad foods, according to the previous experiences of the infants. An infant can be taught to digest any food, but it cannot digest a new food at the first trial any more successfully than a child can play the piano before it has learnt the notes. A very important physiological principle to remember is that almost every living cell can acquire, *de novo*, the special catalytic properties which are necessary for the splitting up or digestion of food substances. Some cells, how-

ever, have greater powers in this respect than others, and the cells concerned in the processes of digestion are highly endowed with this function. For instance, enzymes or catalases are required for splitting up the different varieties of sugars, and these enzymes are improvised by the cells as necessity requires. Dr. R. S. Frew[1] has shown that if the sugar of a young child is changed from one variety to another, the new variety will remain undigested for a few days, until the cells of the organism have accommodated their metabolic processes to the change, and have learnt to supply the new catalytic agent.

In disease we see many evidences of the same phenomenon, although under such pathological conditions the tissue cells rather than the digestive cells are concerned in the production of the catalyzing agents. Immunity to disease is an acquired property of the cells, and so is their capacity to deal with foreign foods; in fact, the processes are supposed to be practically identical, and in both cases, when once the lesson has been learnt, the knowledge remains a more or less permanent possession.

Thus, during childhood the organism learns how to protect itself against a great number of diseases—for instance, against measles, chicken-pox, whooping-cough, scarlet fever, tuberculosis, and a whole host of other diseases. As a rule the lessons, which are somewhat sharp and severe, are not forgotten, but

[1] *The Lancet*, November 4, 1911, p. 1264.

sometimes we come across refractory cases in which the individual only acquires immunity with difficulty, or not at all. This is perhaps more often the case with tuberculosis than with any other disease. In certain cases which are not thoroughly understood, one attack renders the individual more susceptible to, rather than more immune from, subsequent infection. This curious condition, known as "anaphylaxis," is well known in connection with hay-fever, asthma, and influenza, and it is also a well-known phenomenon in connection with drugs—for instance, one small dose of arsenic may render an individual highly sensitive to its action; indeed, so much so that hereafter the smallest dose may produce toxic effects.

There is a strictly comparable phenomenon in the case of different articles of diet: shellfish or almonds at times produce the most intense urticarial rashes, and some babies, and for the matter of that, some grown-up individuals, display such marked intolerance of cow's milk that as an article of diet it must be permanently given up. Anaphylaxis, both in the domain of pathology and of dietetics, is clearly a stage in, or a complement to, immunity; but its exact significance and the best methods of dealing with it are not yet clearly understood.

The phenomenon of anaphylaxis—or "*allergy*," as it has been called by von Pirquet—in its relationship to food idiosyncrasies must clearly be distinguished

from another form of intolerance to special articles of diet, which has a purely psychological basis. The lower nerve centres of the brain and their subconscious activities play a very important part in the behaviour of the infant. Young infants behave purely as automatons; in response to suggestion they act exactly like deeply hypnotized persons or well-trained animals.

In older individuals, in whom the powers of reason have become developed, the direct influence of suggestion may be counteracted by innumerable inhibitions, but in babies, animals, and hypnotized individuals the call of suggestion is imperative, and the exact form the response takes is determined by the nature of the previous responses—in other words, by habit. Thus, to take a simple example, the sucking reflex is one of the earliest and most easily elicited of all the inborn mechanisms of an infant; the imperativeness of this habit is well illustrated in the tyrannical and pernicious influence of the "comforter." The presence of a teat between the lips acts as the suggestion to suck, and the younger the infant the more imperative the call; but as the infant grows older, inhibitions and conflicting reflexes interfere with the purity and spontaneousness of the response. We find, for instance, that in giving test-feeds to infants at our infant consultations at the St. Marylebone General Dispensary, quite young infants take the breast better than older

infants, because the latter are more easily distracted by the strangeness of the environment—in other words, by conflicting stimuli.

As an instance of the influence of suggestion in quite a young infant, I would refer to the case of a baby, two months old, under the care of Dr. W. G. Cazalet, of Sutton:

This baby had a very severe spastic diplegia, from which it subsequently died. My opinion was asked as to whether any further steps could be taken to restrain the severe spasm into which the muscles passed the moment they were brought into action. The condition had been treated with some success by galvanism—that is to say, in so far that the spasm relaxed by the application of the positive electrode to the affected muscles. The interesting feature of this case, and the one which illustrates the point I wish to make clear, is that relaxation of the spasm resulted equally well whether the electric current was turned on or not from the battery; in other words, the laying on of the electrode acted by suggestion and not by reason of the direct action of galvanism.

I could give many other examples of the uses to which suggestion can be applied in the training or treatment of infants; but when we realize that all their actions are dictated by suggestion, the multiplication of examples become superfluous.

In conclusion, however, I must give one instance

of the manner in which suggestion acts in determining the so-called "food idiosyncrasies":

A fat, flabby baby, fed on condensed milk, was brought to my infant consultations for treatment and advice. Among other details, I recommended that the infant should be gradually weaned from the condensed milk, and placed on a diet of desiccated milk. I gave explicit instructions as to how the substitution was to be carried into effect.

Unfortunately, the mother gave too large a quantity of the dried milk on the first occasion, thus omitting to give the infant time to accommodate itself to the changed digestive requirements, with the consequence that the infant was violently sick. Hereafter the baby was sick every time it was supplied with the desiccated milk, no matter how little was given at a time. I came to the conclusion that this was due to suggestion and not to anaphylaxis. And to prove the truth or the reverse of this view, I instructed the mother to try the effect of adding the dried milk in such a way that the infant could not follow the operation with its eyes or ears, for I believed that the sight or the sound of the milk being taken out of the tin might be the effective stimulus. On the occasion of her next visit, the mother reported to me the success of the experiment, and told me that when the food was mixed in an adjoining room, the infant could take equal quantities of dried milk and condensed milk without vomiting. As a control experiment, I now instructed her to go through the process of opening the tin and of pretending to add some of its contents

to the condensed milk, but to be careful not to allow any of the milk powder to reach the bottle. The success of the experiment was again most striking in proving the psychological basis of the idiosyncrasy, for now the infant vomited just as persistently as he did when the milk was really added.

Cases of this kind—and I have had several experiences of them—illustrate very forcibly how important the psychological factor is in the management of infants, and how carefully the motives of an infant's behaviour should be investigated by the analytical method.

In this chapter I have attempted, I am afraid with conspicuous ill-success, to show how necessary it is to remember that, in dealing with infants, the general principles of physiology have applications no less important than in the case of older individuals. I have attempted to show that, as far as protein metabolism is concerned, the organic chemist has given us a lead which we should not be slow to follow. I have attempted also to show that the phenomena of immunity and anaphylaxis have their counterpart in various degrees of tolerance and intolerance, shown by different individuals for different kinds of food. I have also directed attention to the paramount importance of suggestion in the instigation of otherwise inexplicable actions in infants.

CHAPTER III

Some Physiological Principles concerned in the Determination of the Quantitative Food Requirements of Infants

The quantity of food required by infants of different ages and of different weights has been determined not only by the direct calorimetric method, but also indirectly by the test-feed.

The calorimeter method is based on the law of the conservation of energy; that is to say, it is assumed that the energy expended in work, heat production, and other vital activities, is equivalent to the potential energy of the food consumed.

An infant confined in the chamber of a calorimeter is to all intents and purposes an animal at rest. So that, although a considerable amount of energy is expended in the internal work of the body—in carrying on the functions of respiration, circulation, and so on—practically the whole of it is finally converted into heat in overcoming friction or other resistances, and as such can be estimated by calorimetric methods.

We can therefore make a theoretical calculation of the food requirements of the average baby by esti-

mating the average amount of heat lost by infants when confined in calorimeters, due allowance, of course, being made for the energy consumed in growth, or stored up in the form of food reserves.

Calculations of this kind have in the past been repeatedly made by competent observers, and, although their results vary[1] very considerably, they mostly appear to agree in the important respect that the heat dissipation—or, in other words, the food requirement—varies more or less directly with the extent of the skin surface of the baby, and not with the weight or age.

Careful measurements of the superficies of infants of different weights have been made, and it is found that the skin area of a baby weighing 5 kilogrammes (11 pounds) measures 0·350 square metre (3½ square feet), while that of one weighing 10 kilogrammes (22 pounds) measures 0·555 square metre (5½ square feet), and that of a child weighing 40 kilogrammes (88 pounds) measures 1·442 metres (14½ square feet).

Therefore the amount of heat lost by children of the respective weights of 5, 10, and 40 kilogrammes will stand in the proportion of 0·350, 0·555, and 1·442, and not in the proportion of 5, 10, and 40, as might naturally be assumed.

In accordance with these views, the reason why the dissipation of heat is supposed to be in proportion

[1] Pfaundler and Schlossman, American edition, vol. i., p. 435 (second edition).

to the superficial area, and not to the weight, is because the heat is chiefly lost by radiation and conduction from the skin. As a matter of fact, under normal conditions some 60 per cent. of the total heat dissipated is lost by radiation and conduction, some 35 per cent. by evaporation of water at the surface of the skin and of the lungs, and the remaining 5 per cent. is lost in the urine or in other discharges from the body. Since some heat is lost by evaporation of water at the lungs' surface, it cannot be even theoretically true that the heat lost is proportional to the skin area.

Now, since the quantity of food required by any particular infant is dependent on the amount of heat lost by radiation, conduction, and evaporation, and since the amount of this loss is itself chiefly dependent on the superficial area of the skin, it has been supposed to be quite easy, provided the amount of heat lost by any one given infant of known weight is known, to calculate from the known data the food requirements of any other infant situated under similar circumstances.

From such simple data it has been estimated that during the first three months of life an infant requires enough food to supply 99 calories or units of heat for every kilogramme (2 pounds 3 ounces) of body-weight; a calorie, or unit of heat, being that amount of heat which is required to raise 1 litre (35 ounces) of water through 1° of temperature (Centigrade).

For instance, an infant two and a half months old and weighing 5 kilogrammes (11 pounds) will require in the twenty-four hours enough food to produce 495 (99 × 5) calories. By a similar method of calculation it has been estimated that on an average during the next three months infants will require the equivalent of 94 calories per kilogramme (2 pounds 3 ounces) of body-weight; or, to take a concrete example, an infant five months old and weighing 7½ kilogrammes (16½ pounds) will require a food equivalent of 705 (94 × 7·5) calories. Again, on the same basis, it has been estimated that during the last quarter of the first year of life an infant will require a food equivalent of about 75 calories for every kilogramme (2 pounds 3 ounces) of body-weight.

Now, how much milk will infants of different ages and different weights require to afford this theoretical number of calories ?

The amount of heat or the number of calories afforded by the combustion of milk is not absolutely constant, because the chief heat-producing element in milk—namely, fat—is itself liable to variation, but on an average it may be assumed that 1 litre (35 ounces, or 1¾ pints) affords on combustion 700 calories.

If a more accurate estimation of the caloric value of any particular milk, or milk mixture, is required, it may be made from the following data: 1 gramme (15 grains) of fat will produce 9·1 calories, 1 gramme

of sugar will produce 4·1[1] calories, and 1 gramme of protein will also afford 4·1 calories.

On the basis of the above data it is quite easy to calculate how much milk of any particular percentage composition babies of different ages will require. Let us take the simple example of an infant three months old weighing 5 kilogrammes (11 pounds). In twenty-four hours such a baby will dissipate 495 (99 × 5) calories in the twenty-four hours.

How much milk will be required to afford this number of calories ? If 1 litre (35 ounces) affords 700 calories, by quite a simple sum in proportion it may be shown that 495 calories are afforded by 700 c.c. (24½ ounces).

Theoretically, therefore, an infant of the above age and weight will require 700 c.c. of milk to compensate for the 495 calories of heat it is estimated to lose in the twenty-four hours by radiation, conduction, and evaporation; but it will also require a certain additional amount to provide for growth or increment in weight.

On an average, a healthy infant of this age will show an increase in weight of nearly 30 grammes (1 ounce) during the twenty-four hours. How much milk will be required to afford material for this growth ?

The proportion of solid constituents in the baby's

[1] The caloric value of ordinary hydrous lactose is 3·78, while that of the anhydrous variety is 4·1.

body is rather more than twice as much as that in milk, exactly in the proportion of 28·2 to 12, so that assuming that the solids of milk are of the same kind as those of the body, the baby must consume about 60 c.c. (2 ounces) of milk in the twenty-four hours to provide 30 grammes increment in body-weight. This, added to the 700 c.c. required for heat-production, will give a grand total of 760 c.c. (26½ ounces) of milk in the twenty-four hours.

Calculations such as these may have some value in giving us a general conception of the quantitative food requirements of infants, but if we rely too implicitly on them in calculating the dietary of any particular infant, we are quite certain to go widely astray. A baby in a calorimeter does not behave as a baby in the nursery; it is situated under strange and unnatural conditions. Indeed, for the most part infants in calorimeters become restless and fretful, and cry continuously, thereby wasting much energy and dissipating a considerable number of units of heat by evaporation of moisture at the lungs' surface. And, further, we have no right to assume that under the equable conditions of temperature obtaining in the calorimeter the amount of heat lost by radiation and conduction is the same as that which is lost under the ever-varying conditions of a normal environment.

Then, again, appetite, and consequently digestion and absorption, will be influenced by the strange

conditions, and a number of other complications will be introduced which must necessarily detract from the accuracy of the calorimeter results. Without entering into further details, it is obvious that the conditions which determine food requirements in a calorimeter are not identical with those which determine food requirements in a nursery.

The more recent work of Dr. P. Lavialle[1] shows how important are considerations of clothing in estimating the amount of heat lost by radiation and conduction—in other words, how enormously an infant's food requirements are modified by its clothes. Dr. Lavialle, using a calorimeter of the D'Arsonval type, experimented with infants wearing different articles of clothing. Leaving the babies in the calorimeter for varying periods of time, he estimated the exact number of calories which were lost by radiation and conduction in accordance with the nature and character of the clothing worn. He found, for instance, that if an infant wore a simple bonnet which covered the parietal and occipital portions of the head, there was an actual saving in heat expenditure which was equivalent to 65 calories, or to the combustion value of 60 c.c. (2 ounces) of milk. In other words, an infant wearing such a bonnet requires, *ceteris paribus*, 2 ounces less milk in the twenty-four hours than an infant without

[1] Congrès National des Gouttes de Lait ténu à Fécamp les 26, 27, et 28 Mai, 1912; Report, p. 79.

such a covering to the head. Further, he estimated by the same method of experimentation that if the legs were protected by suitable stockings an economy of 220 c.c. (6½ ounces) was effected, and that the difference in heat expenditure when woollen and cotton shawls were used was represented by an equivalent 70 c.c. (2½ ounces) of milk.

Such experiments prove how dangerous it is to attempt to apply theoretical principles to the practical management of infants; it is so easy to leave important factors out of the calculation. There can be no doubt at all that the most important factor in an infant's requirements for food is the factor of heat dissipation. An infant at rest utilizes at least 80 per cent. of its food in maintaining its body temperature at the required level: unlike an adult, it diverts but little energy into the channels of mechanical work; and, as we now know, although it grows rapidly, the amount of food required for this purpose is only equivalent to the intake in the twenty-four hours of some 60 grammes (2 ounces) of breast-milk. It therefore seems almost unaccountable that in the past the question of clothing and environmental temperature should have been taken so little into consideration. A few weeks ago I discussed these matters with a lady who takes a great interest in infant-welfare work. "It seems to me," she said, "that it would be of great interest to calculate how many garments a baby would have

to wear to enable it to do without any milk at all. I think some of our mothers must unconsciously be trying to solve this problem if we are to judge by the multiplicity of clothes they crowd on the bodies of their unfortunate infants." Such a *reductio ad absurdum*, if properly appreciated, emphasizes the important part that clothing plays in the feeding of infants.

I feel sure that it is very necessary to draw attention to this side of the question, for we have only to read the writings of even the greatest authorities on infant feeding to learn how largely this aspect of dietetics is neglected. Professor W. Camerer is probably one of the greatest authorities in the world on the food requirements of infants, but this is what he says in his otherwise most admirable article on "Metabolism and Nutrition" in Pfaundler[1] and Schlossman's textbook on *The Disease of Children*: "The influence of heat and cold can be nearly eliminated by means of clothing and dwellings."

That is to say, Professor Camerer suggests that clothing and housing conditions do not affect the question of food requirements, that in these respects all children are similarly situated, and that their different food requirements depend on other factors.

I would, however, go so far as to say that in estimating the food requirements of any particular infant, the *one* important factor that we ought to

[1] Second American edition, vol. i., p. 381.

take into account is that which is concerned with heat production. I do not mean by this that we must not take into consideration such matters as capacity to digest and assimilate food, habits, idiosyncrasies, and so on; all such factors are of great importance. What I mean is this—that, given two infants of equal ages and equal weights and growing at the same rate, and with normal digestive and assimilative functions, their respective food requirements, apart from the very small quantity required for growth and work, will be mainly dependent on the amount of heat that is lost by radiation, conduction, and evaporation of water. To put the case more concisely, I maintain that the different amounts of food these two infants will respectively require will be dependent on the number and thickness of their clothes, on the amount of skin area (face, head, hands, feet, etc.) exposed to the air, on the temperature of the surroundings, on the degree of humidity of the air, on the ventilation, on the temperature of the bath, and on the number of hours spent in the open air, or in the confinement of the house, and that these factors may be entirely different in the two cases and necessitate totally different quantities of food.

I repeat that it gravely misrepresents the case to state that "the influence of heat and cold is eliminated by the means of clothing and dwellings." I admit that the influence of "*cold*" is almost elimi-

nated in the case of the slum infant, who is wrapped in a multiplicity of garments, sleeps in its mother's arms or in her bed, and is seldom given a bath or taken out of doors; but I submit that therein lies the difference between such an infant's food requirements and that of an infant rationally managed with respect to clothing, housing, exercising, etc.

In the one case there is no opportunity for heat dissipation, and hence there is an extremely restricted demand for heat production, and consequently for food, while in the other, although the demands may vary greatly with the circumstances, there is usually ample opportunity for loss of heat and always a corresponding demand for food.

Although in the past I have myself been guilty of drawing up many a table of quantities for the feeding of infants of varying ages, I now fully admit that such tables are worthless unless other important considerations, such as those of clothing, housing, and airing, are simultaneously taken into consideration and allowances made for them.

I have long held the view that these calorimeter results may be most misleading in determining how much food any particular baby requires. In the first place, an infant acquires certain "habits" of metabolism as the result of its previous experiences in diet. For instance, one baby may be fed on 800 c.c. of breast-milk in the twenty-four hours, and another of the same weight and size may con-

sume a daily allowance of 1,600 c.c. Now, if the first baby is healthy and deals physiologically with its 800 c.c. of milk, it will show an output of half as many calories as the second baby, provided the latter also behaves in a similarly physiological manner. The first baby does not give out half as many calories as the second baby, because it only requires to produce this particular amount of heat to maintain a normal temperature under the particular conditions of the environment; but because it must dissipate this particular number of calories in correspondence with the quantity of food digested and absorbed, or otherwise there would be a storing up of heat or of energy in some other form in the body, which, as Euclid says, "would be absurd." An infant accustomed to consume 1,600 c.c. of milk in the twenty-four hours acquires habits of rapid metabolism and active heat dissipation, which are very different from the sluggish habits acquired by the infant which consumes only half this quantity of milk. These habits become very inveterate, and make the subjects of them behave quite differently though the external conditions of the environment to which they may be respectively exposed are precisely similar. These habits must be taken into consideration in determining dietaries.

There can be no doubt that the actual quantities of food given to different infants do not determine accurately the quantity of heat dissipated, for this

food may only in part be digested and absorbed; and although decomposition of food in the bowel may generate heat, the amount of heat thus produced is not equivalent to the full caloric value of the food consumed. On the other hand, the external conditions will not evoke in different infants precisely the same degree of combustion. Combustion and heat production must depend more on muscle activity and muscle tonus than on any other factor, although the factor of muscle tonus itself may depend on a vast number of afferent impressions reaching the central nervous system, and on the manner in which the nerve cell reflects these impressions and passes them on to the muscles. The whole question of muscular development and muscular tonus, and indeed voluntary and involuntary movements, must be very largely concerned in this question of heat production; hence the unreliability of the calorimeter results in the sense in which they have been employed. The surface stimulation, by changing currents of air impinging on the skin of an infant, must clearly influence muscular tone and muscle metabolism to a very large degree. The monothermic conditions of a calorimeter must deprive the infant of its normal share of such surface stimulation; hence the findings of calorimeter experiments cannot be too exactly applied to ordinary nursery conditions in which the ever changing events will excite the muscles to voluntary movements or

varying degrees of tonus. At the time of writing this I am not fully in possession of a number of interesting facts bearing on this subject, which Dr. Fritz Talbot, of Boston, tells me are undergoing investigation at the Carnegie Institution in Washington.

The second method of estimating the quantitative food requirements of infants—namely, the empirical one of calculating the average amount of milk consumed by healthy infants at the breast—has provided us with a large amount of data for drawing up standards for the artificial feeding of infants; but I submit that deductions drawn from these findings are themselves as liable to misconstruction and misrepresentation as are the results of the more scientific calorimetric method.

The amount of food consumed by breast-fed infants has been estimated by the method to which some years ago I ventured to apply the term "test-feed"; that is to say, the infant is weighed on accurate scales before and after feeding; the difference between the two weighings represents the amount of food consumed. By making a number of such estimations, or by estimating the amount consumed at each feeding, certain averages have been arrived at, which are supposed to represent the average requirements of normal infants, and these figures have been indiscriminately applied to the case of all infants no matter what be the circumstances of the hygienic surroundings.

Now, the point that I wish to make perfectly plain is that the observations on which we rely have been made on infants living under the very best hygienic condition. Some of them have been the observer's own children, while some of them have been infants born and tended in public maternity institutions, where every care and attention have been lavished on the mother, and the standards thus arrived at have been supposed to be applicable to the case of the slum infant, who may be living under the worst possible conditions of housing, ventilation and general hygiene.

A considerable number of figures have been provided by such means, and on the whole I find the standards thus estimated agree very closely with the standards I have myself formed from estimating the amount of breast-milk consumed by the infants of well-to-do mothers in England. On the other hand, until a series of observations were undertaken to show the amount of breast-milk consumed by the average slum infant, there was no criterion whereby to judge how much food such infants commonly consume. It was taken for granted that they obtained as much milk as the better-conditioned infants on whom observations had actually been made.

During the last eight years I have made a practice of giving each breast-fed infant who is brought to my clinics a test-feed, or perhaps many test-feeds.

In this way I have accumulated an enormous amount of evidence on the subject.

It is true that I have not been able to make an estimation of all the feeds given in the twenty-four hours in any one particular case. I have had to content myself with estimating the average amount consumed in the twenty-four hours by multiplying the amount consumed at one feed by the number of feeds taken in the whole day; but all the same, I have now made so many estimations at different hours of the morning, afternoon, and evening that I feel sure that my averages for single feedings, and consequently for the twenty-four hours, are fairly accurate. In estimating the total amount taken in the twenty-four hours from the amount taken at a single feed, one must allow for the total number of feeds and for the fact that the largest feed in the day is usually the first feed in the morning after both mother and infant have enjoyed a long rest. Further, one must make some allowance for the fact that in the strange environment of a dispensary or a hospital an infant will not attend to the business of sucking quite as well as in the home. But making allowance for all such sources of error, I find that the average consumption of breast-milk by the slum infant is about 33 per cent. less than the estimates given by German observers for institute infants, or than the estimates I have myself made in the case of infants in well-to-do families.

An examination of the following tables will show how widely my figures differ from the standards arrived at by foreign observers; it will further show how closely my own estimates agree with the figures independently arrived at by Dr. Ronald Carter, who carried out a similar series of experiments on the infants attending at his infant consultations in North Kensington.

In the first horizontal column I give my own figures, which refer to test-feeds conducted in the case of slum infants attending at my infant consultations in Marylebone. In the second column I give those of Dr. Carter, which apply to a similar class of infant attending at his infant consultations in North Kensington. In the third column I give my own figures for sick infants attending at my out-patient department at the Queen's Hospital for Children, Hackney, a very poor district in the north-east of London. In the remaining columns will be found the figures supplied by German observers. These refer for the most part to institutional infants, or to private cases in a good position of life. My figures, as well as those of Dr. Carter, are based on a very large number of observations, whereas those of the German observers depend sometimes on a single observation, sometimes on small groups of cases, but in no case on a large number of estimations.

If we compare this series of figures, we notice at once that the amount of breast-milk consumed by

TABLE I.—SHOWING THE AVERAGE AMOUNT OF MILK CONSUMED AT A SINGLE TEST-FEED DURING THE VARIOUS AGES UP TO NINE MONTHS ACCORDING TO DIFFERENT OBSERVERS.

		Age in Weeks.			Age in Months.							
		2	3	4	2	3	4	5	6	7	8	9
		Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.
Slum infants in London	Marylebone figures	1·87	1·62	1·95	2·04	2·26	2·23	3·00	2·81	3·08	2·67	—
	Kensington figures	—	1·75	1·85	1·80	2·00	2·15	2·5	2·67	2·72	2·93	3
	Queen's Hospital figures	—	1·00	1·47	2·00	1·84	1·35	2·18	3·00	2·08	—	—
Institutional infants or private cases in Germany	Peter's figures ..	2·4	2·7	2·87	5·42	—	—	—	—	—	—	—
	Camerer's figures ..	2·5	3·5	3·5	3·5	4·5	3·5	—	—	—	—	—
	Beuthner's figures	2·0	2·25	2·75	3·25	4·5	4·5	5·0	—	—	—	—
	Freer's figures ..	2·5	2·8	3·5	4·0	4·5	4·8	4·8	—	—	—	—
	Hachner's figures	2·5	2·5	3·0	5·25	5·5	5·25	5·5	5·5	7·0	—	—

TABLE II.—SHOWING THE AVERAGE AMOUNT OF MILK COMPUTED TO BE CONSUMED IN THE TWENTY-FOUR HOURS BY INFANTS OF VARYING AGES.

		Age in Weeks.			Age in Months.						
		2	3	4	2	3	4	5	6	7	8
		Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.
Slum infants in London	Marylebone infants	18·8	14·77	13·46	16·38	16·02	15·85	13·00	18·25	20·66	12·0
	Kensington figures	—	16·50	14·50	20·00	14·50	13·20	17·20	21·50	15·40	26·2
	Queen's Hospital figures	8·0	—	9·71	18·15	14·30	11·66	9·16	16·25	12·00	12·0
Institutional infants or private cases in Germany	Camerer's figures ..	19·0	20·00	28·00	28·00	28·25	30·50	33·00	33·50	—	—
	Freer's figures ..	17·5	15·00	20·00	27·50	26·25	27·00	28·00	34·00	30·50	—
	Beuthner's figures	13·0	18·00	19·50	27·00	28·50	28·00	—	—	—	—
	Peter's figures ..	16·0	17·00	20·00	21·00	—	—	—	—	—	—
	Hachner's figures	15·0	19·00	19·00	28·00	28·00	26·00	30·00	33·00	44·00	—

the slum-infant in London, as estimated by Dr. Carter and by me, is considerably less than that which is consumed by the better class of German infant.

Take, for instance, the case of the three months old infant in Table II. Slum infants of this age consume on an average, according to my figures, about 16 ounces (480 c.c.) in the twenty-four hours. According to Dr. Carter, such infants consume in Kensington 14½ ounces (435 c.c.), an amount which is exactly the same as the sick infants of this age consume in Hackney. On the other hand, if we refer to the figures given by Camerer, Freer, Beuthner, and Hachner, we find that, according to their estimates, infants of this age consume quantities which vary from 26 ounces (780 c.c.) to 28½ ounces (855 c.c.). Feeling that even my own figures in these tables were based on too small a number of individual estimations, I recently repeated my original experiments, and estimated the average amount of all the test-feeds conducted at the St. Marylebone General Dispensary subsequent to the date at which the first figures were published.[1]

These control figures I give in Tables III. and IV. (p. 84). I give also the number of actual test-feeds on which these estimations are based. These test-feeds were given at the St. Marylebone General Dispensary between the dates April, 1911, and September, 1913.

[1] *The Lancet*, September 2, 1911.

These figures are to my mind extremely interesting, for they show that the infants in my second

TABLE III.

AVERAGE AMOUNT OF BREAST-MILK CONSUMED AT A SINGLE FEED BY SLUM INFANTS IN MARYLEBONE (BETWEEN APRIL, 1911, AND SEPTEMBER, 1913).

	Age in Months.							
	1	2	3	4	5	6	7	8
Quantity of milk consumed ..	Oz. 1·94	Oz. 2·50	Oz. 2·75	Oz. 2·37	Oz. 3·37	Oz. 3·37	Oz. 2·56	Oz. 2·50
Number of estimations on which figures are based ..	60	43	20	20	10	8	4	2

TABLE IV.

AVERAGE AMOUNT OF BREAST-MILK COMPUTED TO BE CONSUMED DURING THE TWENTY-FOUR HOURS BY SLUM INFANTS IN MARYLEBONE (APRIL, 1911, TO SEPTEMBER, 1913).

	Age in Months							
	1	2	3	4	5	6	7	8
Quantity of milk consumed ..	Oz. 17·36	Oz. 20·68	Oz. 18·20	Oz. 18·20	Oz. 22·40	Oz. 20·30	Oz. 18·21	Oz. 17·72

series (Tables III. and IV.) obtained more milk than those of my earlier experiments (Tables I. and II.). The increase is so constant and uniform

that I cannot assign it to any other cause than that, owing to my experience with the test-feed, and to the lessons that I derived therefrom, I have been more successful of late years in overcoming the difficulties connected with the management of lactation, and because I have exercised more care in securing that the infant manifests a greater demand for food by modifications in the clothing and in other hygienic conditions.

But from whatever point of view these figures are regarded, they afford ample material for reflection. For instance, if we are faced with the duty of determining the quantity of food which should be given to an artificially fed infant, are we better advised in following the standards afforded us by the German observers or in taking our cue from the exiguous breast allowances consumed by the slum infant as estimated according to my own tables? This depends, I believe, on the hygienic surroundings of the child.

Here in London we know that the mortality from diarrhœa and wasting diseases is on the whole much greater among the artificially fed than among those fed at the breast. How is it that the mortality rate is so low among the latter, and why is it so high among the artificially fed infants, who receive a very much larger amount of food? And that the latter do receive a much larger quantity of food is known to everybody with any experience of the

methods of artificial feeding indulged in by the poor mothers of London.

I am quite sure that on an average the artificially fed slum infant receives 30 to 60 per cent. more food, estimated according to its caloric value, than does the breast-fed infant of the same age.

Now, my more recent statistics in Marylebone prove that among the infants attending regularly at my infant consultations, those who are artificially fed show a slightly lower proportion of cases of diarrhœa and malnutrition than those who are breast-fed. I attribute this result entirely to the fact that my long experience with the test-feed has taught me that the average slum infant requires very small quantities of food, and that on small quantities of food, if the latter is quantitively adjusted to the physiological needs, it can fare extremely well, and avoid attacks of diarrhœa even in hot weather.

As I have already explained, the quantity of food required by the infant is determined by three factors: (1) The rate of growth, (2) the mechanical work done, and (3) the quantity of heat required to maintain the bodily temperature. The first factor is almost negligible, so that for all practical purposes the amount of food an infant requires to meet its physiological needs resolves itself into the questions—How much energy does it use up in voluntary movements, in involuntary movements, and in the maintenance

of muscular tonus? and How much heat will it lose by radiation, conduction, and evaporation of moisture ?

The slum infant is as a rule enveloped in many more thicknesses of clothing than the well-to-do baby; it is kept in hot, ill-ventilated rooms; and, in fact, is deprived of all those essential stimulants which evoke voluntary and reflex muscular movements, raise tone, and create a demand for food. I feel convinced, therefore, that Nature, in supplying such slum infants with a very restricted allowance of breast-milk, is wiser than we are when we feed them artificially on rations which are physiologically adjusted to infants with greater food requirements, with a more active metabolism, and with better opportunities for dissipating heat.

I hope I shall not be misunderstood when I say that the ordinary slum infant, if artificially fed, should be fed on a very restricted dietary. I do not approve of starvation in any form. I do not feel I have done my duty unless the infants for whose health I am in any way responsible manifest a demand for an adequate allowance of food. A greater demand is created by less clothing, by more air, by more sun, by more exercise, and by a more liberal supply of all those stimuli which quicken the vital processes and induce tonus. With a greater demand for food there should be a correspondingly greater supply, but to give increased quantities of food before there is a physiological requirement for it

is to court disaster. Indeed, the human body positively bristles with mechanisms which protect it against the pathological consequences of excessive feeding. Some of these effect their object at very little expense to the comfort and well-being of the individual; others entail considerable strain.

The simplest mechanism for counteracting the dangers due to excessive feeding, with which the human organism is equipped, is that which provides for the storing up of the excess in some form available for future use. Carbohydrates and fats can be most conveniently and safely stored up in the form of reserves of glycogen and fat; on the other hand, there is no natural provision for the storage of reserves of nitrogenous or proteid foods; such supplies must be put to immediate physiological use, or expelled from the body. Such expulsion clearly entails expenditure of energy as well as wear and tear to the eliminating organs.

Next to storage, it is probable that increased combustion is the readiest means of defence against the dangers consequent on the excessive consumption of food, and this method of disposal applies to all classes of food. In order that there may be an active combustion it is essential that the supply of oxygen should be ample, and that the metabolic processes should be maintained at a high level. When such is the case, all varieties of food are oxidized or reduced to their normal end-products, carbonic acid, water,

and urea, with the production of a corresponding quantity of heat. On the other hand, if there is curtailment in the supply of oxygen, there may be a short-circuiting of these processes, and in such circumstances the oxidation is incomplete, the heat produced less, while a number of intermediate bodies, such as fatty acids, are formed which dispose to a condition of acidosis with all its attendant evils. Subsidiary lines of defence consist in loss of appetite, diarrhœa, vomiting, catarrhs, and mucous discharges, all of which are designed to preserve the life of the individual as a whole, though they may inflict damage on certain of its parts.

When anyone of these protective mechanisms is brought into play, the fact is revealed by the specific character of the pathological symptoms produced. Some of these may be so trivial as to escape all but the keenest observation, while others may be so obtrusive as to attract the attention of the most dull-witted observer.

An abnormal increase in weight, say of 10 to 14 ounces per week, in a baby under a year old, if maintained for any prolonged period of time, should at once suggest that the storage resources of the body are being strained, and such an event should lead us to expect that when the critical limit is reached, resort will be made to inner lines of defence, with possibly more serious consequences to the individual as a whole. Such inner lines of defence are

represented by short-circuited oxidations, diarrhœa, catarrhs, and fevers.

Again, if the capillaries of the cheeks are dilated, if there is sweating about the head, and if the respiration-rate is unduly raised, we are entitled to suspect, in the absence of a better explanation, that reserve methods of heat-dissipation are being called into requisition. Then, if we are wise, we shall take steps to insure that worse things do not befall the child. We should, in fact, curtail the supply, or increase the physiological demand for food.

It is clearly the duty of the physician to exercise the greatest vigilance in the detection of these early symptoms, but it is very difficult to convince the lay mind that rosy cheeks and a fine weight record can be of unfavourable augury. It is a matter of almost daily experience to find that attacks of bronchitis, diarrhœa, or intestinal toxæmia have been preceded by prolonged periods of apparently exuberant health, during which the infant has enjoyed immunity from the effects of overfeeding owing to the protective influence of the first lines of defence. It is only when these fail that the so-called pathological symptoms manifest themselves. But during this preliminary stage of relative immunity it must not be supposed that the organism is in a good state of health nor in a safe condition.

Although it is quite easy to suggest that artificially fed slum infants are often overfed, it is quite a

different story to define an optimum dietary for such infants. Hedging myself in with all possible reservations, and with full knowledge of the scientific difficulty of forming any such estimates, I venture the statement that no infant, breast-fed or artificially fed, can be considered to be in a satisfactory condition if its physiological demand for food is below the following approximate standards: An infant three months old and weighing 5 kilogrammes (11 pounds) should not require less than 690 c.c. (23 ounces) of breast-milk, or its equivalent, in the twenty-four hours; an infant six months old and weighing 7·5 kilogrammes (16½ pounds) should not require less than 900 c.c. (30 ounces); and an infant nine months of age should require not less than 1,080 c.c. (36 ounces). If, when taking food in these quantities, there is evidence, by reason of the development of the symptoms already mentioned, that the intake is excessive, I would advise that steps be taken to increase the demand for food by a revision of the hygienic management of the child rather than by cutting down the supply. As I have already stated, a demand is created when the appropriate stimuli of air, light, and temperature are applied.

CHAPTER IV

Motor Functions of the Digestive System

On thinking over the mistakes which I have made in the diagnosis and treatment of cases of so-called indigestion, I am surprised to discover how many of these arise in connection with disturbances of the motor functions of the alimentary tract, and not with disturbances of the digestive functions proper.

When an infant suffers from vomiting, diarrhœa, wind, or colic, we are very apt to think of undigested food, and inactive ferments, and we turn lightly to the evidence of chemical analysis and of naked-eye examination of vomitus or stools to supply the key to the situation. I do not wish in any way to belittle the value of the information thus afforded; but the point I would particularly emphasize is that a very large number of cases of so-called indigestion prove intractable to treatment because we fail to recognize that the symptoms are due to a perverted or inco-ordinated performance of the motor functions—a result which may be dependent more on habit than on the particular qualities of the food which the infant may consume.

The neuro-muscular mechanisms which control the locomotion of food through the body are extremely complicated, and they are dependent for their efficient working, not only during infancy, but during the whole of life, on the nature of their early experiences and education.

Each link in the complicated chain of neuro-muscular co-ordinations which effects the locomotion of food through the alimentary tract, whether it be associated with the act of deglutition, with the rhythmical openings and closings of the sphincters, or with the peristaltic contractions of the muscles of the colon, is dependent on a delicate and complicated reflex, which is initiated in its due chronological order by the act which immediately precedes it, and thus, for the harmonious working of the whole, an indispensable condition is the harmonious co-operation of each part.

It is quite true that errors in diet, and especially errors in diet during the very early days of life, may produce symptoms which we commonly call "indigestion"; but it must be remembered that these symptoms may be perpetuated as bad habits long after the cause which has provoked them has ceased to exist. And thus it comes about that some of the mistakes in diagnosis and treatment which I propose to chronicle in this chapter will be mainly concerned with symptoms which, though originally produced by faulty methods of feeding, were

wrongly ascribed to defects in the food, and were wrongly treated by changes and alteration in the diet. There is only one cure for faulty habits of this kind, and that is "re-education."

There is a reverse side to the picture, which, though it has no immediate connection with the matter in hand, is yet of interest, in that it explains the often incomprehensibly good results which follow methods of feeding which we know on physiological and rational grounds to be entirely wrong. I mean this: If by good methods of educating the bowel in its motor functions we secure efficient and permanent habits, these good habits will persist, misuse them how we may. Let me give you an example. An infant very carefully fed and managed from the day of birth reached the end of the sixth month without having been sick and without having learned to posset. Then, unfortunately, it was given a bottle of sterilized milk which had become decomposed, and when sterilized milk goes wrong in this way, it becomes a very poisonous food. The same milk was given to another infant, in a sense not so well educated, and who had learned both to posset and to vomit. The well-educated infant retained the whole of the food, and nearly died in consequence. The second infant rejected the whole, and was quite well again in a few hours. This illustration would seem to point a doubtful moral, but there must be moderation in all things, even in the

training of good habits. Knowledge of evil is a safe prophylactic against its insidious effects.

These preliminary remarks will explain why in this chapter I lay so much emphasis on the education of the motor functions.

Very shortly after I was qualified I had the good fortune to see a case which was then going the round of the children specialists. It was a case of intractable vomiting in a very young baby, the cause of which was obscure. Every medical man who saw the case suggested some radical change in the character of the food; but in spite of the unremitting attentions of the profession, the infant died when it was about six weeks old. At the autopsy which, happily, was allowed, the œsophagus was found to be enormously dilated with irregular thickenings of the muscles. At its juncture with the stomach the muscles were extremely hypertrophied, and the lumen showed a marked degree of atresia. In many respects the dilated œsophagus, with its sacculations and thickenings, had analogies with the abnormalities we find in cases of congenital dilatation of the colon, or Hirschsprung's disease. Whether in this particular case the dilatations of the œsophagus were of congenital origin, or whether they were secondarily acquired as the result of spasm of the cardia or inco-ordination of the neuro-muscular mechanism concerned in the propulsion of food down the gullet, will never be known; but, reviewing the whole his-

tory of the case as I now remember it, I cannot help inclining to the view that this was a case of cardio-spasm in an extreme form. Of recent years a good deal of attention has been directed both by Lust[1] and Aschenheim[2] to a condition in infants which has been called "rumination," and in which a very intractable form of regurgitation or vomiting persists. It is supposed to be due to some abnormal or perverted co-ordination of the neuro-muscular mechanisms of the œsophagus. I have seen one or two cases which I now conclude were examples of this kind of rumination, but which at the time I did not recognize as such. Further, I am disposed to think that the essential pathogenesis of cases of rumination such as those described by Lust and Aschenheim, of Hirschsprung's disease (so-called congenital dilatation of the colon), and of the case of dilatation of the œsophagus already referred to, is of a comparable, if not of an identical, character in each instance—that is to say, that all these conditions are due to ill-co-ordinated muscular contractions. I cannot understand otherwise how it can be that such marked hypertrophy combined with such marked dilatation can exist side by side. It seems to me that nothing else than persistent spasms in certain sections or areas can account both for the hypertrophy and dilatation. I believe that

[1] *Monatschrift f. Kinderheilk.*, vol. x., No. 6, 1911.
[2] *Zeitschrift f. Kinderheilk.*, 1913, vol. viii., p. 161.

cases of cardio-spasm in infants are much more common than is generally supposed, and that the few published cases in no way represent the true incidence of the condition.

Some little time ago I showed,[1] with Mr. Douglas Drew, at the Children's Section of the Royal Society of Medicine, a case which we then supposed to be one of congenital stricture of the distal end of the œsophagus. Subsequent events, however, proved that the stricture was probably functional, and not organic, in nature; for Mr. Drew at once succeeded in dilating up the lower end of the œsophagus, and since then the infant has been able to swallow thickened fluids with great ease, and the symptoms have practically disappeared. I have seen cases of cardio-spasm in older individuals, and from comparison of the symptoms manifested in such cases, and of the symptoms noticed in the above case, I believe that I have overlooked several instances of the condition, with very serious results to the infants concerned.

Intractable vomiting is by no means uncommon in infants; it may be due to obstruction to the onward flow of the food current at any point in the alimentary canal, and this obstruction may be consequent on persistent muscular spasms, or on other causes. But certainly, in my experience, pyloric

[1] Proceedings of the Royal Society of Medicine, Children's Section, xxxiii., 1913.

spasm is one of the commonest, if not the most common, cause of vomiting of this kind.

The difficulty of making a correct diagnosis in the days when we had no X rays was very considerable; but now, with the aid of a bismuth meal and the X-ray screen, the detection of the exact point at which obstruction occurs is easy and accurate.

At the present time so much attention is given to pyloric stenosis, whether of the congenital or acquired type, that there is small risk of the condition escaping notice. Indeed, in my judgment it is diagnosed, and cures claimed, far more frequently than is justified by events. I remember the time, however, when no mention of the condition appeared in the textbooks, and when its very existence was known only to a few individuals. The first case I saw was in the year 1895, when my old teacher, the late Dr. W. B. Cheadle, asked me to look after a case of his which was suffering from persistent and violent vomiting. Although we both recognized that the symptoms were due to obstruction in the neighbourhood of the pylorus, owing to the waves of contraction which passed from left to right across a greatly dilated stomach, and which were quite obvious to the naked eye, neither of us suspected hypertrophic pyloric stenosis during life, nor at the autopsy, which fortunately was allowed, did we recognize that the condition was one of extreme interest and rarity. Mr. Jackson Clarke,

then pathologist at St. Mary's Hospital, kindly examined the specimen, and reported that the fusiform tumour which surrounded the pyloric orifice was not a neoplasm, but consisted of hypertrophied muscles only. Some years later (1897) I saw an account of the disease in the *Archives of Pediatrics*,[1] written by Dr. H. Asby, of Manchester, which induced me to inquire into the whole literature of the condition. I subsequently made a list of all the known cases, and finally published my account in the *Archives of Pediatrics*.[2] Placed in its chronological order, this case was the twenty-fourth to be recorded, but since that time an enormous number of cases have been published, and a great literature has grown up round the subject.

Now, passing from symptoms due to inco-ordination of the neuro-muscular mechanisms of the upper reaches of the alimentary canal, concerning which mistakes in diagnosis are often made, to symptoms connected with the motor functions of the large and small intestine, I would preface my observations by stating that mistakes in the diagnosis of such conditions usually arise in connection with one or other of the following symptoms—(1) Diarrhœa, (2) constipation, and (3) colicky pains.

Now, as regards the first of these symptoms—namely, diarrhœa—I feel convinced that this is

[1] *Archives of Pediatrics*, 1897, p. 498.
[2] *Ibid.*, 1900, p. 241.

often wrongly attributed to some indigestible quality of the food when the true explanation is hypersensitiveness of the neuro-muscular mechanism concerned in the locomotion of food through the intestinal canal, a condition which is commonly known as "lienteric diarrhœa." I see many cases of this kind in which change after change in the character and quality of the food leaves the infant in exactly the same loose condition of bowel. In such a case a vicious and intractable reflex has been acquired which can only be cured by patient attempts at re-education, by prolonged intervals between feedings, and by the administration of greatly reduced quantities of food of the blandest and most digestible character.

I see many cases of diarrhœa with so-called undigested curds in the motions, which are regarded as due to indigestion, but which, as a matter of fact, are due to starvation. Frequent dejections of this kind are often associated with debility which is due to inanition, for in starvation the mucous membrane of the bowel suffers from a "paralytic secretion" of mucus, with frequent alvine discharges, which to the inexperienced at once suggests some irritation due to food causes.

The presence of so-called undigested curds in the motions is usually the misleading evidence on which the diagnosis is based. I have repeatedly demonstrated, by means of the test-feed, that infants

passing stools of this character are the victims of inanition, and that so far from obtaining food which disagrees, may obtain practically no milk at all from the mother's breast. Even the fact that these so-called undigested curds of casein continue to appear in the motions when all milk is withdrawn from the diet, and when the infant only subsists on whey, egg-water, or even water, does not appear to carry conviction that they have no more connection with coagulated casein than they have with hard-boiled white of egg, or any other substance with which they have a superficial resemblance. To prove their origin, these so-called curds have been submitted to chemical analysis, and even to biochemical tests. They are known to contain considerable quantities of fatty acids mostly in combination with calcium, forming, in fact, insoluble soaps. Further, they contain a small proportion of albumin, and a remainder which is of uncertain chemical composition, but which contains nitrogen in relatively the same proportion as in caseinogen. On this evidence, and on the evidence of the superficial resemblance to small curds of coagulated casein, these white bodies have been regarded as the undigested remains of milk.

As a matter of fact, if a stool consisting mainly of these so-called curds is carefully washed out in a bowl of water, and the little white balls teased out and disentangled, they will be found to consist of little coiled-

up pieces of mucus, which when floated out in the water, cannot possibly be mistaken for anything else.

The fact that soaps, fatty acids, albumin, bacteria, and calcium salts can be detected in these little white balls by chemical or other forms of analysis in no way weakens the argument that they are the products of the activity of the mucous membrane, and not the undigested remains of milk, for on similar evidence the mucous discharges from the nose or respiratory tract might equally well be considered to originate from milk.

I do not mean to imply, by the somewhat dogmatic statements above expressed, that milk residues do not at times appear in the stools, and especially in cases of lienteric diarrhœa. What I mean is that these small white particles, generally about the size of a pea, which look like pieces of coagulated milk, and which are found in the stools of infants suffering from colicky pains, are really pieces of stringy mucus which have become partially inspissated and coiled up into tight balls by the peristaltic movements of the bowel. By teasing out and unravelling these little balls, it is open to all to convince themselves of the truth of my contention.

Diarrhœa, or at least the too frequent passage of motions, is often attributed to some fault in the character of the food when the true etiological explanation is that the hypersensitive neuromuscular mechanisms of the bowel are stimulated

into activity by some preceding event — as, for instance, by the forcible sucking of the infant at a relatively dry breast, or at some artificial nipple which is pierced with too small a hole. It must be remembered that although the locomotion of food through the alimentary tract is generally regarded as consisting of a number of independent phases, such as deglutition, intestinal peristalsis, and defæcation, nevertheless, each independent neuro-muscular co-ordination, whether it be of œsophagus, stomach, or intestine, is closely associated and bound up in a definite and correlated series, action or cessation of action in the one being the liberating stimulus for activity in the next. Thus violent sucking often initiates painful peristalsis or even lienteric diarrhœa.

Turning now to constipation as a symptom which is often in an etiological sense wrongly interpreted and wrongly treated, I may say that there are three common causes of constipation in infants, although the number of occasional causes is almost infinite. The common causes are—

1. Dulling or disorganization of the rectal reflex by previous over-stimulation or exhaustion of the nerve centres by purgative medicines, enemata, suppositories, or previously existing diarrhœas.

2. Overfeeding, especially with fat.

3. Underfeeding, chiefly in the case of breast-fed infants.

Inasmuch as these three common causes of constipation are in their etiology as widely separated as the poles, it is clearly thoroughly irrational to expect that constipation can be treated by routine methods, as, for instance, by the administration of castor-oil, grey powders, or by increasing the percentage of the fat in the food.

Before we attempt to treat constipation, we must discover the cause. I have certain stock questions with which I ply the mother in order to elucidate the actual cause of the constipation. They are as follows: (1) Are the motions hard or soft ? (2) Are they large or small ? (3) What remedies have you tried ? (4) What food, and how much, have you been giving the baby ?

By means of these questions I can generally discover whether the rectal reflex has been tampered with by injudicious methods of stimulation, and also whether the infant has been obtaining too much or too little food. If the variety of constipation does not fall under any of these headings, I search for other causes.

As regards treatment, the cure of cases of constipation due to dislocation of the normal rectal reflex can only be effected by re-education—often a difficult matter and best promoted by massage and the teaching of a new reflex. This should be applied with absolute regularity every day. The stimulus applied may be the contact of the rim of

a soap-dish in the buttocks, or the touching of the sphincter ani with a little piece of soap.

Constipation due to excess of fat must be treated by a reduction in the percentage of cream in the case of artificially fed infants, and by controlling the quantity of milk consumed in the case of breast-fed infants. Formerly I used to treat a number of infants suffering from this variety of constipation by the routine administration of olive-oil. Olive-oil is, of course, invaluable in cases in which the infant is suffering from fat starvation, but it only aggravates the condition in the class of case I am now referring to. It was in consequence of the realization of this mistake that I came to use petroleum as a lubricant in place of olive-oil, an account of the use of which appears in Chapter IX.

Constipation due to starvation very seldom comes under my notice in artificially fed infants, but it is very common among breast-fed infants of the lower classes. I could give details of dozens of cases which have been brought to my clinics, and which have previously been treated ineffectually with aperients and purgatives, but which have immediately improved when the want of food has been adjusted.

Finally, I would say a few words about that common symptom of disturbed motor function which is so often ascribed wrongly to food causes—namely, colic or wind.

So-called colic or wind in infants is nearly always due to some spasm of sphincter or group of intestinal muscles which interferes with the normal locomotion of food through the alimentary system.

Wind may indeed be retained in the stomach by spasm of the cardiac sphincter, but much more often so-called wind is due to the arrest in spasm of the normal waves of contraction, which should pursue one another in harmonious sequence throughout the whole length of the intestine. The application of the bismuth meal and the X-ray screen has lately revealed some very interesting examples of enterospasm in infants, which have produced troublesome symptoms, the nature of which were not altogether clear before the application of these diagnostic procedures. One of these cases was as follows: An infant at the Nursing Training-School in Hackney had repeated attacks of screaming with serious and violent vomiting. The child was doing badly and losing weight. One day I happened to be at the school when one of these attacks was in progress, and chancing to place my hand on the abdomen, I felt some very forcible waves of contraction passing across the abdomen in its upper third from left to right. As some of the symptoms were not altogether inconsistent with pyloric spasm, I took the infant into the Queen's Hospital, and thoroughly investigated the case by means of bismuth feeds and X-ray examination. When given a feed of thin

Benger's food thickened with 2 ounces of carbonate of bismuth, the infant retained the whole of it, and seemed in less pain than usual; another interesting fact was that the food, instead of experiencing a check at the pyloric valve, passed through the aperture unusually quickly, and continued to travel down the small intestine and through the ileo-cæcal valve in a perfectly normal manner, and at a perfectly normal rate; but when, after some six hours, it reached the splenic flexure, here it encountered an unexpected check, and the bowel wall appeared to lapse into a condition of somewhat prolonged spasm, and from this point onwards the locomotion of the bowel contents was irregular, jerky, and spasmodic. Owing to this discovery, and taking advantage of the benefit which the huge doses of bismuth seemed to confer on the child, I continued to give large doses of this drug combined with petroleum before each meal. The improvement in the infant was immediate; it at once began to put on weight, and within fourteen days was returned to the school in a greatly improved condition, from which it has not up to date relapsed.

This case appears to me to be instructive, because it illustrates the point to which I have more than once referred—namely, that symptoms which are really due to disturbances of the motor function of the bowel, can easily be mistaken for symptoms due to inappropriate food, and as such be in-

effectively treated. This particular case had been treated for weeks by modification in the diet, and by drugs directed to soothe the irritability of the stomach.

If I have given undue attention to the consideration of symptoms referable to disturbances of the motor functions of the alimentary canal as distinguished from those connected with the actual digestion of food, it is not because I belittle the importance of dietetics in the prevention and cure of such accidents. I recognize very fully indeed that in the first place these perverted motor functions are produced by wrong methods of feeding often during the first few days of life when it is easy to teach impressionable nerve centres new reflexes which may have most disastrous results. To these perverted reflexes the Germans have given the name *Bedingungsreflexe*, which may be translated as "conditional" or "facultative reflexes"; but by whatever name they are known, I am sure that they play a leading rôle in the production of such conditions as rumination in infants, pyloric spasm, entero-spasm, constipation, and even diarrhœa. They can only be cured by methods of re-education. It is consequently of the greatest importance to be able to distinguish symptoms which are due to defective digestion proper from those which are due to perverted reflexes, learned, perhaps, a long time previously, and for which at the time being there may be no apparent cause.

CHAPTER V

The Training of Nerve Centres in Infants

In the previous chapter I ventured to suggest that one of the most important factors in the management of infants was the appropriate training of certain simple organic mechanisms. I mean such as those which are concerned with the motor activities of the digestive, respiratory, and vaso-motor systems.

It is quite true that these functions are performed automatically, without our active or conscious participation; but all the same, they are essentially subject to modification in accordance with the individual experiences to which they are subjected, and especially the early experiences which arise soon after birth. The nervous mechanisms by which these automatic functions are controlled are either in actual or potential existence at the time of birth, and the only requirement for setting the machinery in motion is to apply the necessary stimulus.

This stimulus is usually provided by Nature, although her efforts are often frustrated by the unwarrantable interference of man.

To understand the significance of the essential

mechanism of these automatic functions, and the influence which habit exercises upon them, we must concentrate our attention on the nerve cell, or on those groups of cells in the central nervous system or peripheral ganglia which we generally describe as nerve centres.

Nerve centres may be regarded as groups of nerve cells, which are so anatomically and physiologically associated, that they are capable of carrying out complicated muscular co-ordinations with considerable precision. The individual cells of which they are composed work together like highly trained military units or teams of athletes. The more regular their drill, and the more uniform their experiences, the more stereotyped and permanent become their special activities.

In order that a nerve cell, or, indeed, a group of nerve cells, may acquire a permanent habit or bias of action, it is necessary that a series of appropriate and similar stimuli should follow one another in a sequence of the required regularity. In such an event, the mechanism seems almost to work of its own accord; it hardly need wait for the stimulus before commencing to act. It is impossible to exaggerate the importance of this principle in securing the early education of nerve centres.

When the stimuli which evoke any action are regular in periodicity and uniform in strength, the particular function which they control may be

expected to be performed with precision and regularity, but when the stimuli are unequal in force and frequency, bad and irregular habits are formed, which may be difficult to eradicate. As I have elsewhere explained, habits of sleep and of digestion often show evidence of the kind of education to which the nervous centres which control them have been exposed. In this chapter I propose to confine myself mainly to the consideration of the education of those centres which are concerned with the administration of the motor functions of the bowel and the heat-regulating mechanisms of the body as a whole.

With respect to the motor functions of the digestive system, it should be remembered that most of the symptoms which are associated with disturbances of digestion are attributable to dislocation of some muscular co-ordination. For instance, cramp-like contractions of the musculature of the bowel, howsoever provoked, give rise to those painful seizures which we generally call colic, while spasms of sphincters bring about a number of serious events which are familiar to all. Vomiting, as well as diarrhœa, is almost universally due to violent and inco-ordinated muscular contractions; in fact, the smooth and painless working of the motor functions of the digestive tract is dependent on a whole series of muscular co-ordinations which follow one another in sequence, and are most closely dependent the one on the other. The essential element in the smooth

working of such muscular mechanisms must clearly be a highly sensitive series of receptors to keep the central nervous administration in immediate *rapport* with the activities of each individual link in the chain of events.

These receptors are the terminal filaments of the afferent nerves distributed to the various parts of the bowel wall or its attachments. Many authorities claim that these afferent nerves are incapable of conveying painful impressions to the central nervous system, and that impulses passing by this sensory route must be of a nature other than pain, and the fact that the bowel wall can be cut, lacerated, or pinched without the patient experiencing any discomfort is an argument which has been frequently used in support of this view. The painful impressions that are associated with colic or enterospasms have been ascribed by Professor Wilms and others to the dragging or pulling of the peritoneal attachments, which, admittedly, possess sensory nerves capable of conveying impressions of pain. The simple explanation given by Professor C. S. Sherrington appeals to me as being more rational; it is as follows. The sensory nerve endings in the intestines are highly specialized receptors tuned or sensitized to one particular class of impressions only, —namely, those which are indispensable to the organization as a whole, and which have a protective significance; in other words, such as can inform the

central authority of the extent to which the muscular wall is distended or relaxed. Indeed, it seems almost impossible to understand how muscular co-ordination can be maintained without sensory receptors of this kind. To understand how such receptors have acquired special sensitiveness to such stimuli while other forms of stimuli have no effect, it is necessary to suppose that by a process of selective adaptation, both in a phylogenetic and in an ontogenetic sense, only those impressions which are of physiological advantage to the organism are allowed to reach the central nervous system, while those which are unnecessary are disregarded.

In accordance with this interpretation, it is easy to understand why we are unconscious of the normal movements of the bowel and stomach, and why we feel pain when the muscular contractions assume a dangerous degree of intensity, or when the lumen is unduly distended. It is essential to the well-being of the individual that such dangers should give rise to painful impressions which will attract attention.

The striking fact that most of us are blissfully unconscious of the peristaltic waves which pursue one another from one end of the gut to the other, and which give us such excruciating pain when they are irregularly conducted, surely emphasizes in a very marked degree the efficiency of the natural method which, under normal conditions, is concerned in the education of the motor functions.

When we contemplate the smoothness and regularity with which our intestines perform their daily functions, we ought not to regret the many throes and discomforts we suffered in childhood when we were learning to perform these highly important co-ordinations. If they had afforded us no pain when we managed them wrongly, how should we have ever learned to conduct them rightly ? Spasms of the pylorus, enterospasms, and hour-glass contractions are common causes of abdominal pain in infants. They represent, in fact, protective reflexes, which are designed to exclude dangerous forms of food from gaining entrance to vulnerable parts of the digestive tract.

Dysperistalsis, or inco-ordinated contraction of the musculature of the bowel, is certainly one of the commonest causes of pain in infants, but it must be regarded as an essential and necessary forestage of normal painless peristalsis. It is, however, desirable that these necessary but painful experiences should be as few and short-lived as possible, for nothing is better calculated to disturb the development of the central nervous system than constant pain associated with ill-co-ordinated motor functions.

It is, therefore, of considerable importance to study the best means of teaching the bowel its natural functions, and the best means of avoiding those mistakes in feeding, and especially in arti-

ficial feeding, which create exaggerated peristaltic activities, and lead to the establishment of bad habits.

I am convinced that the best means of insuring these ends is to interfere with Nature as little as possible. Throughout the whole period of our evolution, Nature has been experimenting on a huge scale to find out the best method of education, and if she has not discovered a perfect way, she has, at least, found a very good one.

How does Nature teach the bowel those complicated muscular co-ordinations which effect the locomotion of food from stomach to anus ? As in all else, the education must commence at the very beginning, when the nerve centres are young, plastic, and impressionable. Nature begins by giving the muscles very easy lessons. At birth the intestines are full of meconium, a material which is most admirably designed to give the necessary didactic experiences. It is semi-solid, but yet sufficiently fluid to pass along the intestine and distend the rectum, whereby the necessary stimulus is imparted for relaxation of the sphincter ani and for complete evacuation of the rectal contents. I regret to say that it is sometimes a practice among maternity nurses and others who have charge of the infant during the puerperal period, to administer a dose of castor-oil for the express purpose of sweeping this invaluable material out of the bowel.

There can be no more irrational and fatal procedure. Castor-oil is too strong a stimulus; it excites an exaggerated reaction, and leaves the nervous mechanism in a condition of exhaustion, and, further, it deprives the bowel and rectum of the educational material which should last for many days to come. The after-effects of this initial over-stimulation are reactionary fatigue and constipation, so that there are many temptations to repeat the dose before the establishment of lactation can provide the necessary basis for a stool. In this way the natural rhythm and periodicity of the peristaltic wave is disturbed from the very first, and the rectal reflex is dislocated.

A study of the establishment of the normal rectal reflex will well repay attention. As a consequence of the initiation of the peristaltic contraction of the bowel, meconium is slowly squeezed into the rectum. When the walls of the latter are sufficiently distended to excite the sensory receptors, a message is transmitted to the central seat of authority, and reflexly the sphincter ani relaxes, while the whole group of intrinsic and extrinsic muscles concerned in the act of defæcation combine in one concerted act of expulsion. If the peristaltic contractions of the small and large intestines are uniformly conducted, the cistern of the rectum will continue to fill in a definite number of hours, and hence the conditions are favourable for the establishment of a regular and periodic action. Such rhythmic and periodic

habits are not readily established when the feeding, and all the other events which feeding initiates, are not themselves regular. Hence the great importance of regular habits of feeding in the establishment of regular habits of defæcation.

I have occupied so much time in discussing the early education of the bowel and rectum by means of meconium that I cannot delay to consider the analogous functions of colostrum in establishing the early functions of digestion and the gastric and pyloric reflexes. I can only state generally that colostrum is eminently suited for these purposes, and that when, for any reason, the infant is deprived of the advantages which feeding by its own mother confers, the greatest care should be exercised to supply a substitute which corresponds both quantitatively and qualitatively with the educational material which Nature supplies.

In connection with the acquisition of normal motor functions, it must be remembered that pain and discomfort are not altogether unmixed evils, for through their instrumentality, clumsy and ill-co-ordinated movements are at times arrested by syncopal attacks or periods of unconsciousness, and thus the infant is given an opportunity of making a fresh start and a more successful attempt.

Turning now to the consideration of the heat-regulating centres, I would remind you that we are highly dependent on the efficient working of these

centres for our health and comfort. Natural selection has proved that the vital processes of the body are more economically carried on at 98·6° F. than at any other temperature, or, in other words, that there is a waste of energy or a lowering of vitality when the temperature rises above or falls below this point. In strong and healthy individuals wide departures from this optimum temperature seldom occur, although there is usually a slight rise towards evening with a slight fall in the early hours of the morning, fluctuations which must be regarded as falling within physiological limits. The more serious excursions which take place in febrile conditions should properly be regarded as evidence of a breakdown of the thermotaxic mechanisms, although it is possible that they may be of a conservative or protective significance.

Breakdowns in the functions of the heat-regulating centres occur when the latter are over-stimulated or poisoned by toxic substances circulating in the blood, and, in common with other nerve centres, they are prejudicially influenced by fatigue, over-action, or inappropriate stimulation.

Without referring at unnecessary length to the anatomy or physiology of these thermotaxic centres, it may be stated broadly that they consist of groups of nerve cells situated in the base of the brain, which regulate combustion in the body, and of other groups in the cortex, known as the "thermo-inhibi-

tory centres," which control or restrain the activities of these thermogenic centres. Both of these act in close association with the vaso-motor centres which regulate the distribution of blood to the various organs of the body.

By the harmonious co-operation of all these centres, the bodily temperature is maintained at a relatively constant level despite great variations in the surrounding temperature. Thus, not only can the human organism survive a temperature which is sufficiently high to boil water or roast a leg of mutton, but it can also live for many hours in an atmosphere at which mercury freezes.

At the time of birth these complicated mechanisms are incompletely developed, and the infant behaves more or less like a poikilothermic, or cold-blooded, animal; that is to say, its blood-temperature rises and falls in close correspondence with the temperature of the surroundings. Hence, unless special precautions are taken, the temperature of a newborn baby may, within a few hours of birth, experience a sharp fall to 90° F. or even lower. It must, however, be remembered that the ordinary clinical thermometer is not graduated to show such low readings, and consequently, unless special thermometers are used, the infant's temperature may fall to a dangerous point without our knowledge. In view of the fact that any extreme fall in the temperature has a most prejudicial influence on the

vital processes, it is important that no unnecessary loss of heat should occur in the case of the new-born baby. Young infants can, however, survive a lowering of the temperature to a level which would kill older individuals. This is due to the fact that their thermotaxic centres are still undeveloped. If an adult, in whom these centres are fully developed, were to experience a fall in temperature to 90° F. or lower, such a condition would imply complete disorganization of the whole nervous system—a state of affairs which, in all probability, would be quite incompatible with the continuation of life. When practical eugenics were practised in Sparta, new-born infants who, from a physical point of view, were considered unfit to survive, were left naked in the caverns of Taygetus, for it was believed that if they could survive such an ordeal, they would vindicate their right to live. Many new-born infants are to-day unconsciously submitted to the same kind of ordeal by careless attendants, but the modern child does not show the same tenacity of life.

Under favourable conditions the heat-regulating centres of the infant soon become functionally active, but for many years to come they lack stability. This is due to the defective control of the thermo-inhibitory mechanism rather than to the immaturity of the thermogenic centres in the base of the brain.

The time at which the complete mechanism becomes functionally proficient, and the degree of its proficiency, is almost entirely dependent on the experiences to which it is subjected. These nerve centres, like others which subserve other functions, must be trained and educated by the incidence of appropriate stimuli; that is to say, they must be exposed to stimuli of normal strength and of sufficient variety. If they are too strong, they dislocate the delicate mechanism; if they are too weak, they do not sufficiently call the activities of the nerve cells into play.

Antecedent to the crisis of birth there has been no variety in the character of the thermal stimuli, for the fœtus has pursued its existence in the monothermic environment of a water-bath. Consequently, there have been no educational stimuli to train the heat-regulating centres. At the moment of birth all the conditions are changed, and new experiences are apt to crowd only too rapidly on the awakening activities of these susceptible centres. It seems to me to be a matter of very great importance that these early impressions should, in an educational sense, be of the very best kind, for it is during the plastic stages of immaturity that new functions are most easily learned.

Of recent years "faddists" and "cranks" have resorted to practices of "hardening" children by systems of thermic education, which consist in

allowing them to run about in cold weather with bare arms, bare legs, and bare heads. Whatever criticism these particular systems of training may deserve, it is quite impossible, on physiological grounds, to repudiate the general principle that the thermotaxic centres should be educated to their full capacity, for the more efficiently they do their work, the more independent becomes the individual of the temperature of the environment.

Individuals who throughout the period of childhood are sheltered from every breath of air, who are protected from every change of temperature in warm rooms and by thick clothing, are very badly equipped for maintaining their body temperature when at any time they are exposed to unexpected degrees of cold; in fact, under such conditions they very readily contract what is popularly described as a "chill." The pathology of a "chill" may be briefly defined as the dislocation of the thermotaxic and vaso-motor centres by over-stimulation with cold, just as the so-called heat-stroke represents the over-stimulation of the same centres by unusual degrees of heat. Then, again, these centres may be dislocated by the clash of conflicting stimulation. such as occurs when a child, on a very hot day, paddles about in cold water. Under such conditions one set of stimuli calling for a more active metabolism, and for a conservation of heat, reach the thermotaxic centres from the feet, while an entirely

different series reaches them from other parts of the body. The consequence of this is that there may be a severe dislocation of the mechanisms concerned, and the child may suffer from a syndrome of nervous symptoms, which in the language of the uninformed is usually called a "bilious attack."

Although children with well-trained thermotaxic centres can participate with impunity in the pleasures of paddling in cold water while a hot sun shines overhead nevertheless such experiences cannot be regarded as scientific methods of training the mechanisms concerned; and it is due to the unsatisfactory results which sometimes follow from such procedures that the more rational methods of education have simultaneously fallen into disrepute.

There unfortunately exists considerable confusion in the minds of some people as to the distinction between the "*principles*" of hardening, and the "*methods*" or "*systems*" by which the principles are carried out; and this confusion has so befogged the issues that at the present time medical men are almost afraid to mention the word "hardening" for fear of being misunderstood.

I believe, however, that the advantages to the normal child of an efficient education of his heat-regulating centres are so enormously great that I would give him the benefit of as good an education in this respect as circumstances permit. But it will be readily understood that it is one thing to devise

a system and another thing to explain to a second person how it is to be carried out; you may give away the secret of your method, but you cannot always give the required understanding to enable it to be put into practice.

From want of time I find it quite impossible to explain to all mothers who bring their babies to my infant consultations the details of a rational "hardening" method. I reserve my energies for the more serious cases. The ones I chiefly select for the treatment are the infants who come of tuberculous stock, or give evidence of rickets or malnutrition, because in such cases it is most important that the functions both of heat production and of heat dissipation should be efficiently performed.

The main principle involved in a rational method of hardening is to give infants and children as many and as varied experiences in thermal stimulation as possible. The intensity of the stimulation, whether of heat or cold, must be adjusted to the physiological capacities of the child; there must always be progress, but the progress should not be too rapid.

Over-stimulation of these nerve centres at any time may dislocate their delicate mechanism, but over-stimulation during the early stages of their education may have permanent results very prejudicial to their subsequent development.

I cannot, in a short account such as this must necessarily be, give complete details of the method

I employ, so that I purpose only to explain a few of the main principles on which, in my opinion, success depends.

In the first place it is very important that the early lessons should be of a very elementary character, and that the transitions from one degree of stimulation to another should be very carefully graduated.

The stimulation is effected by means of both air and water; the temperature of the room in which the new-born baby is confined must be maintained at first at a somewhat higher level than is desirable for older children, and the baby itself must be wrapped up very warmly, even in cotton-wool, if the surrounding temperature is low, to prevent loss of heat. As time goes on, the temperature of the room may be allowed to vary, and the number and thickness of the clothes may be reduced, always, however, with the exercise of the greatest care that the feet or other parts of the body do not become cold; if the feet become cold, the educational régime has broken down.

The date at which the baby may be first taken out of doors will depend on the weather and other circumstances. This step should not be precipitated. It must be remembered that the new-born baby is quite as slow to learn how to digest and assimilate food as to learn how to control its thermotaxic mechanism. If, therefore, a young

baby suffers much loss of heat, since it is unable to digest and absorb new foods, and thus compensate for the increased combustion necessitated it will be compelled to live on its own tissues, and lose weight. As soon, however, as it has begun to assimilate food and to increase in weight, there is no valid objection why it should not be taken out of doors under suitable conditions of weather, and with suitable precautions against "a chill."

The bath, however, must always remain the chief instrument of education. Thermal stimulation is more easily controlled by means of water, both hot and cold, than by means of air. The infant should have a bath every day, or even two baths a day; but, for the first few days of life, if a bath is given at all, it should be most expeditiously administered, and at a temperature which is slightly above blood heat—*i.e.*, about 100° F. As the infant grows older, variations in the temperature of the water may be introduced, either by giving a tepid douche at the end of the ablutions, or by gradually lowering the temperature of the bath itself. Both methods give excellent results, but on the whole I prefer the second method, although the choice depends to a considerable extent on the intelligence of the person who is responsible for carrying out the orders. A bath thermometer must always be used, and the individual who gives the bath instructed in its use. I find no difficulty in securing the carrying out of the

necessary details, even among the poorest women who bring their infants to my consultations at the St. Marylebone General Dispensary; and the expense of bath thermometers is no obstacle, since they can be bought for a few pence. The women are taught to use these thermometers either by the dispenser or by one of our health visitors, and many mothers appear to take the greatest interest and pride in the proceedings. The instructions I generally give are to administer the first bath at a temperature of 100° F., and to lower the temperature by one degree every day, or every other day, as the condition of the baby or the intelligence of the mother warrants. If the baby shows the least resentment or dislike to the temperature of the water, the mother is told to retrace her steps, and revert to warmer water. As a rule I do not allow thermal education of this kind to commence before the fourth or fifth week of life, and I generally call a halt when the temperature has reached 80° F. Some babies are very much easier to teach than others; some of those attending at my consultations have a cold bath by the age of six months and thoroughly enjoy it; others do not seem to appreciate a temperature below 80° F. Many of my private cases take their cold bath in tap-water (50° to 60° F.) before they are five months old, and always with the greatest benefit. The advantages of the method are very obvious, and the students attending at my consultations frequently express

surprise at the splendid physical condition of the babies who are submitted to this course of treatment. As a rule it is quite easy to distinguish the "graduated cold-bath babies" by their clear complexions and general appearance of health and vigour. At the Nursery Training School[1] in Hackney this method is employed, and I am quite sure it would be impossible to find a healthier or more vigorous set of babies anywhere, although when they are first brought to the school they are often in a very poor condition of health.

It must be remembered that most of the energy-value of an infant's food—namely, about eight-tenths—is expended in the production of heat, and that only a very small proportion—probably about one-fifth—is required for the purposes of growth, or for the performance of mechanical work; consequently, the food requirements of infants depends to a very large extent on the temperature conditions of the environment, and on the opportunities provided for dissipation of heat by radiation, conduction, and evaporation.

In view of these facts we can readily understand how extremely unscientific it is to lay down hard-and-fast rules with respect to the quantities of food required by different infants (see Chapter III.).

[1] This school is for training domestic nurses. It is supported and managed by the Women's Industrial Council. As a rule there are about twenty nurses in training and some twelve babies in residence.

Many years ago[1] I drew attention to the serious consequences which might ensue when infants were fed on diets which were physiologically excessive. At that time little importance was attached to the evils of superalimentation, but now that Finkelstein[2] and others have made definite pronouncements in support of this view, medical opinion is slowly veering round to the belief that among the many evil consequences of overfeeding summer diarrhœa is not the least important. Although few deny that direct and indirect infection plays an important part in the determination of epidemics of this kind, none the less the number of those who believe in autogenous infection as a possible source of danger is daily increasing.

If a slum infant is overfed, the degree of overfeeding becomes relatively greater the moment the weather becomes hot, and relatively decreased when the temperature falls.

In very hot weather the dangers for slum infants from overfeeding are great as compared with the dangers at other seasons of the year, and as compared with the dangers which threaten better-class infants, largely for the reason that the inside temperature of small houses and tenements has been

[1] "The Overfeeding of Infants." A paper read before the British Medical Association's Annual Meeting, Cheltenham, 1901.

[2] Finkelstein, *Deutsch. Med. Woch*, 1909, No 32, pp. 1375-1391.

proved to be disproportionately high as compared with that of larger houses.

Considerable attention has recently been drawn to the disparity between the inside and outside temperatures of small tenements,[1] and the influence this exercises on the determination of diarrhœa among slum infants.

In hot weather all the physiological mechanisms for counteracting excessive feeding are brought into play. Thus the infant loses appetite, digests its food more slowly, absorbs it less freely, and tends to reject it both by vomiting and diarrhœa. But unfortunately, in hot weather infants become thirsty and require large quantities of fluid to compensate for the water lost by evaporation and sweating, and thus Nature's provisions against overfeeding are often inefficacious.

In bottle-feeding this thirst is a source of danger, because to obtain sufficient water infants drain their bottles dry and appear hungry at the end of a meal. This sometimes leads to the supply of a second bottle, or larger feeds.

In breast-feeding the danger is less because, by a merciful intervention of Providence, the milk of the mother becomes more watery.[2]

There can be no reasonable doubt that those

[1] J. W. Schereschewsky, "Heat and Infant Mortality," *Archives of Pediatrics*, December, 1913, p. 916.

[2] Meinert, *Deutsch. Med. Woch.*, 1888, vol. xiv., p. 491.

infants who possess well-disciplined heat-regulating centres are in a far safer position as regards the dangers of summer diarrhœa than are infants in whom these centres have not been adequately trained; for the former can dissipate more effectually an excessive production of heat, and they can also more quickly call into requisition all those indirect mechanisms whereby appetite is lost or food rejected.

But all the same, whether the heat-regulating centres be well or badly educated, in hot weather it is of importance to reduce the food-supply in breast-fed, as well as in bottle-fed, infants; moreover, it is important to facilitate the dissipation of heat by light clothing, tepid, or cool baths, and by the maintenance of the lowest possible temperature in the houses in which the infants are confined. The usual instructions to keep infants warm so as to prevent diarrhœa is as irrational as is the advice to confine infants in stiff binders to strengthen their backs.

In this chapter, although I have only touched the fringe of the subject, I hope I have said enough to attract attention to the great possibilities connected with the careful and methodical training of nerve centres.

CHAPTER VI

Constipation in Infants

The causes of constipation in infants are almost identical with those of adults; but it must be remembered that in the case of older individuals considerations of volition and determination complicate the issue. During infancy the fact that no will-power can be brought to bear makes constipation more difficult to cure and more liable to recur. But for these very reasons, when a habit of regular action has been formed, the regularity of the periodicity is more difficult to disturb. For reasons which are obvious, the establishment of a habit of constipation is attended with dangers and inconveniences which are almost in inverse proportion to the age of the individual; therefore the younger the infant, the more important is it to prevent this disturbance of function.

Nearly all cases of constipation can be referred either to interference with the mechanical locomotion of fæces through the colon and sigmoid or to dislocation of the sensitive reflex of the rectum.

Locomotion of the intestinal contents through the

colon of infants is normally carried on at a disadvantage as compared to that in adults, owing to the fact that the colon is relatively longer, is more convoluted, has freer peritoneal attachments, and is muscularly weaker; but there are many conditions in infancy which can still further aggravate these natural disabilities. For instance, in overfeeding and flatulent distension, the colon, endowed as it is at this time with almost limitless potentialities for growth, can respond to the stimulus, and become not only permanently dilated and enormously convoluted, but also even kinked and dislocated from its normal position. When these anatomical disabilities of the colon are further complicated by feebleness of the intrinsic muscles of the bowel, locomotion of its contents through the large intestine becomes greatly impeded.

The tone and the activities of the muscles which are concerned in the peristaltic movements are under the control of local nervous mechanisms, which in turn are co-ordinated and reinforced by a stream of efferent nerve impulses emanating from spinal and cerebral centres. Hence there is no difficulty in understanding how it is that in general conditions of nervous debility, in which there is universal loss of tone in voluntary muscles, the intestinal musculature should also be involved. Constipation is one of the most frequent complications of rickets, and it is doubtless dependent on factors similar to those

which, in the latter disease, produce the familiar pseudo-paralysis of the skeletal muscles. Whatever may be the essential pathogenesis of rickets, there can be little doubt that the injuries inflicted on delicate nerve cells and nervous connections by circulating poisons play a most important part in the determination of many of the symptoms.

In meningitis, hydrocephalus, and other disturbances of the central system there is a tendency to constipation. In infants, in whom there are associated stigmata of degeneration, inco-ordination of various automatic nerve mechanisms is comparatively common, and those which subserve the functions of defæcation are by no means exempt. Thus, constipation is quite a common symptom in cretins, in mentally defective infants, and in infants with congenital malformations.

The automatic working of colonic peristalsis is thus dependent not only on its own local nerve centres, but also on the integrity of a widely connected central mechanism. At birth this mechanism is set in motion by the operation of many stimuli, such as the descent of the diaphragm and the contraction of the abdominal muscles, which compress the small intestine and empty its contents into the colon, sigmoid, and rectum.

Meconium, owing to its physical qualities, is admirably designed to lubricate the mucous surface of the intestines, and to offer a convenient medium

of resistance to the peristaltic movements. It behaves, in fact, as a complacent "corpus vile," on which the intestines can experimentally exercise their untrained efforts. It is impossible to exaggerate the importance of these first efforts, for they modify all subsequent reactions.

The same is true of all nervous mechanisms, for the reactions of a nerve centre depend on its past experiences, and especially on its first experiences, and a "habit" is formed when a series of actions are compelled to follow one another through the continued operation of a series of stimuli; they become, in fact, organically tied together or associated. After a time the series of reactions follow each other automatically, almost independently of the character of the stimulus. Nature, if she is allowed, generally provides at the proper time the right kind of stimulus to produce a correct habit.

Applying these general principles to the particular case of intestinal peristalsis, it will be readily understood that, if the mild and gentle stimulus of meconium be replaced by a purgative dose of castor-oil, all subsequent reactions will be materially modified; by physiological contrast the stimulus of colostrum and, later, of milk will be relatively ineffective.

Dr. Still says: "I know of no drug which is responsible for more chronic constipation in infancy than castor-oil." I would go even further, and say

I know of no series of doses of purgative medicine which are responsible for so much constipation at any time of life as the *single dose of castor-oil* which clears out meconium from the bowel of the new-born infant.

The first ten days of life are hazardous in many ways for the infant, but especially so in respect of its intestinal functions. During this period there are many temptations to give aperient or purgative drugs, even when the meconium has not been artificially removed; for the amount of food which enters the stomach is necessarily extremely limited, often insufficient to excite active peristalsis or to bring about a satisfactory evacuation.

What is true generally of peristalsis is equally, or even more, true of the specialized peristaltic movement of the rectum, and the whole machinery of this delicate mechanism may be dislocated if unnatural and unduly strong forms of stimuli are applied when it is, so to speak, formulating its reactions. The normal stimulus for the reaction is the presence of ordinary fæcal matter in the sensitive zone of the rectum. If a glycerine suppository be inserted, or a soap-and-water enema be injected, a new and unnaturally powerful stimulus is applied, which again, by physiological contrast, renders the normal stimulus subliminal. I know of few forms of constipation in infants more difficult to treat successfully than that which is due to the use of these artificial

expedients. In infants in whom the sensitive zone has been rendered relatively anæsthetic, the rectum will often be found to be full of dry scybala or impacted fæces which have established a right to the position, and exercise no stimulatory influence on the nerve endings in the bowel wall.

The nerve centres in the lumbar cord with their cerebral connections have a strong tendency, like all other nerve centres, to fall into periodic and rhythmical habits under the influence of a continuously acting series of stimuli. The periodicity in young as well as in older subjects is often determined by accident, or by the advent of some psychological reinforcement.

Some infants habitually have an evacuation when put to the breast or given a bottle. This is a most disadvantageous rhythm, and must be suppressed at all costs. Other infants will pass a motion immediately after their bath, owing possibly to the stimulating influence of the water, or the friction of the towel. This is a habit of which full advantage should be taken. Placing the infant at such times on a porringer or soap-dish will help to establish the habit on a firm basis by introducing a definite element of suggestion into the complicated reflex.

I know of many infants who have been trained to perfect regularity in respect of this function before they were two months old by skilled and persevering nurses, and such infants pass through the whole

period of infancy without requiring any unnatural stimulus for the daily evacuation of the bowels. Habits of this kind, if established at a sufficiently early date, are a practical guarantee of future regularity.

Apart from anatomical disabilities of the colon which predispose to inertia of the bowel, and apart from dislocation of the normal rectal reflex, there are other causes of constipation, and among them, perhaps, the most important is a pre-existing condition of diarrhœa. Severe attacks of diarrhœa exhaust the nerve centres, enfeeble the musculature of the bowel wall, and dry up the secretions. In the chronic mucous colitis which so often follows acute attacks, the internal surface of the colon is frequently roughened and irregularly coated with inspissated mucus. This condition severely embarrasses the locomotion of fæces, and is at times the cause of dysperistalsis or enterospasm.

There are several forms of constipation which are directly due to food causes, and among these a deficient quantity of food is common in breast-fed infants. Quite a number of constipated infants are brought to my consultations at the St. Marylebone General Dispensary owing to this cause alone. The diagnosis is made by applying the test-feed—that is to say, the infants are weighed before and after they are put to the breast. The difference in the weights represents the amount of food con-

sumed. For constipation to ensue as a result of underfeeding, a minimum quantity of food must be supplied to the infant, for I have a number of records in which the infants have subsisted on a half or on a third of the normal allowance, without any interference with the daily evacuation. Constant vomiting acts as a cause of constipation in the same way as a defective supply of food; vomiting due to spasm of the pylorus, and to hypertrophic pyloric stenosis, is almost invariably accompanied by great obstinacy of the bowels.

Constipation due to overfeeding is far more common in bottle-fed infants, and it is especially noticeable among the children of the middle and upper classes. In this variety of constipation the motions are usually very copious, light coloured, greasy, and lumpy. The cause of the constipation is uncertain, though it is not improbably connected with the same nervous incompetence, due to circulating toxins, which is so frequently responsible for inertia of the bowel in the rickety condition. In overfeeding the liver is often found to be large and fatty, and the evidence of the stools points to a defective secretion of bile. This, combined with the fact that pancreatic digestion may also be at fault, is, quite apart from inertia of the bowel, an adequate cause of constipation. My own personal view is that overfeeding leads to constipation because excess of food leads to decomposition in the bowel, and the

products of decomposition in their turn poison the nerve centres which control hepatic, pancreatic, and intestinal functions.

The particular element in the food which is responsible for most of the mischief is a matter of dispute. Finkelstein attributes a large share of the trouble to fat (fat-injury); others attribute it to proteids or to carbohydrates. It must be remembered, however, that carbohydrates and, to some extent, fats are proteid-sparers, whether regarded from the point of view of digestion or from that of nutrition. As a rule they are far more easily digested and absorbed, leaving the more resistant proteids at the mercy of destructive organisms. Although no doubt the acid products of fat and carbohydrate fermentation can act injuriously on nerve cells, most of the evidence goes to prove that the toxins of proteid origin in this respect do greater damage.

Certain other conditions, such as anal fissure, painful ulcers, piles, and congenital malformations, may occasionally give rise to obstinate constipation, but these conditions are rare and consequently unimportant.

The more important of the many causes of constipation fall into place in the following classification:

A. Organic Impediments to Peristalsis:

1. *Congenital malformations :*
   (*a*) Atresia recti.
   (*b*) Imperforate anus.
   (*c*) Dilated colon (Hirschsprung's disease).
2. *Acquired structural alterations :*
   (*a*) Dilated, convoluted, or lengthened colon from overfeeding or flatulent distension.
   (*b*) Inflammatory conditions of—
      (i.) Peritoneum (peritonitis).
      (ii.) Bowel wall (results of long-standing colitis or dysenteric diarrhœa).
      (iii.) Mucous membrane (inspissated mucus in chronic colitis).

B. Interference with Nervous Mechanism of Peristalsis and Defæcation:

1. *Organic disease of the nervous system* (*meningitis, hydrocephalus, tumours of brain and spinal cord*).
2. *Toxic conditions :*
   (*a*) Specific infections (fevers, etc.).
   (*b*) Specific poisoning due to drugs (opium, lead, excess of lime-water, etc.).
   (*c*) Intestinal toxæmias due to decomposition of food in the bowel.

3. *Exhaustion of nerve centres due to over-stimulation by :*
   (*a*) Diarrhœa.
   (*b*) Purgative drugs.
4. *Interference with the peripheral nervous mechanism by :*
   (*a*) Hypersensitiveness of anal sphincter (fissure of anus).
   (*b*) Anæsthesia of sensitive zone of rectum (by enemata, suppositories, presence of foreign bodies, etc.).

C. Faults in the Intestinal Contents:

1. *Insufficient food* (*starvation, vomiting*).
2. *Deficiency of fluid* (*dehydration of tissues by fevers, loss of blood, want of bile, and intestinal secretions*).

The rational treatment of constipation in infants depends largely upon a correct diagnosis of the cause. The routine treatment of the condition by aperients, purgatives, enemata, and suppositories, is not a scientific method.

Inasmuch as it is far easier to prevent the onset of constipation than it is to cure it after the habit has been established, it may be wise to say a few words in respect of prophylaxis before entering upon the question of curative treatment.

In bottle-feeding prophylaxis is comparatively easy, for the quantity and quality of the food are entirely under control. In breast-feeding it is difficult, or impossible, to control or modify the food

without recourse to supplementary feeding. There should be no hesitation in utilizing this method when the physiological indications, or the test-feed, prove that the breast-supply is defective or deficient. I employ supplementary feeding in more than half the breast-fed infants I see in my out-patient clinics, and more often for the purpose of supplementing a deficient diet and correcting constipation than for any other reason.

The test-feed will at once show whether or not there is a deficiency in the supply of breast-milk, and the physiological indications which the history of the case, the weight curve, and the symptoms provide will as a rule prove in what respects the milk is qualitatively defective. The supplementary feedings must be adjusted to correct these defects.

Nurses and mothers are very apt to regard the passage of formed motions of firm consistence and small calibre as indications of constipation which require treatment. It is impossible to insist too strongly that such stools are not of pathological significance; they imply strong and active peristaltic contractions in an intestine which is not dilated, conditions which are of most favourable augury for the prevention of constipation. The long-continued passage of soft semifluid motions gives the musculature of the colon, sigmoid, and rectum very little work to do. Exercise of function is an essential condition of efficiency. Unless the muscles of the intestine have work to do, they will not develop in

the manner and to the extent that is required for the maintenance of their function. Such a condition therefore demands no treatment as long as there is a regular evacuation every day.

The encouragement of a regular and favourable periodicity in the times of evacuation by the means already referred to is certainly one of the most important factors in the prophylactic treatment.

The measures for the prevention of constipation in infants may be summarized as follows: (1) Not to employ aperients, purgatives, enemata, or suppositories, especially during the first few weeks of life. (2) In breast-feeding to make certain by means of the test-feed that there is neither underfeeding nor overfeeding. (3) In breast-feeding to correct quantitative and qualitative defects by supplementary feeding. (4) To induce regularity of "habit" by systematic training.

To return now to the question of cure. The commonest forms of constipation met with in practice are those which are due to (1) dilatation and inertia of the bowel, and (2) interference with the nervous mechanism by over-stimulation from acute attacks of diarrhœa or from abuse of purgative medicines.

An examination of the infant's abdomen combined with percussion of the colon will as a rule afford evidence of the degree of distension of the large intestine. When the dilatation of the colon is considerable, a tympanitic note will generally be elicited high up under the diaphragm on the left side, while

the sigmoid itself may be traced across the abdomen towards the right iliac fossa.

A careful inspection of the motions, if necessary after washing out in a large quantity of water, will reveal the presence or absence of colitis. In the chronic forms of this disorder considerable masses of inspissated mucus, or coiled-up pieces of membrane, can, if the motions are well broken up, generally be identified among the general detritus. The extent and the character of the colitis can as a rule be estimated by the size and appearance of the fragments of membrane.

A digital examination of the rectum will prove the presence or absence of fæces in the rectum. If present, the assumption is justifiable that the sensitive zone has lost its natural irritability, and that the cause of the constipation is to be referred to a dislocation of the normal reflex.

At one time it was my invariable practice to treat cases of constipation in infants with additional feedings of cream. This method of treatment, as Holt, Finkelstein, and others have pointed out, is extremely liable to give rise to the symptoms of fat indigestion, foremost among which is a condition of aggravated constipation. Unless the evidence from collateral sources is clear that the percentage of fat is below the nutritive requirements, this line of treatment has little to commend it. This difficulty can be avoided by substituting petroleum for fat.

Petroleum never gives rise to nutritional or to digestive disturbances; it is an absolutely inert lubricant, which passes out of the bowel in exactly the same condition as it enters the mouth; moreover, every trace of it can be recovered from the fæces.

If given in sufficient quantities, it will soften the hardest scybala, and provide soft, plastic stools, which pass with ease through the sigmoid and rectum. For hospital use an inexpensive and most efficient emulsion can be made by employing Irish moss as the emulsifying agent; in private practice I suggest the use of the following formula, in which the more expensive gum of acacia replaces the Irish moss:

℞	Petrolei liquidi puri	♏xx.
	Pulvis acaciæ	gr. x.
	Olei amygdalæ amaræ	♏ $\frac{1}{30}$
	Elixiris glusidi	♏ $\frac{1}{2}$
	Aquam cinnamomi	ad ʒj.

Fiat emulsio.

If prepared according to this formula, the emulsion is exceedingly pleasant, infants and adults taking it equally well.

For an infant three months old I prescribe as much as an ounce, or as little as a drachm, in divided doses during the twenty-four hours. In some cases I give the pure oil instead of the emulsion in doses of 1 to 4 drachms two or three times a day.

It must be remembered, however, that simple lubricants of the bowel, in spite of their softening

influence on the motions, will not cure all cases of constipation; unaided, they often give most disappointing results, especially in cases of extensive dilatation of the colon or extreme inertia of the bowel, when these conditions are complicated by loss of sensitiveness of the rectum. When the colon is dilated or the musculature feeble, massage of the abdomen, if skilfully applied along the axis of the large intestine and deep into the left iliac fossa, is a most valuable adjuvant. If possible, the services of a skilled masseuse should be called into requisition, but it is quite easy to teach the mother or nurse how to manipulate the intestines with beneficial results. In this connection it is well to remember that in severe cases of dilatation of the colon the sigmoid flexure may take an aberrant course across the abdomen in the direction of the right iliac fossa. Electricity (galvanic) may be employed to reinforce the action of the massage.

In those cases in which considerable injury has been inflicted on the mucous membrane by attacks of acute ulcerative colitis, or by dysenteric diarrhœas, massage must be employed with great caution, otherwise hæmorrhages may occur from partially healed ulcers or inflammatory patches. It is dangerous also to try massage when there is any suspicion of tuberculous disease of the mesenteric glands, or tuberculous ulceration of the bowel.

When the history of the case shows that the existing constipation has been preceded by ulcerative

colitis with stools containing blood or pus, I strongly advise a preliminary course of irrigation of the colon (Plombières' method) by means of a long rectal tube or catheter. When the washings prove that adherent sloughs or plaques of inspissated mucus have been entirely removed, and when there is no pain or tenderness along the course of the colon, it may be considered safe to commence massage.

In obstinate cases irrigation of the colon may be necessitated for several weeks, but as a rule the washings can be discontinued after a few days. As soon as the massage is commenced, the petroleum emulsion must be given in full doses. By the combined use of irrigation, massage, and petroleum, few cases of constipation resist treatment, but it must be admitted that there is a small residuum of cases in which these expedients fail.

In out-patient practice, where neither irrigation nor massage can be conveniently applied, a considerable number of refractory cases are met with. In such instances it may be necessary to resort to drugs which overcome the inertia of the bowel wall; for this purpose there is no safer drug than cascara sagrada. A small dose of nux vomica is also advantageous when there is general loss of nervous tone. A useful prescription is as follows:

℞ Elixiris cascaræ aromatici .. ♏iij.
Tincturæ nucis vomicæ .. .. ♏j.
Emulsionem petrolei .. .. ad ℥j.

One teaspoonful three times a day for an infant three months old.

In private practice it is convenient to prescribe the cascara and nux vomica in a drop-bottle, and to give directions that the required dose is to be added to each teaspoonful of the emulsion at the time of administration; in this way the dose can be modified from day to day, and gradually tailed off as the constipation improves.

In certain instances excessive dryness of the motions suggests the employment of expedients which loosen the secretions of the bowel and promote the flow of bile. For these purposes salicylate of sodium, citrate of sodium, vinum ipecacuanhæ, and iodide of ammonium are useful; but it must be borne in mind that symptomatic treatment of this kind often brings its own retribution, and leaves behind an aggravated condition of the symptom it is proposed to treat.

However, in those cases in which it is thought desirable to have recourse to these expedients, the following formula may be found useful:

℞	Sodii citratis	gr. iij.
	Ammonii iodidi	gr. j.
	Vini ipecacuanhæ	♏v.
	Emulsionem petrolei	ad ℥j.

One teaspoonful to be given three or four times a day.

For that variety of constipation in which a white and greasy appearance of the stools indicates that the pancreatic secretion is also at fault, and especially in those cases in which the motions are also offensive, I find no preparation so useful as liquor

pancreaticus given in full doses. The formula I generally employ is as follows:

℞ Liquoris pancreatici .. .. ♏x.
Emulsionem petrolei .. .. ad ʒj.
To be taken one hour after each feeding.

The treatment of constipation in infants may be summarized as follows:

1. In all cases the exciting cause, such as deficiency or excess of food, or qualitative faults, must be treated by appropriate means.

2. The motions may be softened by free doses of petroleum emulsion, and in aggravated cases by small doses of drugs which promote intestinal secretion and the outflow of bile.

3. Inertia of the bowel may be treated by massage, or massage combined with electricity; in aggravated cases by cascara sagrada and nux vomica.

4. In cases in which a chronic colitis complicates the condition, a preliminary course of irrigation (Plombières' method) may be employed.

5. In cases in which the motions are light-coloured and offensive, liquor pancreaticus may be added to the petroleum.

6. In all cases regularity of habit must be enforced by careful and systematic training.

CHAPTER VII

The Rational Treatment of Some Common Symptoms in Infancy

MARASMUS — VOMITING — CONTINUOUS CRYING — TROUBLESOME COUGHS—DIARRHŒA—THRUSH—SORE BUTTOCKS.

It is generally supposed that in the out-patient departments of children's hospitals physicians meet with a large number of interesting cases, but as far as my experience goes the vast majority of patients who are brought for treatment suffer from just the same commonplace complaints as are met with in general practice. A man's success or failure in private practice very largely depends on how he treats these commonplace disorders, and not on his skill in diagnosing rare and obscure diseases. I feel, therefore, that I need not offer any excuse for describing the methods which I myself have found useful in dealing with these common disorders.

A few months ago I made a note of the causes, or the alleged causes, for which forty-two consecutive infants under one year of age were brought to my out-patient department for treatment. In each case I asked the mother the same question—namely,

"What is the matter with your baby?"—and the following is an analysis of the replies: Ten were reported to be suffering from wasting, seven from sickness, six from fits of screaming, five from constipation, five from cough, three from diarrhœa, one from snuffles, one from throwing back of the head, one from bandy legs, and the remainder from heterogeneous symptoms of an equally uninteresting character.

The analysis bears out on a small scale what must be the experience of all hospital physicians—namely, that the greater part of their time is occupied in dealing with cases of the most commonplace description. So-called interesting and rare cases are extremely scarce. A fuller analysis proved that at least 80 per cent. of symptoms complained of were due to errors in feeding. It is clear, therefore, that it must be by attention to the dietetic treatment that success in the management of the majority of the cases presented for treatment can be achieved.

This line of treatment is, unfortunately, often thought beneath the dignity of the specialist; his thoughts are so occupied in making an elaborate diagnosis and in the medicinal treatment that often little time remains free for detailed instruction with regard to diet and other hygienic matters. It thus comes about that the mother's anxiety for information on these important points is often relieved by the presentation of a printed paper of directions for the feeding of normal infants. The value of such

papers is, at the best of times, small; but their use in the treatment of sick children is, in my opinion, to be strongly deprecated, for such children require individual treatment; they cannot be fed by rule of thumb on standard dietaries.

Marasmus.

Now, before I refer to the treatment of wasting, the commonest symptom for which infants are brought for treatment, I would ask to be allowed to deal with certain general considerations. Infants may waste from general constitutional disorders, from immaturity, prematurity, or from specific infections; but the vast majority of them waste because the nature of their food or the mode of its administration is, or has been, ill-adapted to their particular requirements.

We know that no individual, whether young or old, is capable of utilizing for the purposes of nutrition many of the articles of diet which are presented in the form of food until such articles have been dealt with in a very special way by the processes of digestion. We know, for instance, if foreign proteid bodies such as meat juice, white of egg, or lactalbumins, are injected directly into the bloodvessels, that they either prove actually toxic, or are eliminated from the system as foreign bodies by the kidneys or other excretory organs in an unchanged condition.

The only proteid bodies which can be utilized by

the tissues for the purposes of nutrition are those which are of a certain specific "make-up" or definite molecular structure. Each individual builds up his own specific proteids to fulfil his own specific needs and to suit the delicate biochemical reactions of his own tissues. These specific proteids are built up out of the relatively simple fragments into which foreign proteids are broken up in the process of digestion. For instance, the vastly complicated caseinogen molecule of cow's milk is split up by the proteolytic action of gastric, pancreatic, and intestinal ferments into fragmentary particles of amino-acids, or into small chains or amino-acids (polypeptides). Out of these fragments, or "bricks," as they are picturesquely called by Abderhalden, the synthetic activities of the mucous membrane of the intestines build up new proteids of the required molecular "make-up." What is true of proteids is also true of sugars and fats. Each foreign molecule must be reduced to relatively simple and rudimentary fragments by the processes of digestion, and these fragments must be rearranged on the required architectural plan during the processes of assimilation before they can be utilized by the tissues for the purposes of nutrition.

Nutrition is therefore clearly dependent not only on the satisfactory disruption of food elements into their more elementary fragments, but also on the satisfactory rearrangement of these fragments during

the processes of absorption. Nutrition cannot be furthered by forcing foreign food into the system.

The new-born infant is not provided with the necessary machinery for shattering the molecules of foreign food; it has to acquire the art by its own experiences. Further, it must learn how to propel the food it has consumed from the stomach into the duodenum and onwards through the entire length of the intestines. This essential and preliminary stage is often so badly learned by artificially fed infants that the major proportion of all ingested food is vomited through the cardiac orifice of the stomach instead of being discharged through the pylorus into the duodenum.

Nature will as a rule provide the necessary experiences, but, alas ! too often human ingenuity outwits her efforts and seek by short cuts to dispense with the more circuitous but safer routes.

I do not propose to delay the practical consideration of treatment by enlarging on the fascinating subject of the manner in which Nature teaches the new-born infant to digest human milk by means of simple lessons in the digestion of colostrum.

To learn to digest cow's milk cannot be an easy task at any time. Some of us never learn to do so satisfactorily; it seems to me, therefore, to be merely courting disaster to present the new-born infant with a variety of food which so stubbornly resists cleavage into its component fragments.

It was not therefore a matter of surprise that six out of the ten cases of marasmus to which I have already referred were given cow's milk before they were many days old, or before they had learnt the simpler lesson of digesting their mother's milk.

The several processes of the locomotion of food through the digestive tract, of its fragmentation into elementary particles, of its reconstitution on specific lines, and its final breakdown by the internal metabolism of the tissues are so intimately associated and mutually interdependent that weakness in any one link is reflected throughout the whole chain, and may lead to the same general result—namely, marasmus, or wasting.

It is therefore clearly the first step in the rational treatment of wasting conditions to determine as accurately as possible, by a review of the past history or present condition, the precise link in the chain of processes which has broken down and given rise to the trouble.

It would prove too tedious to enumerate all the possible weaknesses or combinations of weaknesses which a critical examination of a large number of cases of wasting can disclose; but apart from a certain number of cases in which symptoms of vomiting, diarrhœa, or convulsions, dominate the scene, the great majority of cases are due to a more or less common cause, and, as far as my experience serves me, these cases can be cured with a reasonable degree

of certainty by the application of a comparatively simple method of treatment.

The type of case to which I refer conforms more or less accurately to the following description:

The infant frequently, but not always, vomits after feeding; the stools are too frequent, sometimes after feeding, sometimes at irregular intervals; they nearly always contain so-called undigested curds; they have a foul odour; and the buttocks are usually red and excoriated. The infant cries a great deal, is restless, sleeps badly, and continuously loses weight. On careful inquiry, some such history as the following will be elicited:

During the first or second day of life the midwife has administered a dose of castor-oil, which has swept the bowel clear of all meconium. This dose is necessarily followed by a period of constipation, for no material is left in the bowel to constitute a natural action, nor does the limited supply of colostrum afforded by the breast for the first few days after birth in any way afford an adequate basis for a motion. The colon is relatively dry and empty, while with each wave of peristalsis its unlubricated surfaces ride over one another with a considerable degree of friction, giving rise to dysperistalsis, tormina, or even enterospasms. If under such circumstances an action follows, or if a second dose of castor-oil has been administered in the hope of affording relief, the motion will be found to contain

a number of small white bodies, which are almost invariably regarded as undigested curds. If, however, these little particles be washed out in water and carefully examined, they will be found to be not undigested curd, but little strands or pieces of mucus or mucous membrane, which have been forcibly torn off the surface of the bowel and rolled up into little balls by the irregular and violent peristaltic contractions of the colon. If these little balls of intestinal secretion are fresh, they present the appearance of raw white of egg; but if they have remained in the bowel for some hours, they become opaque, and then look like hard-boiled white of egg, or undigested curd. In nearly every stool all possible transitions are met with, from stringy pieces of glairy mucus to those little hard balls of opaque material which certainly have a most deceptive similarity to broken-up and undigested coagula of casein. Even to the naked eye their true character is easily revealed if they are freely teased out in water; and on many occasions I have found small punctate traces of blood on the surface which was once attached—evidence which proves the force with which they have been torn off the surface of the bowel.

The abrasions or breaches of continuity which are thus caused in the delicate epithelial lining of the colon is to my mind an adequate explanation of the many troubles which follow. They explain the habit of dysperistalsis which is so persistent in such

cases even under the most careful methods of treatment. They explain the extreme liability to intestinal infections, and they explain the easy decomposition and fermentation of food in the lower segments of the gut. A smooth, intact and healthy condition of the epithelial lining of the colon is essential for the normal locomotion and absorption of food in this portion of the bowel.

Matters are naturally made considerably worse if at this time cow's milk is substituted for the breast-milk, which is supposed to be disagreeing or to be inadequate in amount.

It is quite impossible to exaggerate the importance of the part which meconium plays in the early protection of the bowel wall from rough usage. It acts as a perfect lubricating medium, and also as a most happily designed material for constituting soft non-irritating motions until such time as the breasts are secreting freely and the infant is receiving sufficient nutriment to provide the basis for a normal stool. In seven out of the ten cases of wasting recorded above, I discovered that this fatal dose of castor-oil had been administered before the infant was forty-eight hours old.

The subsequent history of infants who present these early symptoms can easily be predicted. Breast-milk is said to disagree or to be insufficient in amount, and the infant is tried first with one kind of food and then another, always, however, with the same result.

The whole digestive mechanism has been thoroughly dislocated from the first, and no kind of food can agree; the surface of the colon is roughened and inefficient both in its locomotory and absorbent functions. The infant is never free from tormina (generally called "wind") unless its intestinal tract is kept freely lubricated by aperients or by an active secretion of mucus.

The treatment of these cases is complicated by the fact that the wasting condition of the infant invites a liberal supply of food; but under such circumstances very little food can be absorbed, and that which is not absorbed is decomposed or undergoes fermentation, and hence adds greatly to the trouble. Further, the infant's nervous system is worn and racked by the constant pain of dysperistalsis and by the toxins that are absorbed from the bowel.

The indications for treatment are to give small quantities of food which can be easily digested and absorbed, and also some indifferent material which will not decompose, which will form the basis of a motion, and which will lubricate and soothe the irritable mucous membrane of the colon and small intestine. For hospital cases I find the following method eminently satisfactory: I give, for an infant eight to twelve weeks old, one teaspoonful of condensed milk in two to three tablespoonfuls of water every three hours; in each feeding I give one to two teaspoonfuls of petroleum emulsion. If there is diarrhœa, I give glycerine of bismuth combined with

the emulsion, and in doses from half to two drachms, according to the severity of the symptoms. If there is vomiting, the bismuth and petroleum are given independently about five minutes before feeding. If there is flatulence, I give varying doses of milk of magnesia or carbonate of soda, and if the powers of digestion are feeble, I also give elixir of papain or liquor pancreaticus.

At the earliest opportunity I increase the amount of the feedings, and finally I begin to substitute cow's milk for the condensed milk by very carefully graduated increments, generally ten drops at a time. By this means I re-educate the infant in its digestive and motor functions, and, as I have already stated, the results, if slow, are in the end highly satisfactory. Confidence, patience, and consistency are absolutely necessary; otherwise, if the infant does not make the progress which the mother seems to expect, we may be tempted to make experiments and try short-cuts, which in the end prove no more satisfactory than the haphazard methods which were tried before, and which failed to give relief.

Vomiting.

After wasting, vomiting was the most common symptom in my group of cases. Of the forty-two cases above mentioned, seven were brought because of this symptom, and one in six is, I believe, about the average frequency of this symptom among young infants who are brought to hospital for treatment.

Vomiting may occur as a symptom quite independently of gastric disturbance in association with intestinal, nervous, or constitutional trouble, and recently my attention has been directed to cases of persistent vomiting connected with spasm of the cardiac sphincter of the stomach (cardio-spasm).

On this occasion I propose to deal only with vomiting of gastric origin. From the point of view of treatment I find it convenient to classify the varieties of vomiting in relationship to the time interval after feeding at which they occur. The first question I always ask is, "How soon after feeding does the vomiting take place?"

The varieties may be classified as follows:

1. Vomiting which occurs immediately after feeding.

2. Vomiting which occurs from ten to thirty minutes after feeding.

3. Vomiting which occurs more than thirty minutes after feeding.

Dealing with these three classes independently, we find that vomiting immediately after feeding may be due to—(*a*) Simple overfilling of the stomach; (*b*) eructation of gas; (*c*) violent movements of the stomach induced by (i.) the irritating or stimulating character of the food, (ii.) the irritable condition of the mucous membrane or nervous mechanism, (iii.) shaking or jolting the infant.

Vomiting which occurs from ten to thirty minutes after feeding may be due to—(*a*) The coagulation of

caseinogen and the presence of a too solid clot in the stomach; (*b*) the presence of an excess of acid in the stomach.

Vomiting which occurs more than half an hour after feeding is generally due to dilatation of the stomach, or to spasm or obstruction of the pyloric orifice.

Apart from the time interval which intervenes between feeding and vomiting, the character of the vomit affords useful diagnostic information. It should be noticed whether the food is returned unchanged, clotted, or with a strongly sour odour, or—as, indeed, often happens—whether the vomit consists simply of fluid which has the appearance of clear water.

The treatment depends, naturally, on the cause.

If the vomiting occurs immediately after feeding—if the food is returned unchanged, and the act occurs without effort or distress—it is nearly always due to overfilling of the stomach, and can be prevented by reducing the quantity of food.

If the vomiting occurs a few minutes after feeding, and is accompanied with a noisy eructation of gas, it can often be prevented by holding the infant in the upright position until the gas has been belched up. This expedient is simple, and in many cases most efficacious. At the same time precautions should be taken to prevent the infant swallowing air by adjusting the valve of the bottle, by enlarging the hole in the nipple, or in breast-feeding by holding the

nursling in a more convenient position at the breast, if it is suspected that any one of these causes is the reason of the vomiting.

Vomiting occurring soon after feeding, and accompanied by violent movements of the stomach, which can generally be recognized by waves of contraction passing across the abdomen, can as a rule be prevented by large doses of bismuth. I was led to adopt this method after noticing the fact that the habitual vomiters of this character seldom vomited after the administration of a bismuth feed given for X-ray examination.

Two teaspoonfuls of glycerine of bismuth combined with half a teaspoonful of milk of magnesia, ten drops of tincture of orange and one tablespoonful of water, make a most elegant mixture for an infant. If given about ten minutes before a feeding, the stomach is quieted down, and the food will seldom be rejected. As a rule it will not be found necessary to repeat the dose often, but even when it is found requisite to give a considerable number of doses, I have never noticed any undesirable consequences. The magnesia tends to correct any resulting constipation.

Vomiting which occurs from ten to thirty minutes after feeding, especially when the vomit contains solid curds, can generally be prevented by giving a few grains of citrate of soda, either at the time of feeding or shortly afterwards. The citrate should be given freely at first—say 5 grammes to the ounce

of milk—and then gradually reduced in quantity. I do not think it advisable to give continued large doses of this salt, as obstinate constipation may ultimately result. If the vomit is strongly acid, ℥ xv.-xxx. of milk of magnesia are a most invaluable corrective. It is best to give this antacid just before the usual time of vomiting. If the activity of the gastric juices is feeble, elixir of papain in ℥x. doses generally corrects the trouble.

That comparatively common form of vomiting which consists in the return of a large quantity of clear fluid, generally about half an hour after feeding, is in my experience better treated by giving undiluted milk with citrate of soda than by any other means. The reduction in volume involved in the giving of undiluted milk has, I doubt not, a beneficial influence; but I believe also that such vomiting occurs chiefly among infants who have active peptic digestions, and the administration of a food which occupies the energies of digestion and gives the stomach some work to do has a certain basis of rationalism. At any rate, from practical experience I am convinced that the method is worth trying.

The treatment of cases of vomiting occurring more than half an hour after feeding generally resolves itself into the treatment of a dilated stomach. Washing out the viscus is naturally the rational method of meeting the difficulty, but this is not always easy in out-patient practice. Lengthening the periods between feeding, the giving of the food

in more concentrated form, and in the administration of alkalies just before the vomiting usually occurs, are the best means of combating the difficulties.

Before I leave the subject of vomiting I would insist on the great importance of long intervals between feedings both as a prophylactic and as a cure for many forms of sickness. I have come to the conclusion that two-hourly feedings cannot be defended on physiological grounds either for young infants or for sick infants. Many of the best authorities on the Continent recommend much longer intervals, and personally I have found that infants are more likely to thrive when they are fed every three hours than when the intervals are shorter.

One of the most difficult forms of vomiting to treat is that which is dependent on habit, and this variety of sickness may occur at any period after feeding. A habit of this kind is very easily acquired, and it persists long after the cause which has provoked it has been removed. It becomes, in fact, one of those "conditional reflexes" to which Professor Pawlow has called attention. In such cases the dial of the gastric motor mechanism is set, so to speak, with the indicator pointing to the word "vomit," and vomit the infant will, however carefully you may change the diet or method of feeding.

I have found that an exceedingly useful method of treating this kind of vomiting is to exhaust the vomiting centre just before feeding-time by the administration of an emetic. I generally give—

℞ Vini ipecacuanhæ .. .. .. ℥j.
Ammonii carbonatis .. .. gr. ij.
Aquam .. .. ad ℥ss.

If this dose does not cause sickness, I order the dose to be repeated. This violent stimulation of the vomiting centre is followed by a period of quiescence or exhaustion, and as a rule the succeeding meal is retained. I have cured a large number of habitual vomiters by this method. Sometimes a single dose fulfils its object, sometimes the dose has to be given on two or three successive days. I rarely get a complete failure. The trouble in applying this method is the difficulty of making a positive diagnosis of the nature of the vomiting.

Continuous Crying.

Continuous crying or screaming seems at first sight a somewhat trivial symptom, but it is by no means trivial to the parent who has to live in the same room with the source of the disturbance. The late Dr. Cheadle used to say there were only two causes of continuous crying in infants—first, the cutting of the eye teeth; the second, earache. When an infant is brought to me for this symptom, I always think of these two most probable causes; and although it is dangerous to ascribe symptoms to dentition, I have found teething to be the most frequent cause, although earache is exceedingly common. When there is slight pharyngeal cough, when glands can be felt in the neck, and when the infant rolls its head

from side to side and pulls at its ear, even without confirmation of the diagnosis by direct inspection of the membranum tympani—which is not altogether easy in young infants—I consider it quite justifiable to instil some opium into the external auditory meatus. I employ the following formula:

℞	Tincturæ opii	♏x.
	Acidi carbolici	gr. x.
	Glycerinum	ad ℥j.

Intermittent fits of screaming are far more common than continuous crying, and they are as a rule associated with disturbances of the motor mechanism of the digestive tract. Wind in the stomach that cannot be expelled, pyloric spasm, hour-glass contraction, dysperistalsis, and the tormina of mucous colitis are the most common causes in my experiences.

Of the six infants included in the above list, four were suffering from dysperistalsis due to mucous colitis, one from earache, and one from laryngitis.

The treatment of the tormina of dysperistalsis has already been referred to; it is most successfully treated by free doses of the mixture I described as consisting of milk of magnesia, glycerine of bismuth, and petroleum emulsion. If necessary, a small quantity of tincture of opium, compound tincture of camphor, or compound tincture of cardamoms, may be added to the first dose, and afterwards omitted. The petroleum alone, or the petroleum with the bismuth, must be continued as a prophylactic measure for some days.

Laryngitis is by no means an uncommon cause of crying in infants. It may be recognized by the hoarse character of the cry and the evidently painful cough. It is rapidly relieved by hot fomentations to the throat, and by expectorants.

There is a widespread belief that thirst is a common cause of crying. I cannot say that it has been my experience to find that water is a panacea for many cases of crying.

Volumes might be written on the subject of the psychology of crying. There can be no doubt that crying very easily becomes a habit—another instance of a conditional reflex, and some infants show the greatest regularity in this respect; at the same moment day after day they will wake up and commence crying. How the suggestion arises it is not easy to say. It is quite certain, however, that the personality of certain women has a most baneful influence over certain infants, while other women have a correspondingly good influence in soothing these conditions of irritability. It is quite astonishing how very quick infants are to learn when crying pays them. When they know their mothers are weak enough to pick them up and nurse them if they cry long enough, they will scream for hours until the unwilling resistance is overcome.

Troublesome Coughs.

Immeasurably the commonest cause of cough, at least as far as infants in London are concerned, is the

pharyngeal catarrh. Very slight irritation or congestion of the naso-pharynx will give rise to this reflex symptom. The reflex once acquired is very apt to persist and become troublesome. It is the precursor of adenoid vegetations, Eustachian catarrh, and running ears. I have on record quite a hundred cases of infants who have developed successively the pharyngeal cough, then a small chain of glands in the neck, then earache, and finally otorrhœa. Owing to my unhappy experiences of this sequence of events among my babies in Marylebone, I have paid considerable attention to such prophylactic measures as come within the range of practical therapeutics.

Early operation is undoubtedly the best practice, but there are obvious objections to this drastic proceeding. On the other hand, regular and persistent irrigation of the pharynx through the nose is free from objection, and on the whole gives very good results. We supply the infants with a cheap nasal syringe and an antiseptic collunarium of the following formula:

Lotio Thymolis.

℞	Acid. boraci	℥ij.
	Acid. benzoici	ʒj.
	Thymolis	ʒj.
	Eucalyptol	ʒss.
	Glycerini	℥viij.
	Spiritûs rectificati	℥ij.
	Liquoris cocci cacti	ʒij.
	Aquam	ad ℥lxxx.

Adde partes quattuor aquæ callidæ

The mothers must, of course, be instructed how to use the syringe.

An occasional painting of the tonsils and pharynx with a solution of nitrate of silver (10 grains to the ounce) decidedly expedites the cure.

The frequency of this septic condition of the pharynx among edentulous infants suggests that adenoids and tonsils are more likely to be responsible for carious teeth than that carious teeth are the precursors of septic inflammation of the naso-pharynx.

The next commonest cause of cough is bronchial catarrh; indeed, among hospital patients this variety of cough is even more common than the foregoing, for infants with merely a pharyngeal cough are not as a rule considered ill enough to be brought to hospital. Both bronchial catarrh and tracheitis, especially the latter, are troublesome, for the reason that the infant seldom coughs with sufficient force to expel the mucus; for this purpose there is nothing more valuable than the administration of an emetic consisting of vinum ipecacuanhæ and carbonate of ammonium.

In hospital practice the treatment of cough is very perfunctory. The stock cough mixture is given indifferently in the early stages of congestion before there is any mucous secretion, in the second stage when the secretion is free, and in the third stage when the secretion has become muco-purulent.

Both at the Queen's Hospital and at the St. Marylebone General Dispensary I employ three

stock mixtures adapted to the pathological indications of the three successive stages above mentioned. The formulæ of these three mixtures are as follows:

MISTURA TUSSIS INFANTILIS.

No. 1.

℞	Potassii citratis	gr. iij.
	Ammonii iodidi	gr. j.
	Vin. ipecacuanhæ	♏ij.
	Tincturæ camphoræ compositæ ..	♏iij.
	Syrupi aurantii	♏x.
	Aquam	ad ℥j.

No. 2.

℞	Ammonii carbonatis	gr. j.
	Oxymellis scillæ	♏v.
	Vini ipecacuanhæ	♏ij.
	Syrup tolutani	♏vi.
	Aquam	ad ℥j.

No. 3.

℞	Ammonii carbonatis	gr. i.
	Terebeni	♏ij.
	Syrup tolutani	♏v.
	Pulveris acaciæ	gr. ii.
	Aquam	ad ℥j.

The other causes of cough, such as enlarged bronchial glands, pneumonia, tuberculous disease of the lung, and the reflex cough of stomach or ear origin, do not require detailed mention. With respect to whooping-cough it should be remembered that young infants very often do not whoop at all, and consequently the diagnosis may easily be missed unless special inquiry is made to establish the true character of the attacks. It is useful to

remember that with the development of whooping-cough in infants the intervals between the paroxysms become longer as the actual attacks become more violent, whereas with ordinary bronchitis the intervals become shorter and the actual attacks of coughing longer, though not more violent.

The formula for the mixture I employ in whooping-cough is as follows:

℞	Potassii nitratis	gr. j.
	Ammonii bromidi	gr. ij.
	Ammonii iodidi	gr. j.
	Ammonii carbonatis	gr. ½
	Tinctura belladonnæ	♏ij.
	Vini ipecacuanhæ	♏j.
	Aquam chloroformi	ad ℥j.

As the case progresses I freely increase the tincture of belladonna and the ammonium bromidi.

Diarrhœa.

The number of cases of diarrhœa which occurred in my series of forty-two infants was small—*i.e.*, three only—owing to the season of the year; doubtless in summer the proportion would have been far higher.

For the purposes of treatment the varieties of diarrhœa may be conveniently classified as follows:

1. Acute cases of summer diarrhœa.
2. The diarrhœa which accompanies mucous colitis or enteritis.
3. Lienteric diarrhœa.

Summer Diarrhœa with acute symptoms of collapse or exhaustion must be drastically dealt with.

All food should be suspended for twenty-four hours at least; the colon should be thoroughly washed out with clysters of hot water injected at a low pressure by means of soft rubber catheter. Either a douche-can or a glass funnel may be employed. The temperature of the water should be at least 100° F., and the quantity should be not less than 1 pint. In my opinion this proceeding has advantages over the subcutaneous injection of isotonic saline, since it serves the double purpose by washing out the bowel and of supplying the tissues with much-needed fluid.

If vomiting is not a prominent symptom, small quantities of brandy and opium may be given by the mouth. Fifteen minims of brandy and ½ to 1 minim of the tincture of opium given in a table-spoonful of hot water will usually help to relieve the symptoms of collapse. In those cases in which the feet are particularly cold, 10 minims of sweet spirits of nitre will be found to be useful in mitigating the vaso-motor spasm. The popular plan of giving arrowroot gruel is highly irrational, and personally I have no faith in egg-water. It is far better, after the bowel has been completely cleared out, to leave it in absolute rest, and thus give it an opportunity of recovering.

The subacute or chronic diarrhœa of mucous colitis, or enteritis, does not demand such drastic treatment. If the symptoms are severe, it is advisable to give water exclusively for twenty-four

hours or longer, but in the majority of the milder cases it is unnecessary to suspend breast-feeding, or to alter the bottle-feeds, provided these are otherwise of a suitable character.

In the treatment of mucous colitis or enteritis there are few drugs of equal value with castor-oil. This oil may be administered in small and frequent doses in the form of an emulsion, or better, I believe, in a single and comparatively large dose at night-time. I usually order ½ to 1 drachm every night until the diarrhœa has subsided. If, as is often the case, the infant suffers from tormina and cries much, I give large doses of glycerine of bismuth, either alone or combined with opium and prepared chalk. There is no preparation of bismuth so adapted for administration to infants as the glycerine of carbonate of bismuth. Bismuth is not an easy drug to administer to infants, as all nurses know; in most of its forms it is gritty and remains in the mouth. Moreover, it is often rejected altogether, whereas the glycerine preparation, especially if combined with a little saccharin and cinnamon-water, is very well liked by babies, and can be taken in large doses.

The following is a formula which I often employ:

℞	Glycerini bismuthi carbonatis ..	ʒss.
	Elixi glusidi	♏ss.
	Aquam cinnamomi	ad ʒij.

Many will think this a large dose of bismuth to give a young infant, but the best effects of bismuth are only obtained by giving large quantities.

Cases of lienteric diarrhœa call for treatment on the lines of re-educating the digestive processes. Very often the general inefficiency of the digestive processes is accompanied by mucous colitis or enteritis, and if so, these conditions must be treated in the manner already described. Since the digestive processes are in abeyance, all food for a time must be given in a completely predigested condition. The most convenient form of giving predigested food to hospital patients is to supply them with Fairchild's peptogenic powders, and instruct the mothers to digest the milk for forty minutes before giving it to the infant. For an infant three months old I order 3 ounces of predigested whole milk every three hours —a combination of "threes" which makes the method easy to carry out and also to remember.

As the condition improves the milk can be digested less and less every day, say, for two minutes less, until the infant's reinstated powers of digestion enable it to deal with plain, untreated milk.

In severe cases of lienteric diarrhœa a tonic treatment with hypophosphites, sanatogen, or even with small doses of arsenic, may accelerate the cure.

Thrush, Sore Buttocks, and other Common Infections in Infancy.

I regard infancy and childhood as a period in which the individual acquires immunity from the dangers of the environment, be the latter the germs

of infection, physical agencies, such as heat or cold, or even moral and psychological influences. In consequence of this opinion I do not take the same serious view of many of the infections that is taken by certain people. For instance, I consider that the individual who has safely survived attacks of measles, mumps, chicken-pox, whooping-cough, and half a dozen additional infective complaints to which childhood is prone, is a more useful, healthy, and efficient person than one who has suffered from none of them, and whose troubles are still to come.

I look forward to the time, and at no distant date, when we shall provide our children with an artificially acquired immunity to all these complaints, just as we now make them immune to smallpox. To allow a child to enter into deadly combat with full-venomed smallpox, when we can perfectly safely teach him how to grapple with the enemy by rehearsals in the academy with the blunted foils of an attenuated virus, seems to me most foolish; and I shall certainly gratefully welcome any means which may be discovered of providing our children with an artificially acquired immunity to other common infective diseases, as safe and as certain as that which we now possess in vaccination against smallpox.

As things are at present, a child runs great risks in acquiring immunity against many of the infective fevers, such as scarlet fever, measles, and tubercu-

losis, but when once he has wrestled with the disease and conquered it, he is relatively safe. But there is an additional danger when these battles are fought in too rapid sequence or at unfavourable times—when the child has to meet a new enemy before it has had time to recover from the exhaustion due to the one which has preceded it.

The new-born infant is exposed to a number of infections, although in many ways it is ill-equipped to fight with them. Some of these infections are quite accidental and avoided only with difficulty; others are easily prevented with a little care and forethought.

There can be little doubt that many of the infections from which infants suffer take place through inoculation at points in the surface epithelium which have received wounds or damage of some kind. The common seats of infection are—(1) The raw surface of the umbilical cord; (2) the epithelium of the mouth or the tongue; (3) the mucous membrane of the nose, ear, or eyes; (4) the skin on the top of the head or on the buttocks; (5) the mucous membrane of the intestinal tract.

I cannot here describe in detail the manner in which wounds are inflicted at all these points soon after the child is born, but I would refer briefly to one or two.

I find " thrush " of far more frequent occurrence when the mouths of young babies have been carefully

cleaned out than when they have been left, so to speak, "dirty." The instinct of cleanliness must, in this respect as well as in many other departments of infant management, be tempered with respect for surface epitheliums. I am glad to see that in the instructions issued by the United States Public Health Service and by the Bulletin of the National Organization for Public Health Nursing in America, a caution is uttered against cleaning the infant's mouth. I have no doubt myself that most of the cases of thrush which come under my own observation are due to scrubbing the surface epithelium off the tongue with pieces of harsh linen.

If the mouth is to be cleaned at all, it should be very gently swabbed out with cotton-wool soaked in glycerine of borax; but as a rule the mouth should be kept clean by the physiological method of preserving an intact mucous lining rather than by the application of the linen rag.

Inflammations of the eye and nostrils are caused also by similar or comparable acts of interference, and the unsightly scurf or dandruff which so often makes its appearance on the top of the head is, I believe, also caused by too much energy in removing the vernix caseosa of new-born infants.

Red buttocks, though largely dependent on rectal and intestinal irritation, are also due in some degree to the unwise use of soap, water, and towel. It is very easy to wound the sensitive skin of the young

baby in this way. The skin of the buttocks, which must necessarily be exposed to constant infection by soiled napkins, should be treated with the utmost care, and in the same sort of way that the backs of bedridden patients are protected from bedsores. I find the application of hazeline cream and of eau de Cologne and water answers this purpose most excellently.

The actual treatment of the buttocks when once they have become sore and red is another matter. It is of the first importance to restrict the amount of water in the food when the infant is being artificially fed. When breast-fed, this limitation of fluid is more difficult.

The infant should be changed often and the napkin should be very loosely applied, so as not to increase the soreness through friction. In some cases it is well to apply no napkin, but to allow the child to lie on a pad of absorbent wool.

It is very difficult to say in any particular case which is likely to be the best local application. Sometimes one, sometimes another, appears to give the better result, but one or other of the following, which may be tried in turn, is almost certain to effect a cure: (1) Black wash applied on lint; (2) ointment of resorcin (1 gramme to the ounce); (3) calamine and lead lotion in equal parts, with ten drops of laudanum to the ounce; (4) pure liquid paraffin; (5) olive-oil.

CHAPTER VIII

The Uses of Dried Milk in Infant Feeding

Whether regarded from the economic, commercial, or nutritional point of view, milk is such a valuable food that there is little cause for surprise that human ingenuity has been constantly engaged in attempts to discover some practical means of preserving it either in its natural condition or in some condensed form, and thus to prevent the serious losses which naturally occur in so perishable an article of food. But so innumerable and deep-rooted are the prejudices in favour of fresh milk, that inventors and manufacturers have experienced almost insuperable difficulties in obtaining a market for even the best varieties of preserved milk. In spite of the physiological evidence that a limited degree of heat does not impair the nutritive qualities of milk, the public and, I regret to say, a small section of the medical profession still believe that a diet of boiled milk is incompatible with good nutrition. The huge collective experience of infant consultations not only in England, but also throughout Europe and America, has proved beyond question that the sterilization of

milk has had even a greater influence in reducing infant mortality than the most painstaking attempts to provide an absolutely irreproachable milk-supply. In this connection it is particularly interesting to note that certain of the pioneers of the "pure-milk" movement in America are now the active advocates of pasteurization. For reasons which I have elsewhere[1] summarized, it is beyond question true that a limited degree of heat does not impair the nutritive qualities of milk, although excessive heating or prolonged keeping may destroy certain principles in milk or other fresh foods, which are essential for good nutrition. These principles are known as "vitamines"; but they can be so easily supplied in an independent form—in orange juice or grape juice, for instance—that their possible destruction by heat is no argument against the pasteurization, sterilization, or desiccation if these operations confer other and important advantages.

There are many factors concerned in infant mortality, and of these good and careful mothering is undoubtedly the most important; but some of the best results of which I have personal knowledge have been in those cases in which good mothering has been combined with the employment of dried milk. The experiences of Leicester, Sheffield, and Marylebone in England, and in many centres in France and Belgium, prove this conclusively; and in this connection I cannot refrain from quoting a

[1] *The Milk Problem*, Bedrock, January, 1913, p. 515.

passage (translated) from Professor C. Porcher's *Le Lait Desseché*, p. 122.[1]

"At a certain infant clinic in Ghent the infant-mortality rate was as high as 260 per 1,000 in the year 1901. In the year 1903 sterilized milk was supplied to the infants, and the rate fell to 150 per 1,000. In the year 1907 a house-to-house visitation scheme, carried on by trained health workers, was inaugurated, and the death-rate fell to 60 per 1,000. In the year 1908 dried milk was substituted for sterilized dairy milk, and the rate fell to 34 per 1,000." This striking experience proves that the very best results are not incompatible with the use of dried milk. Dried milk, however, without good mothercraft, is of no more avail than breast-milk, or dairy milk under similar conditions.

Before I proceed to a description of the methods of employing dried milk in infant feeding, I may perhaps be permitted to make a few general remarks on the history of its manufacture.

Although attempts were made in the middle of last century to condense milk to the stage of dryness, all efforts in this direction proved a complete failure, until, in the year 1903, Mr. S. Amundsen succeeded in employing on a commercial scale a method of desiccation invented a few years previously by Dr. Ekenberg. Necessity is the father of invention, and the establishment of Mr. Amundsen's factory in

[1] Published by Asselin et Hougeau, Place de l'École de Médecine, Paris, 1912.

Kristinnia was almost the necessary consequence of that fact that in this part of Sweden there was a considerable butter industry, and a large and unavoidable loss of by-products and residuals: the separated milk, although largely used for the fattening of pigs and other animals, proved so perishable and difficult of transport, that it entailed a very considerable waste of valuable material. By the Ekenberg process, which I shall shortly describe, the separated milk was reduced to dryness and distributed among farmers as a food for their animals in a highly convenient and transportable form. This early venture, however, cannot be described as an unqualified success, and chiefly for the reason that the market for desiccated separated milk was at that time extremely limited, and partly because the method could not then be used for the desiccation of milk from which the butter-fat had not been extracted. This difficulty in the drying of fat has proved the rock on which many milk-desiccating ventures have come to grief.

It was not long, however, before the Ekenberg process was so far improved that manufacturers were able to produce dried milk on a commercial scale without the preliminary removal of the cream, and from that time forward one improvement after another has been introduced until at the present moment there are three distinct methods of manufacture, each good in its way, and each possessing special advantages.

The principle of the Ekenberg process consists in the partial condensation of the milk at a low temperature under reduced pressure, and its subsequent desiccation within the interior of cylinders heated to a comparatively low temperature. The milk solidifies into a crystalline mass on the surface of the cylinders, which are kept in constant rotation, and this mass is subsequently broken up and pulverized. This method is not employed to any large extent in this country, but it is more popular in France and in other parts of Europe. In England the method usually employed is that which is known as the Just-Hatmaker process. In this method the previously concentrated milk is spread on the outer surface of rotating cylinders, which are heated to a high temperature by steam (160° C.). The thin film of milk dries very rapidly on the highly polished surfaces, and when dry is scraped off by sharp knife-blades, and subsequently pulverized, as in the Ekenberg process. This is the process which has been made familiar to a large section of the British public by frequent demonstrations at Earl's Court and other exhibitions.

A third process, generally known as the Bévenot-de-Neveu method, consists in concentrating the milk *in vacuo* and at a low temperature, and then forcing it under high pressure (250 atmospheres) through minute perforations in a metal disc into the drying chamber. The nebula of homogenized milk is then surrounded by an envelope of dry and hot air

and swept across the chamber. Owing to the fine state of division of the particles in which the condensed milk is presented, and to its intimate contact with dry air, the milk is almost instantaneously desiccated, and falls as an extremely fine powder to the floor of the chamber. The moisture thus evaporated is carried off as a cloud of steam, while the snow-like desiccated milk is rapidly swept up from the floor and packed in tins or other receptacles.

The distinguishing feature of this method lies in the rapidity with which the concentrated milk is evaporated in the drying-chamber. So finely atomized is the milk that even at comparatively low temperatures the moisture is almost instantaneously evaporated; indeed, this evaporation is so rapid that the water is removed from the coagulable ingredients, such as the whey proteids, before they have time to become coagulated by the heat—at least this is the explanation which has been given to account for the possibility of reconstituting with water the coagulable substances which have been desiccated by this method. On any other grounds it seems difficult to explain how it is that substances such as meat juice and chlorophyll can be completely desiccated by the method at temperatures which would, under normal conditions, coagulate and destroy their organic properties, and thus render them insoluble in water.

By the Bévenot-de-Neveu process of desiccation, milk and whey can be reduced to the condition of a

very dry powder containing no more than 1 per cent. of water, apparently without alteration of their physical properties; that is to say, none of the enzymes or vitamines appear to be destroyed, and the milk, when reconstituted with water, can be coagulated by rennet or heat, precipitated with acids, and soured by lactic-acid ferments, just as is the case with milk fresh from the cow. Moreover, when allowed to stand, the cream will slowly rise as it does with fresh milk which has been homogenized.

These results are to my mind of immense advantage, for the chief objection usually raised to desiccated milks is that they are so profoundly altered by the heat to which they have been subjected in the course of manufacture that they no longer possess those subtle and vital properties which are supposed to be essential for good nutrition.

Milks desiccated by the three processes which I have briefly described possess special physical properties. Some of them possess distinctive chemical properties as well, for to certain of them substances such as phosphate of sodium, saccharated lime, or glucose, are added to facilitate the operations of drying and to render the finished product more readily soluble in water.

The appearance of milk dried on the surface of cylinders, as in the Ekenberg or Just-Hatmaker processes, is that of irregular polygonal plaques of varying dimensions and of striated structure, whereas the powder dried by the Bévenot-de-Neveu pro-

cess is very much finer and more homogeneous. It is fairly soluble in hot, but resistant to cold, water. The Bévenot-de-Neveu milk is equally soluble in hot and cold water, and can be readily reconstituted by beating with a fork or special whisk.

The appearances of the cylinder-dried and air-dried are also distinctive. The colour of Just-Hatmaker milk is biscuit yellow, that of Bévenot-de-Neveu milk of a peculiarly snow-like white. When allowed to stand, the fat rises in the former as a yellow oil, in the latter as a rich cream. The odour of the cylinder-dried milk is agreeable, and distinctly biscuity. The odour of Bévenot-de-Neveu milk is slightly tallowy, especially when it has been kept for some time. This is due to the oxidation of the fat, a result which appears to follow from the fine state of division in which the fat particles are presented to the oxygen of the air. Although this oxidation in no way affects the nutritive value of the milk, it detracts from its popularity. This is unfortunate, for in all other respects Bévenot-de-Neveu milk is, according to my experience, superior to other varieties of desiccated milk. This taste, however, is one to which most people soon become accustomed.

Dried milks, whether prepared by the cylinder or the air-process, are usually sold in three qualities: Firstly, as "full-fat" milk, from which no cream has been extracted before drying; secondly, as "half-cream," in which part of the fat has been removed; and, thirdly, as desiccated milk, from which all the

cream has been separated. To these three varieties yet a fourth may be added—namely, milk modified to the standard required, or supposed to be required, for infant feeding.

These milks vary in price in proportion to their cream content. Full-cream milk sells at about 1s. 6d. per pound, and separated milk at about 7d. When reconstituted with water and made up to their original bulk, the best dried milks cost practically the same as the best dairy milks—*i.e.*, about 4d. to 5d. a quart.

Dried milk, as Professor Porcher says, is "la vache dans le placard"; that is to say, if you have dried milk, you are as well off as if you kept a cow in the larder ready to be milked at any moment. Dairy milk deteriorates from the moment it is milked up till the moment of consumption; if consumed eighteen hours after milking, the deterioration may be extreme. Dried milk represents milk which has only deteriorated between the time of milking and desiccation. This usually is not more than four hours, and need not be more than one hour.

In infant feeding dried milk is no better adapted to the physiological requirements of infants than is ordinary cow's milk. It must be modified to the nutritional and digestive requirements of the infant in the same way that cow's milk must itself be modified. Many are of the opinion that infants can be brought up successfully on whole milk which has not been modified in any way. It is true some

infants will apparently thrive without any serious disasters even on a diet of unaltered cow's milk. But the best results are not obtained in this way.

The physiological requirements of the infant and the calf are quite different; they live under different conditions and grow at different rates.

If there is any truth in the generally held belief that the proportions of proteid, fats, and carbohydrates in the milk of different species of mammals is designed to meet the specific requirements of their own particular young, it seems to me to be most illogical to expect that the milk of two mammals so morphologically different as the human being and the cow can be mutually interchangeable.

It is the simplest thing in the world to teach an infant to digest cow's milk, even in the undiluted or in the non-citrated condition; but it does not necessarily follow that the proportions of its main constituents are well adapted to the nutritional requirements of the growing child. Indeed, I am prepared to defend the thesis that cow's milk, in its unaltered condition, is not adapted to the physiological needs of the infant. If cow's milk is to be used with success in infant feeding, it must be modified by dilution and fortified with fat and sugar, or treated in some other way to bring it up to the approximate standard of breast-milk; and if dried milk is to be used for the same purpose, it also must be modified in the same way.

If a good variety of dried milk is diluted with water

in the proportion of one part of the powder to eight parts of water, the resulting mixture is, or should be, of the same percentage composition as the undiluted milk from which it was originally prepared.

If, therefore, undiluted cow's milk can be regarded as a good food for a baby, we can reproduce it by prescribing so many ounces of the reconstituted dried milk made up in the proportion of one drachm of the powder to one ounce of water.

But if you wish to modify the resulting mixture so that it shall approximate to the composition of breast-milk, you must proceed more carefully, dilute more freely, and add cream and sugar.

Assuming the percentage composition of breast-milk to be—1·5 per cent. proteins, 6·5 per cent. carbohydrates, and 3·5 per cent. fat, a mixture of this percentage composition (Formula I.) can be prepared by combining two tablespoonfuls of full-cream dried milk, six teaspoonfuls of sugar, one ounce of thick cream (46 per cent. fat), in one pint of water. Such a mixture, however, in one noteworthy respect fails to correspond with breast-milk—it contains practically the whole of its protein in the form of caseinogen, and not in the form of caseinogen plus whey proteins. Some authorities attach importance to whey proteins in infant feeding, and attribute many of the failures to rear infants successfully on cow's milk to a different supply of these elements.

In breast-milk the total 1·5 per cent. of protein is

made up of 0·5 per cent. caseinogen and 1 per cent. whey proteins; whereas in cow's milk the proportion is, approximately, 3 per cent. caseinogen to 1 per cent. of whey proteids, and in ordinary desiccated milks this deficiency is even more pronounced. If, therefore, dried milk is to be modified to correspond to breast-milk in respect of its content in whey proteids, the latter must be added independently.

From this point of view, it is extremely fortunate that the Bévenot-de-Neveu process of desiccation permits of the manufacture of a whey powder which, when reconstituted with water, almost exactly reproduces the original whey from which it was prepared. Dried whey powder of this kind is sold under the name of Sweet Whey, or Sec-Wa.

Now, by an appropriate combination of dried milk, whey powder, sugar, and cream we can prepare a humanized milk which has a percentage composition the same as human milk—namely, caseinogen 0·5 per cent., whey proteins 1 per cent., sugar 6·5 per cent., fat 3·5 per cent. The formula is as follows (Formula II.):

Full-cream dried milk, 3 teaspoonfuls; Sec-Wa, 2½ tablespoonfuls; sugar, 2 teaspoonfuls; thick cream, 1 ounce (46 per cent.); and water to 1 pint.

This is a very valuable substitute for breast-milk, but somewhat expensive to use owing to the large quantity of dried whey powder and cream required in its preparation.

Care with respect to the exact balance between the

different kinds of proteins—*i.e.*, the caseinogen and whey proteins—is only necessary in the case of quite young or delicate infants who have not acquired the power of digesting caseinogen.

Strong, healthy infants, who have been accustomed to take ordinary cow's milk, or who have been gradually habituated to larger quantities of caseinogen by a graduated course of feeding, thrive well on a mixture of the following formula (Formula III.):

Proteins, 2·5 per cent.; sugar, 6·5 per cent.; fat, 3·5 per cent.

This is prepared by combining 2 ounces of full-cream dried milk, ½ an ounce of sugar, 1½ ounces of thick cream (46 per cent.), and water to the pint.

The transition from Formula II. to Formula III. should be carefully made by the gradual substitution of the sugar and the full-cream dried milk for the whey powder.

I feel this account would be incomplete without referring to the use of dried separated milk, although the only advantage to be derived from using it is one of economy.

I am now feeding a large number of infants on desiccated separated milk, and modifying it for use by adding supplementary fat, and sweetening it with a small quantity of sugar. The best fat to add is cream, but this is expensive, and any other fat or oil will answer the purpose; perhaps a combination of several fats is even better than one single variety of

oil. I have, however, obtained excellent results with an emulsion of linseed-oil, which is generally known as "Marylebone cream." The formula for preparing 20 ounces of a mixture of separated dried milk and Marylebone cream is as follows (Formula IV.):

Separated dried milk, 1½ ounces; Marylebone cream (50 per cent. fat), 1½ ounces; sugar, ½ ounce; water to 1 pint.

The cost of feeding infants on this mixture is only about 2d. a day.

When dried milks or other preserved foods are employed, it is well to give some fresh fruit juice or other antiscorbutic—a teaspoonful of orange juice or the expressed juice of two grapes.

Such formulæ must not be slavishly followed. The art of scientific feeding consists in the adaptation of the food to the individual requirements, which can be understood only by a study of the infant both in health and disease, of the caloric values of food elements, and of the expenditure in heat and energy. The table on the next page will prove helpful.

All quantities must be based on the physiological requirements of the individual. As a rough basis for calculation it may be assumed that a normal infant of three months requires from 40 to 50 calories per pound of body-weight; that is to say, an infant of this age, weighing 10 pounds, requires 400 to 500 calories in the twenty-four hours. Younger and smaller infants require a larger number of calories per pound of body-weight, and older and

larger infants rather less. From these data it is easy to adjust the quantity of food to the requirements of different infants, allowance being made for special conditions. For instance, more food is required in cold weather and when the infant is growing rapidly and manifesting great muscular activity. In hot

PERCENTAGE COMPOSITION.

Article.	Proteins.		Sugar.	Fat.	Approximate Caloric Value.	
	Caseinogen.	Whey Proteins.			Per Gramme.	Per Ounce.
Dried Milk:					Calories.	Calories.
Full cream	24·50	1·94	38·92	28·00	5	146
Half cream	30·58	2·42	39·70	15·10	4	119
Separated ..	31·40	2·49	55·00	1·00	4	104
Whey powder	—	14·25	74·50	0·27	4	102
Thick cream (46 per cent.)	—	—	3·00	46·00	4	122
Thin cream (16 per cent.)	—	—	4·00	16·00	2	48
Marylebone cream ..	—	—	—	50·00	5	127

weather, when it increases in weight slowly and remains inactive, less food should be given.

I do not, however, recommend adherence to any one particular food, no matter how good or how cheap it may be. The requirements of nutrition are so subtle that it is wise to give new foods and make a few changes every now and then in case some important element in the diet has been omitted; but every change should be made gradually, for fear of disturbing the functions of digestion.

CHAPTER IX

The Uses of Petroleum in the Treatment of Constipation and Other Diseases in Infants

The therapeutic uses of petroleum for internal administration are almost as old as history itself. Herodotus and Pliny both refer to it in their writings as a liquid with medicinal properties of considerable value. During the eighteenth and early nineteenth century, travellers in Russia, Roumania, Bavaria, South America, and other countries where oil-wells are situated, refer occasionally to the consumption of liquid bitumen, white naphtha, or St. Quirinus's oil by the natives as cures for various diseases. On the other hand, since the time that paraffin was introduced into Europe for illuminating purposes, medical literature has abounded in references to cases of accidental poisoning and attempted suicide by the swallowing of the crude oil. This fact may possibly explain the strong prejudice shown by some people against taking the purified forms of the oil by the mouth for medicinal purposes.

My first acquaintance with the uses of the more refined and non-toxic varieties of paraffin dates from

the year 1893, when petroleum in the form of an emulsion was brought to my notice as a substitute for cod-liver oil in the treatment of consumption and wasting diseases. Under the late Dr. W. B. Cheadle's directions, I gave this new emulsion a prolonged and careful trial in several cases of tuberculous disease in children who were warded in St. Mary's Hospital, but with such disappointing results that we soon abandoned its use in favour of our old friends cod-liver oil, maltine, and steel wine.

If, at that time, I had known what I learnt a few years later—namely, that Dr. N. A. Randolph,[1] of Philadelphia, had proved in the year 1884 that paraffin when swallowed by the mouth passed through the alimentary tract in an unabsorbed and unchanged condition—I should probably have spared myself the pains of making clinical experiments to prove its virtues as a food. When I entered into private practice a few years later, I was surprised to observe that the psychological influence of persistent advertisement had already won for this petroleum emulsion a strong position in the affection of the medical profession as well as of the lay public as a cure for bronchitis and other pulmonary complaints. Knowing, then, that petroleum acted merely as an inert substance in the alimentary tract, and that none of it was absorbed into the system, I came to the

[1] Proceedings of the Academy of Natural Science, Philadelphia, 1884.

conclusion that its reputation depended either on the kind of virtues which belong to bread pills or on the considerable doses of hypophosphites which were added, very wisely, on the principle that if the petroleum failed, the other drugs might succeed.

In the year 1906 I began to alter my views with respect to the possible value of petroleum, and I came to the conclusion that it must possess therapeutic properties in the treatment of constipation, and that as a remedial agent in this condition it must be of indirect use in many other morbid conditions.

My enlightenment came in this way. I was at the the time in great difficulties in respect to the treatment of constipation in infants, for I found that if the dietetic treatment of this condition by olive-oil—a line of treatment which I greatly preferred to the irrational use of drugs, enemas, or glycerine suppositories—was pursued too far, it inevitably led to an unfortunate *impasse*. An occasional teaspoonful of olive-oil is an excellent corrective to constipation in infants when the latter condition is due to a deficiency of fat; but in those cases in which constipation supervenes, in spite of the fact that fat is already supplied in adequate amount—the additional administration of olive-oil only aggravates the symptom. In attempting to discover some lubricant which could effect the required object without causing so-called "fat injuries," I called to mind

certain observations which had been made some years previously by Dr. Robert Hutchison,[1] in which he pointed out that, although the claims of the manufacturers that petroleum emulsion could serve as a substitute for cod-liver oil could not be substantiated, it was possible that petroleum itself could act as an artificial substitute for mucus, and thus be of value in other directions. This idea of employing petroleum as an artificial substitute for mucus in cases of constipation appealed strongly to my imagination. I therefore decided to give it an immediate trial, and made my first experiments on a number of constipated infants who were attending at my infant consultations in Marylebone.

The success which attended my early experiences with petroleum as an intestinal lubricant for infants was so encouraging that in a very short time I practically abandoned all other forms of aperient medicine; and it speaks well for the method that this practice has been so widely adopted in the treatment of constipation in older subjects.

Although I had repeatedly pointed out, both in public and in private, the merits of petroleum in cases of intestinal stasis and constipation, it was not till I published a full account of its influence in such conditions in my book on the *Physiological Feeding of Infants*, published in July, 1909, and again in an article in the special Constipation Number of the

[1] *British Medical Journal*, March 24, 1898.

Practitioner, May, 1910, that the method came into general use.

Most of the paraffin which is now used for internal administration is of the liquid variety—"Petroleum liquidum purum," it is, however, a body of very indefinite composition. The official standards, while authorizing certain limits as to the volatility and specific gravity, do not fix definitely the chemical composition of the oil.

It thus comes about that no two samples are exactly alike, either as regards taste or composition, and manufacturers have taken advantage of these distinctions to sell special brands under registered names at fancy prices. As long, however, as a liquid petroleum is tasteless and free from toxic properties, one kind is as good as another, and it certainly is unwise to pay a fancy price for a fancy name.

When the idea first occurred to me to treat the constipation of infants by petroleum, I thought I would try the original petroleum emulsion which had been so largely advertised as a substitute for cod-liver oil; but I gave up this idea when I remembered that it was fortified with considerable quantities of mixed hypophosphites, which might introduce fresh and undesirable complications. I therefore took counsel with the dispenser at the St. Marylebone General Dispensary, and he devised the formulary of an emulsion, which, under the name of Marylebone

Petroleum Emulsion, answers the purposes required. The emulsifying agent is a decoction of Irish moss, a very much better medium than gum acacia or tragacanth, which is usually employed. It is much cheaper, and it contains a small quantity of iodine, which, I believe, has a really beneficial influence on most of the conditions for which the emulsion is usually given. The flavouring is quite pleasant, and the small addition of benzoic acid preserves the decoction of Irish moss from fermentative changes. The following is the formula for preparing this emulsion:

℞	Paraffini liquidi B.P.	33·0
	Acidi benzoici }	āā 0·05
	Glusidi }	
	Olei cinnamomi	0·10
	Decoctum chondri crispi	ad 100·00

The chief objection to prescribing this emulsion is that it is practically impossible to make it in small quantities; it must be made in bulk if it is to be of good quality. Another objection to the use of an emulsion of petroleum instead of the plain oil is that larger quantities of it must be taken, and at more frequent intervals, if the required result is to be obtained. These disadvantages, however, are compensated for by its efficient action. Emulsions of petroleum are now made on an improved principle, which allows them to contain 60 per cent. of petroleum as compared with 30 per cent. in the older

preparations. In these the emulsification is so fine that it has been claimed that the petroleum is actually absorbed and excreted in the urine: even if these claims are true, I cannot see that the absorption of such an inert substance carries with it any particular advantage. Indeed, I can quite conceive that it might be an actual danger.

The liquid paraffins which are now used in such large quantities are very much purer oils than those originally obtainable; a few of them are coloured and flavoured, and sold under fancy names as proprietary articles. We experimented at the St. Marylebone General Dispensary for a long time in an endeavour to flavour liquid paraffin in such a manner as to make it really agreeable to take. The best, however, that we succeeded in making was coloured with chlorophyl and flavoured with menthol. We called this new preparation Crème de Menthe, and it has been very well liked by those patients for whom it has been prescribed; and it certainly has more than a colourable resemblance to the liqueur. The great difficulty in making liquid paraffin really palatable is that comparatively few flavouring substances are soluble in it, difficulties which do not arise in the case of the emulsion.

During the last two years the use of liquid paraffins has been largely replaced by the introduction of solid or jellified forms, which can be flavoured and coloured according to taste; these are taken with a

spoon like a confection or preserve, and answer all the purposes of the ordinary liquid oil.

Although in their natural state, these solid paraffins look exactly like vaseline; they are, as a matter of fact, true emulsions, a fact which explains why they can be coloured and flavoured.

The history of these solid or emulsified paraffins is extremely interesting, but into this matter I cannot here enter. I can only refer those of my readers who are interested in the question to a paper of Mr. S. U. Pickering,[1] which contains a full account of the whole matter. In a private letter to me, Mr. Pickering very kindly explains how it is that an emulsion of paraffin can be made so as to appear quite transparent, and at the same time consist almost entirely of paraffin with the addition only of the merest trace of the emulsifying agents. He says: "The explanation of the semisolid or jelly emulsions is clearer to me now than it was then" (*i.e.*, in 1907, at the time he wrote the paper referred to above—E. P.). "Globules of uniform size in a liquid medium require that medium to amount to about 25 per cent. of the volume of the whole mixture, for filling up the interspaces; if the globules are not uniform, the volume of liquid will be somewhat less; but a very large reduction in it involves the globules becoming distorted so as to fit closer, and ultimately they must

[1] "Emulsions," by Spencer Umfreville Pickering, M.A., F.R.S., Transactions of the Chemical Society, 1907, vol. xci.

assume such a form as a dodecahedron, being tightly packed, like bricks, together, with only a film of molecular thickness separating the droplets. This accounts for the rigidity of the mass, its transparency, and its showing no visible structure under the microscope. Dry air causes it to demulsify by drying up the separating film, and when wetted it becomes opaque, as the films increase in thickness and the oil particles assume a globular form."

These solid paraffins are an immense improvement on the old vaselines which, until two years ago, were practically the only solid form in which petroleum could be administered by way of the mouth. It is difficult to imagine anything more nauseating than vaseline naked and undisguised as a medicament for oral administration. And yet, to my knowledge, it has been largely prescribed in this form, and supplied to patients in wooden pill-boxes, with directions that it was to be eaten with a spoon.

This inartistic method of dispensing solid paraffin has now been superseded by these solid emulsions, which can be coloured and flavoured in a great variety of ways. Many people much prefer these solid preparations to the liquid forms, or even to the simple emulsions such as I have described; but for infants there can be no doubt that the liquid emulsions are more appropriate.

The general claims of paraffin as an intestinal lubricant require no corroboration on my part, but in its

special application in the treatment of those heterogeneous disorders of infancy which are often classified as indigestion, the great value of paraffin is not yet fully appreciated. As I have elsewhere (p. 106) pointed out, most of the so-called troubles of indigestion in infancy are associated with disturbances of the motor functions, such as spasms of sphincters, enterospasms or dysperistalses of one kind or another. In these conditions it is extremely useful to have at command an efficient lubricant, such as petroleum, which can penetrate to the lower reaches of the bowels without absorption, and without chemical change. In severe cases of so-called colic, or windy spasms in infants, I sometimes almost fill the intestines with petroleum emulsion, either alone or in combination with carbonate of bismuth. I learnt the value of large doses of bismuth in these cases when I was investigating with the X-rays and bismuth feed the causes of intestinal motor disturbances in infants. In many of these cases I noticed that the crying and pain subsided immediately after the administration of the bismuth. Since then I have given very large doses of this drug in combination with petroleum emulsion with the greatest confidence, and generally with the most gratifying results. The chief objection to the administration of bismuth in large doses is that its gritty properties make it distasteful to infants; this disadvantage is overcome by using the preparation known as "glycerinum bismuthi car-

bonatis," a most elegant preparation of milky softness, details for the making of which are given in "The Codex." One drachm, or even two drachms, of this combined with an equal quantity of petroleum emulsion serves as a most efficient carminative for infants troubled with wind or colic. It may be given independently or combined with the contents of the infant's bottle. A mixture of this kind is a most efficient substitute for meconium, to the important physiological functions of which I have already drawn attention (p. 134). When this natural intestinal and antiseptic lubricant is by design or accident discharged from the bowel of the new-born infant, disturbances of motor functions are very liable to supervene. In such cases the free exhibition of this artificial meconium has a most excellent effect in restoring harmony to these functions.

I am not prepared to support the statement that petroleum is a powerful antiseptic agent. Our experiences in attempting to discover an efficient preservative for our emulsions give the lie to this belief; but, all the same, there can be no doubt that it does in some degree limit and retard the decomposition of those nutrient media in which it is combined in large proportion. It does so, I feel convinced, by coating either the bacteria or the nutriment on which they thrive with an impenetrable film of a substance which cannot mix with, or become incorporated, in the protoplasmic contents of the living cell. We know

from experience that the stools of persons who regularly take paraffin are, if not exactly odourless, at any rate far less offensive than when the oil is not taken. This is, however, open to the interpretation that it is quite as much due to the rapidity of transit of food through the intestinal tract as to the inhibitory influence of the petroleum on the growth of the bacteria themselves.

One of the most valuable uses of petroleum is in the treatment of thread-worms in children. This subject, however, hardly comes within the compass of this discussion, but I refer to it because I believe that its almost specific action as a vermifuge in such cases is dependent, not so much on its lethal influence on the parasites or their eggs as upon its direct influence on the mucous membrane. Paraffin in its crude form has long enjoyed a high reputation as a local application in cases of catarrhal or diphtheritic inflammation of mucous membranes. It has been claimed[1] that pieces of diphtheritic membrane, when emersed in crude paraffin, soon become soft and friable. On similar grounds it might be supposed that paraffin, when applied to unhealthy mucous membranes, has a health-giving and cleaning-up influence. In the treatment of chronic catarrhs of the nose and pharynx, the purer forms of petroleum in combination with menthol obtained a very considerable vogue a few years ago, and when applied to the

[1] *Year-Book of Treatment*, 1895, p. 1678.

affected mucous membranes in the form of a fine spray by means of B. and W.'s useful little paroleine naso-pharyngeal atomizer, it affords excellent results.

Whether, however, petroleum owes its efficacy in cases of intestinal disorder to its therapeutic effect on the mucous membrane or to its influence on the motor functions of the bowel, it can well be imagined that in cases of thread-worm infection it acts by cleaning up the crypts or other lurking-places in an unhealthy mucous membrane, in which the eggs would otherwise have an opportunity of incubating undisturbed.

Although petroleum is, in the great majority of cases, a most efficient lubricant and aperient, nevertheless in certain exceptional instances it undoubtedly predisposes to constipation. This paradoxical effect which must be familiar to all those who have had much experience of the drug, is, I believe, to be explained on the following grounds. In some individuals a regular action of the bowels can only be maintained by the stimulating and provocative action of irritating particles, such as the seeds or husks of fruits or vegetables. In such cases petroleum may predispose to constipation by its emollient influence on the mucous membrane, thus depriving the rectum or its neuro-muscular mechanisms of the required stimulation. Such constipation does not, however, imply that stasis in the higher regions of the bowel has not been cured by the petroleum.

In considering the alternative hypotheses on which the efficacy of petroleum in cases of intestinal disorders may be explained, it may not be altogether irrelevant to remember that paraffin may have the same influence in inhibiting absorption of food, as that which I have suggested it may exercise in the case of bacteria—that is to say, it may coat either the food or the mucous membrane with an impenetrable film of oil in such a way as to interfere with the absorption of the products of digestion. In my experience hypernutrition or the absorption of an excess of food frequently interferes with sound nutrition, and especially is this true of infants and young children of the upper and middle classes.

If this belief is well founded, it may be that the reason why petroleum proves so beneficial in many cases of malnutrition is because it retards rather than promotes the absorption of nutritive material.

As far as the treatment of infants is concerned, I have been quite consistent in my adherence to the emulsion in preference to any of the other forms of the mineral oil, and this is chiefly for the reason that the emulsions mix more intimately with the ingested food than is possible with the pure oil. I think that the softening effects of paraffin on the contents of the descending colon and rectum must be more pronounced when the oil is evenly distributed with the food than when it is confined to special portions, and for this reason I think it far

better to give a dose of the emulsion with every feeding than to give only one dose of the plain oil during the twenty-four hours. I admit, however, that in certain obstinate cases the mass-effect of a large dose of the oil given once a day reinforces the milder but more sustained influence of repeated doses of the emulsion.

I find petroleum emulsion such a universally useful preparation in the treatment of infantile disorders that now I almost invariably use it as the vehicle in which to administer the particular drugs I wish to prescribe. It is immaterial whether such drugs be soluble, insoluble, acid, neutral, or alkaline; they all combine well with it, and their taste is effectually disguised. In case of insoluble drugs, such as sulphur or bismuth, it is important to see that the bottle is well shaken before pouring out a dose.

Before I conclude, one word as to dosage. As a rule one teaspoonful of the emulsion after or with each feeding is enough, but I do not hesitate to give as much as half an ounce six or eight times a day. I have never noticed any untoward results either with the emulsion or with the pure oil. Of the latter, I generally prescribe half to three drachms once a day.

Summary.

1. The internal administration of crude petroleum for medicinal purposes dates from very early days, but the use of the more refined oils is of recent origin.

Towards the end of the last century it was largely administered in the form of an emulsion, combined with hypophosphites, under the belief that it possessed nutritive properties and could serve as a substitute for cod-liver oil.

2. In 1899 Dr. Robert Hutchison repeated the almost forgotten experiments of Dr. Randolf (1884), and proved that petroleum was not absorbed from the bowel, that it had no nutritive properties, and that the only rational therapeutic purpose it could serve was as a substitute for mucus.

3. Paraffin is a rational specific in the treatment of constipation in infants.

4. Petroleum emulsions are extremely useful in the treatment of all forms of indigestion in infants.

5. The efficacy of petroleum in these conditions may depend on—

(*a*) Its lubricating properties.
(*b*) Antiseptic properties.
(*c*) Its cleaning-up effect on the mucous membrane.

6. Petroleum emulsion is a most useful vehicle for most drugs, soluble as well as insoluble, which are prescribed for infants. It may be given with perfect safety in very large doses.

CHAPTER X

Convulsions in Infancy

In dealing with the question of convulsions, it is important to keep clearly in view the difference between the exciting and predisposing causes.

In order that convulsions may take place, it is necessary that there shall be an exciting cause, a *causa movens*, or a liberating stimulus. Whether or not any particular exciting cause is strong enough to determine convulsions depends on the degree of excitability of the whole nervous sphere or of certain of its parts.

Some infants have convulsions because the exciting cause is peculiarly intense—strong enough, in fact, to cause unconsciousness and throw the whole of the nervous sphere into violent and inco-ordinated activity, even when the central nervous system is in a perfectly normal condition, or of unusual stability.

Other infants will manifest convulsive phenomena when the strength of the liberating stimulus is comparatively feeble. Hence in general terms we may

say that the determination of convulsions depends on the relationship of two factors—(1) The degree of excitability of the nervous sphere; and (2) in the intensity of the exciting cause.

It must, however, be remembered that spontaneous actions do not occur in nature. There is always a liberating stimulus, though that stimulus may lie deeply concealed. It is one of the greatest reproaches to our medical literature that so much of it is permeated with suggestions that pathological phenomena can occur spontaneously, and that idiopathic diseases—diseases which occur by themselves without causes—can exist. In the literature of convulsions there are to be found innumerable references to idiopathic or spontaneous manifestations of convulsive symptoms. Convulsions cannot, however, on scientific grounds, be said to originate spontaneously.

One or other of the following are the more usual classifications of convulsions in infants:

1. Essential or symptomatic.
2. Organic or functional.
3. Sympathetic or hæmatogenous.

It is very difficult to say which of these is the least satisfactory. The first assumes that, while one class of convulsions (symptomatic) is evolved by causes (liberating stimuli), another class (essential) manifests itself spontaneously.

The second classification recognizes distinctions between convulsions which are due to structural changes in the nervous system and those which are not due to such changes. Such distinctions are purely arbitrary, and must continue to disappear as our microscopic and histological technique improves.

The third classification, which we owe to Soltmann, differentiates between convulsions which are due to blood-changes — such, for instance, as those which are due to the development of specific toxins—and those which are due to reflex causes.

In a sense all convulsions are reflex—that is to say, they must have a liberating stimulus which acts reflexly through some sensory nerve, the only possible exception being those directly due to stimulation of the central nervous system. Such stimulation is rare, as, for example, electrical or mechanical stimulation of nerve cells. Blood states or conditions are not exciting causes of convulsions; they predispose to convulsions by raising the excitability of the nervous sphere. Take, for instance, such conditions as poisoning with strychnine, or the toxins of tetanus or hydrophobia—conditions which, according to Soltmann's definitions, would give rise to hæmatogenous convulsions. But under such conditions convulsions are not manifested unless the liberating stimulus is applied.

An individual suffering from strychnine-poisoning will lie comparatively comfortable and free from convulsions as long as he is undisturbed ; but any sudden stimulus, such as a loud noise, an unexpected movement, a catch in the breath, or some attempt to swallow or cough, may apply the fatal spark, and give rise to the dreaded explosion.

Convulsions in children are not difficult to understand if the picture of strychnine-poisoning is kept before the eyes. For the determination of convulsions there must be both an adequate liberating stimulus and an adequately receptive state of the central nervous system. In order that a liberating stimulus may be adequate to evoke convulsions, the central nervous system must be tuned up to the necessary pitch of excitability.

Now, the central nervous systems of infants, and, indeed, of children generally, are tuned up to a higher pitch of excitability than those of older individuals for three definite reasons. First, because their nervous system is growing and developing, and all growing and developing tissues are, for obvious reasons, more unstable than those which are more mature. Secondly, the inhibitory centres in the cortex which control and limit purposeless and inco-ordinate contractions of muscles are either undeveloped or imperfectly developed. Thirdly, the axis cylinders of the conducting paths in the central

nervous system are still ill-provided with their myelin sheaths, and consequently are in a less favourable position to prevent the escape of nerve currents, if so they may be called, from one axis cylinder to another.

Childhood in itself may consequently be considered as a predisposing cause of convulsions. Then, again, in childhood the organism is constantly exposed to internal and external events which tend to increase the already excitable condition of the nervous sphere. Let me enumerate only a few. Infancy and childhood are, as it were, probationary periods, in which the organism has to acquire immunity from the dangers which assail it in the environment. The infant or child has to learn how to deal with the poisons of whooping-cough, measles, chicken-pox, influenza, the various catarrhal infections, tuberculosis, and the microbic organisms which infest the intestinal tract. The acquisition of immunity in each case entails a very considerable strain upon the system, for during the process the blood is flooded with new and often highly poisonous substances, which as a rule raise the degree of excitability of the nervous sphere to so high a pitch that relatively slight liberating stimuli will determine an explosive convulsion. Thus is it quite a usual event for specific fevers in infants and children to herald their advent by a violent convulsion, the equivalent of the rigors in older individuals with more stable

nervous systems. What is true of one is true of all, and it is unnecessary for me to enter into further details of these acute toxæmias which lay so heavy a strain on the nervous system of the developing child.

The influence of the psychological environment, however, plays quite as important a part in raising the excitability of the nervous sphere in infants as do actual poisons circulating in the blood. Nervous and emotional stimuli impress their mark upon the plastic brain as readily as impressions of a more substantial and material kind. The infant who is fussed over, played with unwisely and too often, who is the object of the anxiety of solicitous and nervous parents, reacts to this state of nervous tension, and himself becomes neurotic and hysterical. One of the earliest tendencies in human nature is that of imitation. Czerny[1] says the very laugh of the nursling is in imitation of that of the one who nurses him. The play of his features is under the direct influence of the picture of the surrounding personalities. How readily the production of nervousness may be influenced by the mere factor of imitation is quite evident to all those who observe carefully. Personally I have more faith in the psychological influence of the complacent and so-called cow-like woman, than in the quality of her milk, as a factor in

[1] *Des Arzt als Erzieher des Kindes*, Deuticke. Leipzig and Wien, 1908.

the successful nursing of infants. There are some nurses as well as some mothers who always seem to provoke the nervous state in infants placed under their charge, just as there are many placid, quiet nurses who seem to soothe and quiet the infants.

It is, indeed, a striking and significant fact that those infants who are subject only to general nursing care in the wards of a hospital or in nursery training schools, and are spared the danger of parental anxiety and over-solicitous care on the part of devoted nurses, show stability and equilibrium of their nervous centres which is quite unlike that which is seen in babies living at home.

I have many times removed infants from the electrical environment of the anxious home, and have transferred them to the non-temperamental atmosphere of nursing homes or training schools, with the most remarkable and immediate improvement in their condition, and this without in any way altering the food or other details of management.

I must still delay for a moment and say a few words about certain of the chronic conditions which permanently raise the excitability of the nervous sphere, and engender a condition which is so liable to spasmodic manifestations that it has been dignified with a special descriptive designation or title—namely, spasmophilia.

The condition of spasmophilia may be hereditary,

congenital, or acquired. It is usually acquired by the repeated access of noxæ, often by way of the blood-stream to the nervous system, which tend to disturb the normal nutrition of the nerve cells.

The most common form of noxa is some variety of poison which is generated in the alimentary tract, and which is due to imperfect digestion, improper food, or excess of food. Whenever such toxins are generated in the digestive tract, they are carried to the liver, and there for the most part rendered harmless or destroyed; but there are limits to the tolerance of the best-ordered liver, and when this much-suffering organ at length breaks down in function, then the whole system, including the nervous sphere, is exposed to the noxious influence of such toxic bodies. Artificially fed infants are far more liable to develop symptoms of spasmophilia, because, as I have been able to show, I think conclusively (*The Lancet*, September 2, 1911), they are almost invariably overfed, at least as compared with breast-fed infants.

Thiemich has even gone so far as to state that there is something specific in breast-milk which not only prevents the development, but actually cures the symptoms of spasmophilia, and Finkelstein believes there is some specific substance in cow's milk which actually produces a condition of raised excitability of the nervous sphere. For my part,

I see difficulties in accepting these views. I believe, as I have already stated, that any method of feeding which leads to imperfect or incomplete digestion also leads to the decomposition or fermentation of food in the bowel, and this in its turn leads to the flooding of the system with poisonous products, which destroy the stability of the central nervous system; but I believe there is nothing specific either in mother's milk or in cow's milk which can on the one hand prevent, or on the other hand promote, spasmophilic conditions.

In the next chapter I shall explain the conditions which may lead to rickets; these are also the conditions which lead to spasmophilia. I will not, therefore, insist further on this point, but rather refer the reader to p. 231, where he will find all the necessary details. I append here a provisional classification of the underlying conditions which predispose to the convulsive state in infants:

I. *Chronic Predisposing Causes.*

1. Conditions accompanied with demonstrable lesions of the nervous sphere.

(*a*) Traumatic lesions, birth palsies, hæmorrhages, etc.

(*b*) Syphilis.

(*c*) Hydrocephalus.

(*d*) Meningitis.

(*e*) Tumours, new growth, etc.

2. Conditions unaccompanied by demonstrable lesions of the nervous sphere.

   (*a*) Spasmophilia.
   (*b*) Epilepsy.
   (*c*) Congenital or hereditary nervous diathesis.

II. *Acute Predisposing Causes.*

1. Poisons admitted from without.

   (*a*) Food poisons (ptomaine, etc.).
   (*b*) Drugs, such as strychnine, lead, arsenic.

2. Poisons generated within.

   (*a*) Specific infections.
   (*b*) Products of intestinal putrefaction and decomposition.
   (*c*) Products of defective internal metabolism.

With a full knowledge that this classification is defective in many respects, I now pass on to a consideration of the exciting causes or liberating stimuli which actually give rise to the convulsive seizure. Any event in the external environment or within the organism of the infant which is capable of producing a reflex disturbance can also, under conditions of raised excitability of the nervous sphere, cause an actual convulsion, whether such convulsion take the form of violent and inco-ordinated motor activity

(convulsive seizure), or merely to cessation of consciousness or suspension of any of the organic functions, such, for instance, as those of respiration, or of the heart's action — so-called "internal convulsions."

In my experience the most common forms of stimuli which excite convulsions are as follows:

1. Distended stomach, pyloric spasm, wind in the stomach.

2. Enterospasm, colic, wind, fissures of the rectum or anus.

3. Middle-ear trouble, distension of the middle ear from pent-up discharges.

4. Sore gums and erupting teeth.

5. Calculi in urinary systems, gravel.

6. Irritation of the skin from dermatitis or parasites.

7. Sudden shocks, starts, noises, bright lights, etc.

Painful impressions such as are included in the above category may be sufficiently intense to cause convulsions in infants or children, even when the nervous sphere is not in a condition of raised excitability. But as a rule such stimuli are not sufficient to cause actual convulsions. It will be noticed that in the above list dentition is included as a cause of convulsions, and I believe it is far the most common cause, although many people do not agree with this view. It is argued that dentition is a physio-

logical act, that a physiological act is not accompanied by pain, and that consequently no convulsion can follow as the result of dentition. This syllogism is unsound in its major premise, in its minor premise, and in its general conclusion. There is no true distinction between a physiological and a pathological act; both are conservative and designed to preserve the life of the individual, though one may perhaps give pleasure and the other pain. Pain itself is one of the most useful and necessary protective symptoms with which the organism is equipped; it is like pleasure essentially physiological. The cutting of a tooth can give pain even under normal circumstances, a fact to which most of us can testify from personal experiences at the age of second dentition. Further, I believe that dentition acts both as a predisposing cause of raised excitability of the nervous sphere, and as an exciting cause, and thus it may *cause* convulsions in both senses. As a predisposing cause the growing tooth may disturb the nutrition of those parts of the central nervous system with which it may be connected by a constant flow of efferent and afferent impulses, and this disturbance may overflow by irradiation to other parts of the nervous system, and raise the general level of excitability of the whole nervous sphere. And as the direct stimulus of a convulsive reflex it may act by inducing actual pain when the gums are touched.

It is not to be expected that all should accept this view; because infants who evince serious symptoms during teething must necessarily be in a condition of raised nervous excitability, and this is nearly always due to some independent pathological condition which is apparent to the trained observer. The fact that serious symptoms arise during the time of dentition in unhealthy, badly managed infants only does not disprove the fact that teething may be either one of the predisposing causes or, indeed, the exciting cause of convulsions or other symptoms in such children. It is only necessary to observe closely a sufficiently large number of relatively healthy infants to be able to disabuse one's mind of the belief that teething causes no symptoms. The reflex or irradiated influence of the erupting tooth is quite sufficient to cause slight symptoms in most infants, although in those with stable nervous systems the disturbance may be so slight as almost to escape observation. When the incisors are cut, a slight running from or redness of the nose may be the only indication of the physiological activity occurring in the tooth. Slight patches of eczema, papules on the chin, or flushing on the cheeks, sometimes draw one's attention to the prospective eruption. Running of the eyes, earache, or pharyngeal cough, sometimes accompanies the cutting of the canines or molars.

Personally, I always pay very considerable atten-

tion to the statements of nurses or mothers concerning the manner in which particular infants, or infants in the same family, are said to cut their teeth. Some are stated to cut them with bronchitis, some with diarrhœa; others merely with loss of weight; and yet again others with convulsions. I can certainly confirm these statements from personal observation in many hundreds of cases.

When the excitability of the nervous sphere is raised by dentition or other causes, the explosion, when it occurs, or if it occurs, represents purposeless dissipation of nerve energy from the least well-regulated nerve centres, or from those centres which have been subject to similar disturbances before—an example, as it were, of the incidence of disease at some *locus minoris resistentiæ*. In this way may be explained the recurrence of similar symptoms on the occasion of each eruption of a tooth.

The management of convulsions and similar paroxysmal neuroses in infants is clearly concerned with the treatment of the underlying or predisposing cause, and this involves so large a number of general considerations that I hesitate to refer to them here. I would, however, emphasize the fact that the condition of spasmophilia, or that condition of raised excitability of the whole nervous sphere to which I have so frequently referred in this chapter, is practically the same as that which we have to treat in cases of early rickets, and the indications for treat-

ment which I shall presently give for this latter disease will apply equally well for those conditions in which convulsions are the chief symptoms. The central nervous system must in such cases be protected from circulating poisons due to inappropriate feeding and unhealthy intestinal conditions, and it must be protected from undue excitation by the general stimuli of the environment, whether these be physical, chemical, or psychological.

I believe that the bromides exercise a restraining influence on the explosiveness of the central nervous system; and to infants inclined to convulsions I generally give from 12 to 30 grains of bromide of ammonium in the twenty-four hours. Phosphorus, in my experience, is almost a specific for cases of spasmophilia coexisting with a condition of rickets. It can be prescribed in the form of phosphorated cod-liver oil, 1 part of phosphorus being dissolved in 10,000 parts of the oil, the dose being 20 to 60 drops two or three times a day.

As far as the treatment of the actual attack is concerned, chloroform certainly has an immediate and powerful influence on convulsive seizures which are accompanied with spasm of muscles. In the so-called inward convulsions, during which the infant usually ceases to breathe and becomes blue in the face, surface stimulation by a hot mustard bath or a cold bath, or flagellation with a wet towel, usually has a most salutary effect.

CHAPTER XI

Rickets: Its Cause and Treatment

From the time that Glisson first described rickets, in the year 1650, until the present day pathologists and clinicians have been busy trying to discover the essential nature of the disease. Up to date this discovery has not been made, although many plausible theories have been forthcoming.

A satisfactory theory of the pathogenesis of rickets has to fulfil a great number of conditions. It must explain why the disease occurs as the result of bad feeding, mal-hygiene, and hereditary influence, and it has to explain a vast and heterogeneous series of symptoms, their amenability to treatment, and their usually evanescent duration, even when special therapeutic measures are not applied.

With respect to the pathology of rickets, there are a vast number of known facts; there are also hypotheses and theories innumerable. Before I attempt to unfold my own views on these debatable matters, I think it desirable to state briefly certain of the known facts in the etiology, pathology, and nosology of the disease.

As regards the etiology, we know that heredity plays a double part, which is both direct and indirect. We know that infants can be born with the symptoms of rickets fully developed. Such cases are rare, but distinct from achondroplasia and osteogenesis imperfecta, both of which interesting conditions have, from time to time, been classified as varieties of rickets. Further, we know—at least, as far as the bony deformities are concerned—that there is at times a strong family predisposition to the disease, a predisposition which asserts itself despite the most careful hygienic and dietetic precautions.

We know that rachitis is a disease of civilization, and most common in Northern Europe. It avoids, for the most part, very hot countries, very cold countries, and high altitudes. It occurs in the most crowded quarters of dense centres of population, where there is little sun, little air, and little room for movement. It does not occur among the Esquimaux, although they may live in darkness for several consecutive months.

It occurs among the children of the rich, who want for nothing, and it occurs amongst the poorest classes, who certainly have very little food. It occurs amongst breast-fed infants who are weaned early, as well as amongst those who are weaned late. It occurs amongst infants who are fed on sterilized milk and patent foods just as it occurs amongst those who are fed on raw milk.

The late Dr. W. B. Cheadle insisted on the fact that rickets was due to a deficiency in the supply of fat. Dr. A. C. F. Rabagliati has claimed that it is due to excess of carbohydrates, and Dr. Lahmann incriminates a defective supply of inorganic salts. In a word, every possible error of feeding that it is possible to imagine has at one time or another been held responsible for the causation of rickets.

We are in possession of much experimental evidence which relates to the production and the cure of the condition. For instance, we know that rickets can be produced in animals by restriction of nitrogenous foods (W. A. Henry at the Wisconsin Experimental Station). We know that it can be caused by feeding them exclusively on meat, and cured by addition of fat (Guérin and Bland-Sutton).

Further, we know that in active rickets there is always a disturbance of the "calcium balance"; that is to say, more calcium is excreted from the body than is taken in with the food, and analysis of the ash of the tissues of the body shows that there is always a defective mineralization as regards the calcium base, more especially in bone.

A most important physiological observation is that of Nobécourt.[1] This observer has proved that rickety infants cannot burn up or utilize sugar or other soluble carbohydrates with the same

[1] Nobécourt, *Rev. Mens. des Mal. de l'Enf.*, April, 1901, p. 161.

facility as normal infants; in other words, rickety infants have a low "index of utilization" with respect to sugar; they very readily give evidence of glycosuria when fed on an excess of soluble carbohydrates.

Araki[1] and Irisawa,[2] working in Hoppe-Seyler's laboratory, proved that animals fed on a liberal diet of carbohydrates produced more lactic acid when the oxygen supply was restricted than when the allowance was unlimited.

Finlay[3] produced rickets in young animals by depriving them of exercise, whereas the control animals, with a free opportunity for exercise, showed no evidence of the disease.

Any satisfactory theory of the pathogenesis of rickets must offer some explanation of these facts. Do the theories which have heretofore been advanced harmonize with them?

The favourite theory in this country is that rickets is due to a deficient supply of fat. This seems to me an unsatisfactory explanation. Rickets certainly does occur in fat starvation, but it also occurs in infants who consume an excess of fat.

Rickets has been regarded as due to the development of an acidosis—an over-production of lactic acid, carbonic acid, and other acids.

[1] *Zeitsch. f. Phys. Chem.*, vol. xv., p. 546.

[2] *Ibid.*, vol. xvii., p. 340.

[3] Pfaundler and Schlossmann (second edition), vol. ii., p. 106.

As militating against this theory, it has been urged that the removal of calcium from the body and the resultant changes in bone which are caused by an artificially induced acidosis differ from analogous processes in true rickets in the following respects: In an artificially produced acidosis the bony changes are those of a simple osteoporosis which can be cured by the administration of calcium salts, whereas in true rickets such administration has no beneficial influence on the osseous development. Further, it has been argued against that particular variety of acidosis which is known as "carbonic acid intoxication" (Wachsmuth's carbonic acid theory) that in congenital morbus cordis, where the excess of carbonic acid in the blood may be extreme, there is no definite tendency for the development of the rachitic symptoms.

The conception that rickets is an infective disorder is no more satisfactory. If it is merely an infective disorder, why can it be produced at will by want of fat, excess of carbohydrates, want of exercise, and deprivation or excess of other elements in the food ?

That rickets is essentially a nervous disorder has been held by many writers. The prominence of nervous manifestations lends colour to this theory. Nervous irritability, spasmus nutans, laryngismus stridulus, convulsions, tetany, paresis of muscles, and general want of tone in both striped and un-

striped muscles, and dystrophies of bone and other tissues are only some of the more common phenomena which are clearly compatible with such an explanation. It may be argued that these nervous symptoms are simply indicative of some underlying pathological process — such, for instance, as the depletion of the system of calcium salts—and that they are not primary factors in the disease itself.

One of the latest theories is that of Stoeltzner,[1] which connects rickets with disease of the adrenal bodies. He asserts that not only are the adrenals small in rickets, but that they are also deficient in adrenalin. He claims that adrenalin benefits cases of rickets, and that it has a similarly beneficial influence in cases of osteomalacia, which is practically the same disease.

The peculiar dilatation of bloodvessels, and of hollow viscera, as well as the want of tone in the muscles of rachitic infants, and the known physiological action of adrenalin in promoting tone in involuntary muscles, are of course suggestive that there may be some association between adrenal disease and rickets. The conception, however, that a disease so common as rickets can be due in all cases to the implication of one organ seems altogether an extravagant and narrow view.

For my part, I do not believe for one moment

[1] Stoeltzner, *Jahrb. f. Kinderheilk.*, 1899; and Pfaundler and Schlossmann (second edition), vol. ii., p. 106.

that the pathological processes underlying rickets are capable of being explained in this exceedingly simple manner.

Just as the etiology of rickets is complex, and the symptoms manifold, so do I believe that the pathology is composite and involved.

Moreover, I am not at all sure that we are quite right in describing as rickets many of the cases of mal-nutrition which are commonly regarded as such. I think in the past we have been somewhat careless in our conception and in our definitions of the disease. Such symptoms as sweating about the head, muscular debility, and nerve irritability are often seen either in combination or alone without any indications whatsoever of the typical bony deformities of rickets. And, on the other hand, I have seen many cases of typical bony deformity in children twelve to eighteen months of age who have not previously shown any constitutional symptoms, and who have had, as far as one could judge, most excellent health—that is to say, who have shown a good weight-chart, have cut their teeth at the normal times, have walked before they have been a year old, and have had no symptoms of indigestion.

These curious cases of perverted growth of bone, and chiefly of the long bones, unaccompanied by any other of the symptoms usually expected in rickets, seem to be connected with a very strong

hereditary predisposition, and in my opinion have a close affinity with syphilis, though of an attenuated form, which has been passed down through two or three generations.

I certainly believe that many cases of rickets with marked bony deformity have a syphilitic taint.

The views as to the pathogenesis of rickets which follow are intended to apply to that syndrome of symptoms which is usually described in our text-books—that is to say, to a general disease of the whole system, and not to a disease of bone alone.

I think that the pathogenesis of the disease thus defined must be regarded as a vicious cycle of events in which each individual link in the chain acts and reacts on the others. In describing this vicious cycle it is difficult to know at what point to begin; indeed, in the production of rickets there is no one starting-point; the disease may start in a variety of ways.

The vicious cycle may be briefly described as consisting of an inefficient liver associated with a disturbed central nervous system acting and reacting on one another.

These are the two pathological pivots on which, according to my view, the symptoms mainly hinge.

The liver may be primarily damaged by faulty methods of feeding, from abuse of its functions, or from overwork, or it may be inherently or congenitally weak. As a rule there is first indigestion,

with the formation of toxic products of indigestion, then efforts on the part of the liver to oxidize or destroy these products, then collapse or failure of liver function with the escape of these unoxidized products into the general circulation, and finally poisoning of the nervous system itself.

Poisoning of the nervous system, from whatever cause induced, not only intensifies the liver inefficiency by interfering with its nervous mechanism, but it also leads to incapacity of other furnaces in the body, and herein lies the essence of the vicious cycle of events. In rickets we find loss of muscular tone or even pseudo-paralysis. If the liver and other great furnaces of the body are incapacitated, normal food-products absorbed into the circulation can no longer be oxidized to their normal end-products, nor can they be readily disposed of by other physiological means. Hence follows an acidosis, and for the neutralization of these acids all available bases are called into requisition. The tissues are thus deprived of calcium, ammonium, and other bases. It it difficult to neutralize such an acidosis by the artificial administration of calcium or other metallic salts, for such bodies usually enter the circulation already saturated with acid radicles. This may explain why we fail to cure rickets by the administration of calcium salts or other alkalies. Moreover, correction of the acidosis does not remove the underlying cause. When, however, there has

been fat-starvation, it is understandable how the administration of fat may check the acidosis, for fat may enter the circulation in combination with sodium, potassium or other metallic bases in the form of soaps. And within the tissues such soaps may yield up their bases for the neutralization of free acids, while the fatty acids may be stored up as fat or employed for the purposes of energy production or for the building of nerve-tissue.

There can be no doubt that any depression of the central nervous system brought about by an existing acidosis or toxæmia must lower the capacity of the whole system for utilizing such food-products as may be absorbed. This may explain the low "index of utilization" and want of muscular tone in rickety infants.

The bony changes are partly explained by the acidosis, partly by the great activity of the hæmogenetic functions of the marrow which are called for by the existing conditions, and partly by the interruption of normal trophic impulses emanating from the central nervous system.

In all toxæmic conditions—and the same is true of conditions of acidosis—there may be a great destruction of the red blood-cells—in fact, a free hæmolysis. In rickets these conditions would cause an intense anæmia were it not for the compensatory activity of the hæmogenetic organs of the body. Findlay[1] has shown that so far from anæmia being universal in

[1] Findlay, *British Medical Journal*, May 15, 1909.

rickety conditions, it is seldom found, owing to the compensatory activity of the blood-forming tissues. This compensatory action may explain the congestion of the epiphyses. In other words, the typical bone changes which are characteristic of rickets may be due partly to the acidosis which deprives the bone of its metallic bases, and partly to hypernutrition of the epiphyses due to a compensatory or conservative activity of the blood-forming marrow necessitated by a threatened anæmia.

Put into simple terms, rickets is due to a relative overfeeding, or to a relative incapacity on the part of the tissues to put ingested and absorbed food to physiological use. It is generally accompanied by disturbance of digestion, and always accompanied by disturbance of the central nervous system. All those etiological factors which depress vitality or metabolism will contribute to the rachitic state, whereas all those therapeutic resources, such as sunlight, cold air, friction, massage, exercise, movement, nerve tonics, and stimulants find at once in this theory a rational explanation. Even the reputed benefit of adrenalin can be explained in the terms of this theory, because, as we know well, it promotes the tone of involuntary muscle. In other words, it promotes the physiological activity of muscle, and thus creates a demand for food, and at the same time it may prevent vascular congestion of the epiphyses of bone.

This theory also, in some degree, explains why

rickets is seldom found in conditions of marasmus or atrophy; under such conditions food is voided by vomiting or diarrhœa—it is not absorbed, nor, indeed, are the products of decomposition. Hence there is no overfeeding, no excess of food, relative or absolute, requiring oxidation within the tissues, and consequently there is no acidosis. No acidosis, no disturbance of the calcium balance, no anæmia, and no bony changes.

In the rachitic infant the stomach, intestines, and liver are often enormous.[1] There are also at times great reserves of food stored up in the tissues as fat, glycogen, or low forms of connective tissue; but the nobler tissues, such as the muscles and the nervous system, are generally in a condition of delayed or arrested development.

Rickets, then, is a disease which is generally caused by inappropriate food; this causes indigestion, taxes the scavenging functions of the liver, and finally poisons the nervous system. Then follows impairment of function of all the important organs which are under nervous control. Absorbed food is then not utilized to the full and burnt up to its end products, carbonic acid and urea. It is only half oxidized, and hence a condition of acidosis is produced; the acidosis causes a disturbance of the calcium balance, and the demineralization of bone. The toxæmia and acidosis combined tend to produce an anæmia, which, however, seldom

[1] Marfan, *Rev. Mens. des Mal. de l'Enf.*, February, 1895.

actually develops owing to the compensatory activity of the hæmogenetic organs of the body (red marrow). The overactivity of the blood-forming elements in bone leads to the well-known deformities of bone (enlargement of epiphyses), deformities which are intensified by the want of normal nervous (trophic) control.

The rational treatment of rickets comprises, first and foremost, the regulation of the diet on physiological lines. The diet must be designed to meet the requirements of digestion, tissue metabolism, and of development. A physiological demand for food must be created by the application of all those external forms of stimulation which act reflexly through the nervous system on the muscles, and which are responsible for the maintenance of muscular tone. Such stimuli are light, changes of temperature (cold air, cold douches, etc.), massage, friction, and handling or playing with the infant. In a word, treatment must be designed to prevent overfeeding—that is to say, relatively to the infant's power of metabolism.

If this conception of the pathogenesis of rickets cannot adequately explain all its many and varied manifestations, I believe that it constitutes, at least, a rational basis for its prevention. The only cases of rickets occurring among the infants who have been brought to my infant consultations, which I have been unable to prevent, are those in whom the hereditary bias to dystrophy of bone has

been overwhelmingly strong. I have some records of cases in which rickets has developed after the first year, although during the first twelve months of life there has no been suggestion or suspicion of rickets, indigestion, acidosis, or muscular debility. In all these cases there has been a strong and unmistakable family predisposition to the disease.

I regard such prophylactic measures as the graduated cold bath and free opportunity for muscular exercise as only second in importance to the avoidance of dietaries which, in respect of quality and quantity, are calculated to disturb the developing functions of digestion.

I wish to anticipate an objection to this theory which will naturally occur to those who critically examine it—namely, that overfeeding cannot be a cause of rickets in semi-starved infants. To this I reply firstly, that, in my experience, semi-starved infants rarely develop rickets; and, secondly, that under certain conditions almost any food, no matter how little, may represent a *relative* excess (see Chapter III., p. 87). An infant who is incapacitated by reason of its nervous depression from performing muscular movements, whose muscles are without tone, and in whom the liver is functionally paralyzed, is only able to apply the smallest quantity of food to physiological use; and if not put to physiological use, it will lead to an acidosis and a glycosuria, both of which are important elements in the syndrome of rickets.

CHAPTER XII

The Teaching of Mothercraft and its Influence on Infant Mortality

It is not my intention to refer at length to the history of the movement which has resulted in the establishment of health societies, infant consultations, schools for mothers, and such-like institutions, which have been actively engaged in the teaching of mothercraft in this country, further than to indicate certain milestones which have marked its progress.

In the first place, it is interesting to record that one of the very first of these institutions was founded in Liverpool in the year 1893, under the title of "The Ladies' Sanitary Institution," and that in the neighbouring city of Manchester a somewhat similar association—namely, "The Ladies' Public Health Society"—was brought into being at an even earlier date, in the year 1887. It cannot be claimed that the work undertaken by these pioneer societies was specifically directed towards the amelioration of the lot of infants, nor for the teaching of mothercraft, but it operated indirectly in this direction, and paved the way for the particular kind of work,

which first took concrete shape in Wakefield in 1903, under the energetic lead of Miss Marguérite Le F. Boileau, and in 1904 in Huddersfield through the initiative by Mr. Benjamin Broadbent.

The first health society to be founded in London was that of Westminster, in the year 1904, a large and energetically conducted society which depended for its success on a carefully organized system of house-to-house visiting.

In the year 1906 St. Marylebone widened the field of activities open to such societies by the institution of a centre under medical supervision to which infants could be brought for periodic examination and advice; this system of medical inspection (infant consultations), combined with house-to-house visitation by properly qualified voluntary health visitors, has formed the basis on which most of the more modern health societies have been constituted. In the following year, 1907, St. Pancras organized a still more ambitious association, which, under the title of Schools for Mothers, included under one roof a system of medical inspection, a restaurant for nursing-mothers, classes for needlework, cookery, and all those other branches of domestic economy which are now understood under the term "mothercraft." From this time forward in rapid succession, and in almost bewildering numbers, new associations were inaugurated in Birmingham, Reading, Stepney, and other large centres of popula-

tion, all of them directing, in a voluntary capacity, their energies towards the relief of infant mortality, and most of them working in the closest co-operation with the Public Health Authority. In 1909 the number of these societies had so increased that their federation under a central society was considered to be justified. Thus was founded a society which at first was known as the Society of Infant Consultations, and which within eighteen months of its foundation was merged, as an independent department, in the larger organization of the National League for Physical Education and Improvement. This new department was called the Association of Infant Consultations and Schools for Mothers, and it is now a most flourishing and active body, to which are affiliated 118 local societies, with 217 branches in different parts of the country. The work of this association is mainly concerned in the co-ordination of the activities of local societies, in the collection of statistics, in the promotion of new branches, in the preparation and distribution of leaflets and Press literature bearing on the subject of mothercraft. It also organizes National and Inter-school Mothercraft Competitions, and in many other ways brings its influence to bear on the maintenance of a high standard of efficiency in the work done by the affiliated societies.

It is difficult to appraise with any degree of accuracy the extent to which this voluntary movement

has been instrumental in lessening the mortality among infants in this country, because its work has been so inextricably bound up with that of the Public Health services, and because its influence is in many ways oblique and indirect. It is, however, well to remember that most of the factors which are generally considered as having an important bearing on the mitigation of infant mortality—I mean such factors as improved public sanitation, greater material prosperity, better housing, and a higher standard of living—had full opportunity of proving their influence in this direction during that period of unexampled sanitary and hygienic reform which extended from the middle to the close of the last century. During this period the general death-rate continued to fall in a way that falsified the preconceptions of statisticians, and yet the death-rate for England and Wales among infants under one year of age remained during the last four years of the century at exactly the same figure—namely, 155 per 1,000 births—as it stood at during the four years included between 1861 and 1865.

During the last fourteen years the death-rate among infants has steadily fallen in England and Wales, and in 1912 reached the satisfactory figure of 95. In London itself the fall has been even more conspicuous, and has now reached 91. It would be illogical to ascribe these striking results to any one cause, but they must clearly be due to some

new influence or influences not in operation before 1900. The falling birth-rate, and many other national, social, and economic conditions have all combined to enhance the value of infants, and hence more care and vigilance have been exercised both by private individuals and public authorities to protect and preserve this valuable asset. The period of decline in the death-rate among infants has coincided with one of immense advance in our knowledge of the feeding and general management of infants and young children. During this period almost a new branch of medicine has been created, a branch which is exclusively devoted to the study of the child in health, as distinct from the child in disease. The two branches are necessarily complementary, but up to the end of last century our students were taught to attach an exaggerated importance to morbid symptoms. To-day all this is very different. Our whole system of medical service is changing, and our chief energies are now directed towards the prevention and early detection of small ailments in the child before they have assumed serious proportions, and while they are still amenable to treatment.

Experience gained at Gouttes de Lait and other institutions, where large numbers of infants have been kept constantly under skilled medical observation, has revealed some very curious facts. It has shown, for instance, that the successful management

of infants, whether breast-fed or bottle-fed, depends on the observance of a few very simple rules and principles which can be easily taught by a good teacher to moderately intelligent mothers, and very easily followed out in the home, in spite of unfavourable social, economic, and hygienic conditions.

Although I do not claim it as a proof of this statement, I submit the following as an instance of what can be done by good mothercraft in the face of economic disadvantages and necessarily bad hygienic conditions: The second prize in the recent Mothercraft Competitions in London was awarded to a poor woman who was successfully bringing up a family of three on a weekly allowance of 11s. 6d.

The late Professor Pierre Budin very clearly proved, in his Clinique Tarnier, that good management was the chief factor in the prevention of infant mortality, and it has also been proved at the School for Mothers in Ghent with results which a friend of mine described the other day as being "too good to be true." To these latter results I shall return later, but for the moment I would indicate briefly the simple principles on which the successful management of infants has been shown to depend. This knowledge has been arrived at by the collective evidence of a large number of Schools for Mothers in France, Belgium, and England. If infants are breast-fed, the feedings must be given at absolutely regular intervals and at not too short intervals; the infants

must not sleep in the same beds as their mothers, and they must not be fed more than once at night, preferably not at all. They must not be wrapped up in too many clothes; they must not have stiff binders which impede movement, and when it is added that they must be regularly bathed, regularly aired, and regularly exercised, it may almost be claimed that all the canons of good mothercraft have been enumerated. Infants do not die because they do not receive enough food; they die because they are fed irregularly or too often, or because they are given too much. They do not die because they are exposed to cold and the inclemency of the weather; they die because they are kept too much indoors, with windows and doors too closely sealed; they die because they have too many clothes, not because they shiver in rags; they do not die because they are unloved and uncared for, they die because they are rocked and nursed and comforted too much; they die, in fact, for want of the exercise of good mothercraft, and not from poverty, starvation, or bad sanitation. Infants will live and thrive in spite of poverty and bad sanitation, but they will not survive bad mothercraft; and this is the discovery that schools for mothers have made, and the secret of this huge fall in the mortality-rate during the last ten years. This discovery has filtered down from expert sources to the lower levels of intelligence, and it has welled up from the springs

below and permeated every social stratum. To-day it is actually and literally safer[1] for an infant to be born in the most unsalubrious area of the East End of London than it was fourteen years ago to be born in the healthiest and most favoured parts of Hampstead, and I maintain that this extraordinary result has been mainly secured by the spread of a knowledge of mothercraft through various public agencies, and through the research and propaganda work of Schools for Mothers, not from changes in climatic, hygienic, economic or social conditions.

It has now become the fashion to take an intelligent interest in matters of health generally, but in knowledge which relates to the health of babies I notice the most extraordinary improvement of recent years. Fathers, as well as mothers, now often make quite a study of the subject, and what with the active missionary work of whole armies of health workers, official as well as voluntary, and the educational influence of School Care Committees, enlightened knowledge on these subjects is spreading through the land like a fierce and living contagion. The most active foci of infection are undoubtedly those little beehives of industry which are known as Infant Consultations or Schools for Mothers. Here congregate together all those who take the keenest interest

[1] The death-rate in Hampstead in 1901 was 102, in Stepney 164. In 1912 the death-rate in Stepney was 105, and in Hampstead 62.

in infant welfare work—doctors, nurses, mothers, daughters, and sometimes fathers; and here pass in review before the eyes of intelligent observation all the phases of health, development, and diseases.

To my mind, it is impossible to over-estimate the value of such object-lessons. In the old days of ignorance women were counted authorities in baby management if they had had a tolerably large experience in their own families, no matter how unhappy those experiences may have been. We know how misleading knowledge derived from narrow experiences may be, for certain infants will occasionally survive the most monstrous mismanagement, though the same treatment imposed on other infants may have the most fatal consequences.

At infant consultations visitors can see not only individual infants, but scores of infants, treated according to various methods, and they can observe the results and draw their own conclusions. For this reason I regard it as important that the medical direction of these institutions should be in the best and most skilful hands. Budin said an infant consultation was as good as the man who conducts it; now perhaps we should say as the woman who conducts it. It is therefore a matter for congratulation that there is a distinct tendency for the more highly qualified practitioner to take up this class of work. In London, and in some of the larger provincial towns, the same class of men or women who hold hospital appointments are giving

their time and services to this new work, and with no loss of dignity to themselves; for it is becoming more and more recognized that preventive medicine is one of the highest and worthiest branches of our profession.

Infant consultations are not yet utilized to full advantage as schools for medical students, young mothers of the upper and middle classes, and possibly for some of the older girls in the elementary and secondary schools. They certainly afford most valuable opportunities for the instruction of domestic and trained nurses.

Not only is it desirable that highly qualified medical men and women should give their services to these institutions, but I also regard it as of immense importance that, as regards the methods of artificial feeding employed, more than one system should be tried, in order that their respective merits may be demonstrated to those who attend for the purposes of instruction. At one infant consultation with which I am acquainted, one of the doctors in attendance is an advocate of raw milk, another of pasteurized. No doubt some useful deductions as to the respective advantages of the two methods will be forthcoming as the result of the varied demonstrations. At my own consultation I employ every system with which I am acquainted, and I continually introduce new methods and new devices for improving or attempting to improve the results we obtain.

To indicate how a change of methods can influence the mortality and morbidity rate among the infants on whom they are practised I would give the following examples: In the year 1891, before the Nathan-Strauss Pasteurizing Milk Stations were opened in the old city of New York, the deaths from epidemic diarrhœa among children under five years of age were at the rate of 125 per 1,000 for the three months, June, July, and August. From the year of their institution until the present time the rate has been steadily falling, until last year it was reduced to the highly creditable figure of 38.[1]

It is not claimed that other factors are not concerned in this result—as, for instance, the more exact measurement of the milk supplied to infants which the Nathan-Strauss system involves—but there can be no question but that the main factor has been the supply of clean safe milk, instead of the highly dangerous and foul milk which was previously distributed in this quarter of New York during the summer months. Experience has proved that the precaution of sterilizing milk in the home with the same purpose in view has similarly been instrumental in decreasing the number of cases of diarrhœa in the hot weather, and to teach how this can be done efficiently is one of the functions of a school for mothers. Again, Dr. G. Variot,[2] who has had a very wide experience in the medical supervision of

[1] *The Lancet*, May 30, 1914, p. 1556.

[2] *La Clinique Infantile*, May 15, 1914, p. 289.

a large number of infants at his Goutte de Lait, Belville, Paris, has been able to show that if sufficient care be taken in the management of artificial feeding, the condition of nutrition at the twelfth month is not necessarily inferior to that of breast-fed infants.

Now, to return to the experiences of the School for Mothers at Ghent which were characterized by my friend as being "too good to be true." I give these on the authority of Professor Porcher[1] of Lyons. In 1901 the death-rate of the infants attending at the consultation was 260 per 1,000, a most appalling figure. Two years later, in 1903, sterilized milk was substituted for so-called "fresh milk" in the artificial feeding of those infants who were not breast-fed, and the death-rate fell to 140 per 1,000. In 1907 a system of domiciliary visiting was inaugurated, and the rate fell to 60 per 1,000. In 1908 dried milk was substituted for sterilized milk, and the rate fell to 34 per 1,000.

The experiences of Marylebone in this connection may not be without interest, for before the campaign of instruction began this central metropolitan borough was, from the point of view of infant mortality, one of the worst in London.

The borough of St. Marylebone has an estimated population of 123,000, and although it has a large number of very poor inhabitants and a large slum quarter, a considerable part of the district is occupied by shops and large business premises. It

[1] *Le Lait Desséché*, p. 122.

also contains a high-class residential population, living in large, well-constructed houses, private and flats; and, further, it has the distinction of containing those famous streets and squares where doctors most do congregate. Thus, right in the very centre of Marylebone are Harley Street, Wimpole Street, Welbeck Street, Cavendish Square, Portman Square, and Portland Place, all of which are almost exclusively occupied by medical men. In Marylebone, therefore, if anywhere in England, we ought to find in practical operation all the expedients for the preservation of infant life which are known to medical science. Yet here in Marylebone, at the very doorstep of Esculapius, in a comparatively well-to-do district, with all the resources of civilization to hand, there was, but fifteen years ago—*i.e.*, in 1899—an infant mortality of 190 per 1,000 births.

There was good reason, therefore, why Marylebone should set its house in order, and this, I think I may say, it has done, for to-day the infantile mortality-rate is 90. How has this feat been accomplished? I cannot afford the time to enter into all the details of sanitary reform introduced into the borough by a succession of distinguished and energetic Medical Officers of Health, commencing with Dr. Winter Blyth, continuing with Dr. Meredith Young, and now represented in the active personality of Dr. Charles Porter. All of these have effected reforms and all have left the impression of their office on a continuously declining mortality-rate. Who can

place his finger on the factor which has contributed chiefly to this splendid result? Is it chiefly due to the clearing away of plague centres, insanitary dwellings, and the thinning out of areas of congested population? Is it due to improved cleaning, scavenging, watering, and paving of the streets? Is it due to closer inspection of tenements, to a more liberal supply of water, or to improved drainage in the houses? Is it due to an improvement in the milk-supply, and the more careful supervision of dairies? Who shall say? But we all know that each one of these factors has contributed its quota to the result on which Marylebone justly prides itself, and all praise to those who have been responsible for these several reforms.

It is not, however, with sanitary and municipal matters of this kind—important as they undoubtedly are—that I propose for the moment to concern myself. The great and important factors in infant mortality are ignorance and the many secondary disabilities that poverty brings in its train. Poverty, primarily and directly, I do not hold responsible for nearly as many deaths as ignorance, but poverty secondarily and indirectly is, of course, a mighty factor in the problem. For poverty implies dirt and overcrowding; it often keeps the mother away from the home and compels her to go out to work; and it often leads to drink, thriftlessness, and despair. Actual want of food I do not regard as an important factor in infant mortality. Infants live and thrive

on exceptionally small quantities of milk, whether it be breast-milk or cow's milk; but they die in shoals because they are given too much, or because it is given too frequently, or too strong, or otherwise ill-adjusted to their needs.

When Marylebone began its serious work in 1906 the infantile death-rate was 121. As I have already said, in 1899 it stood at 190. To this level it had been reduced chiefly by sanitary reform. In February of that year (1906) there was convened at the Boroughs' Public Health Offices an open meeting of all those individuals and representatives of public bodies or societies who were interested in questions affecting the public health, sanitation, or infant mortality. And at this meeting, which was very largely attended, a society called the Borough of St. Marylebone Health Society was formally inaugurated. The society was composed of representatives of the Public Health Department, with the Medical Officer of Health (Dr. Wynter Blyth) as chairman; it included representatives of the Charity Organization Society, of the Churches, Chapels, Dispensaries, Hospitals, and Charitable Institutions in the Borough. In fact, every organization was represented which could in any way promote the objects of the society. The objects of this voluntary society were to act in co-operation with the Public Health Department, and to extend and amplify its work in connection with the prevention of the spread of tuberculosis and the saving of infant life by

means of voluntary effort—to inaugurate, in fact, "a system of voluntary service in a municipal setting." To accomplish this object, the society set itself to work to organize a service of voluntary workers for the whole district.

Its first work was to find suitable volunteers for this service; these were chiefly recruited from among the wives and daughters of medical men in the neighbourhood. I suppose that no society of this kind has ever been favoured with so energetic and serious-minded a company of workers as those who were first numbered in the ranks of the St. Maryle bone Health Society. Having obtained recruits, we proceeded to organize: we arranged a very complete series of lectures and demonstrations, covering all the subjects that would be useful or necessary for the work. Then we divided the Borough into districts and subdistricts, formed independent committees for each, and divided up our workers as economically and impartially as we were able. In our two branches of work—*i.e.*, that concerned with the prevention of consumption and the saving of infant life—there has been continued an unbroken progress. Our work among consumptives has culminated in a fully equipped tuberculosis dispensary and an open-air school for consumptive children, supported by voluntary contributions. With respect to the second department of the work—*i.e.*, that which is concerned with combating infant mortality—I propose to describe the system

as it operates at the present time, and omit the preliminary stages of its evolution and expansion.

Our Public Health Department, under the Early Notification of Births Act, is informed of all births which occur in the Borough within thirty-six hours of the time of birth. The houses in which these births occur are then visited by members of the staff of salaried women sanitary inspectors. These inspectors are highly qualified and fully instructed in all matters that relate to the management of infants; moreover, they have been carefully selected for their qualities of tact; they talk with the mothers, and give them such oral or printed directions as they think necessary. If they observe that the conditions are bad, they make a second call at a short interval, or depute one of the voluntary health workers to visit the case. If the services of the latter are called into requisition, such voluntary health visitor as may be appointed takes over the case and in future keeps a vigilant eye on the mother and baby. If the case requires medical supervision or in any way proves intractable, the voluntary health visitor refers the infant to one of the infant consultations which have been established in the Borough; and it is about these infant consultations that I wish particularly to speak, for by means of them a knowledge of mothercraft has been widely disseminated throughout the district.

In 1906, when it was thought that the work in

Marylebone would be greatly furthered if we could have some central station where infants could be referred for medical inspection, advice, and treatment, there were no institutions of this kind in England. There were already established a few milk depots, conducted very much after the manner of the so-called Gouttes de Lait in France and Belgium, for the most part without any medical supervision; but these institutions never had been a success in England, and they had always proved most expensive. Besides, our idea was to supply very little milk and a great deal of advice; in fact, we wanted to encourage breast-feeding all we could, and allow these new institutions to act rather as educational centres than as centres for relief.

The establishment of an infant consultation was therefore quite an experiment in England, and in order that it might prove a success I visited some of the best-known institutions in Belgium and on the Continent, and borrowed from them some of their best, or what I conceived to be their best, points, and modified them to suit our own conditions. From the first it was my aim to conduct my consultation on lines as scientific as possible, to make it a teaching centre for voluntary health workers, and to a certain extent a school for medical men and nurses engaged in similar kinds of work. This latter aim is at present in course of development.

To these ends I have a very complete system of

note-taking. We record particulars of the family history, of the past and present history of the infant itself, of its physical condition, and of the advice given. The notes are taken by health visitors, of whom generally some four to six are present during the holding of the consultation. One of the official sanitary inspectors also attends at my consultations, and acts as my chief of staff. As this lady has been working at my clinic some five or six years, it may readily be imagined that much of the work devolves on her shoulders. Two other colleagues of this lady also attend on two other days at consultations which are held in another district of the Borough. To carry out the idea of making the consultation a teaching centre, I have consistently refused to be restricted to any one system of feeding. I use all methods impartially. I employ whole milk, citrated whole milk, carefully home-modified diluted milk, specially modified milk sold at special dairies, condensed milk, and dried milk, and in all cases the mothers are taught how to prepare the food at home. I have kept a careful record of the results, and they will be published in due course.

Breast-feeding is conducted on the most up-to-date and approved lines. A test-feed—that is to say, an estimation of the amount of breast-milk taken at a feeding—is made in every case, and the feeding regulated in accordance. If the breast-milk proves insufficient in quantity or weak in quality, supplementary feedings of modified milk, or dried

milk, are given in all cases. There is individual attention to each case, and our breast-fed infants do particularly well. By means of supplementary feedings, many babies continue at the breast who without them might be reduced to artificial feeding.

The health visitors always follow up the cases that attend at the consultations, and by periodical visits to the home see that the instructions are carried out.

Although we see a considerable number of normal cases at the consultations, we see also a large variety of difficult and abnormal cases, which require special treatment; the experience which we all get from these cases is very valuable. The number of mothers attending has steadily increased during the eight years the consultations have been in operation, but I have never aimed at great numbers. I have tried to make the work at the clinic "intensive rather than extensive." I have concentrated on the thorough education of a few mothers rather than on the superficial instruction of many. The number of new cases in 1913 was 178, and the number of individual attendances 1,223.

It is especially in connection with the initiation and organization of voluntary work of this kind that a central co-ordinating society, such as the Association of Infant Consultation, and Schools for Mothers can be so useful; for at its conferences, discussions and committee meetings, we have not only many opportunities for the exchange of experience and the comparison of statistics, but we have all

the machinery for the direct and rapid dissemination of new and useful knowledge. In this connection I attach great importance to the recent Press campaign which has been initiated as one of the items in our propaganda. We publish from time to time in *National Health*, and, owing to the kindness of their editors, in a large number of provincial papers, short articles on mothercraft which have been approved of by the members of our executive committee—a committee which makes a special study of these points. We also publish occasionally a series of mothercraft questions, and the approved answers. We also organize, both for London and the provinces, annual mothercraft competitions in which the various metropolitan and provincial Schools for Mothers contend in friendly rivalry for a challenge shield. As one of the examiners in these competitions, I can, to some extent, judge of the standard of knowledge displayed by the competitors sent up from the various schools which take part in these competitions, and I can definitely say that even within the last twelve months there has been an enormous improvement in the knowledge displayed by the mothers. Some of the answers given by the mothers in this year's mothercraft examination are astoundingly accurate and to the point.

In conclusion, I would quote the following words from Dr. John Robertson's excellent paper on "The Special Responsibilities of Sanitary Authorities in regard to Infant Welfare," which was read at the

recent Conference on Infant Mortality held in Liverpool:[1]

"The prevention of infant mortality must depend on many forces all working together, but of these I am satisfied that the greatest is education in its widest sense. What has been accomplished along these lines is sufficient to encourage us to go on and insist on a continuation of the reduction in mortality which has now set in.

"First let me point to the fact that infant mortality is a class mortality. I show you a map of my own city which indicates quite clearly that the mortality in the central areas is considerably more than double what it is in the suburbs. We have many very large artisan areas where the rate of mortality is less than half of what it is in the slum areas of the centre.

"I feel certain that the main causes of these great differences are not that the housing conditions are much worse, nor the conditions of poverty much greater, or that drunkenness and vice are more prevalent in the slum areas, but that the mothers in these areas suffer from a greater ignorance as to what constitutes healthy and reasonable conditions for their babies than do the mothers in the suburban ring. To guard against misapprehension I must, of course, admit that housing, poverty, drink, and vice do play an important part in the production of infant mortality, but not the most important part."

[1] July 2, 1914.

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