Observations

ON

COMMON MISTAKES IN THE ARTIFICIAL FEEDING OF INFANTS.

BY

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It is common experience that we learn more from our mistakes than we do from our successes, but in no sense is this more true than in connexion with infant feeding. It is a disadvantage rather than a blessing, both for himself and his patients, when the young practitioner is successful in this department of his work at the threshold of his career, for in such circumstances he is apt to regard himself as an expert and an authority in a matter of which no man can become a complete master, even though he devote a long life to the subject. We learn more from our own mistakes than we do from those of others, and I offer no apology for making certain confessions of the mistakes which I have made myself during many years of practice, for although they may not be so helpful to others as they have been to myself, they may possibly assist others to avoid falling into the same traps.

During his novitiate the practitioner learns very little about the details of infant management; at least, in my day he learned very little until he married and had children of his own; on these he could experiment and learn at first hand from bitter experience the full degree of his own incompetency. The worst thing that can happen to such a tiro is to beget a child of such irrepressible vitality that his sins of commission or omission remain unrevealed. I fed my first child, with the most perfect results, on milk carefully modified on a percentage basis by the Walker Gordon Laboratories. Exactly the same feeding had fatal consequences in the case of my second child—through no fault of the laboratories, but solely owing to my own incompetence—and it was that never-to-be-forgotten experience that determined me to devote my life to a study of the means of obviating such disasters in the future. I came across a somewhat analogous case the other day, when a young practitioner asked my advice in respect of a desperately wasted baby which had been fed in exactly the same method as two of his own infants, which, according to his account, had fared extremely well. The food employed was a baked flour sold under a particularly attractive and high-sounding title. As he was leaving the house he said, "By the by, do you happen to know what this food really is?" When I told him that it consisted of nothing more than baked flour sold at a fancy price he seemed greatly disturbed, and told me he always understood it was some artificial digestant.

It often takes a long time to learn the insistent truth that what is one man's food is another man's poison, and want of appreciation of this fundamental principle in infant feeding frequently leads the young practitioner to hold in high regard for general use certain peculiarly constituted preparations which have proved of signal service in the treatment of pathological conditions. For instance, infants who have been fed on rich nursery milk, with an excessive percentage of cream, and who have in consequence acquired intolerance of fat, may be fed quite rationally for a time on a malted milk which contains practically no fat but a very high percentage of malt sugar. The inexperienced person who is ignorant of the exact chemical composition of such and similar foods, and who does not realize the physiological necessity of balance, may very easily draw faulty inferences from his observations, and regard foods which are really suitable only for pathological conditions as physiological foods applicable for normal conditions. A great many of the ill balanced proprietary foods which are still on the market owe their reputation and popularity to causes of this kind.

Owing to recent discoveries of biochemists, and to elaborate and carefully conducted feeding experiments on animals, often carried out on whole colonies of quickly

breeding varieties, we now know a great deal more about the essential requirements of animals and, by inference, the ultimate results of incorrectly balanced dietaries in the case of human beings, than we knew a few years ago—in fact, a great deal more than we ever learned or could learn from the observations of feeding experiments carried out on human individuals for very short periods and practically never for more than one generation. We are very apt to judge of the suitability, or the reverse, of certain methods of feeding or of particular foods by the immediate and not by their ultimate results. The human organism has such wonderful reserve powers, such remarkable powers of adaptation and compensation, that the full consequences of a defective dietary may remain latent or unobserved, not only during the greater part of infancy, but possibly during a whole lifetime. This has been clearly shown in the case of animals experimentally fed, and it may be read in the epidemiological histories of whole nations who have perpetuated the same faulty dietetic customs for several generations. If infants were capable of holding up the danger signal of distress immediately they were improperly fed, their feeding would soon be placed on a more satisfactory basis. But from the analogy of the feeding of lower animals we now have so complete a knowledge of the nutritional requirements of the human body, both from the point of view of development and maintenance, that, even in the absence of symptoms which attract attention, it is easy to predict what will be the ultimate consequence of any particular line of feeding. Even in such widely studied matters as the vitamin deficiency diseases we have no means of diagnosing their first beginnings except from the history of the feeding. We know, for instance, that the symptoms of scurvy in infants do not manifest themselves for some three or four months after the commencement of a vitamin-free diet. This is the reason for the astonishing practice, which is so prevalent in this country, of delaying the administration of antiscorbutics until after the third month of life. The argument is so plausible: infants under three months of age do not have scurvy; therefore they do not require antiscorbutics. If there is one period more than another when infants, and especially premature infants, stand in need of this and other accessory factors in their diet, it is during the first three months of life.

Another example of the delayed effects of faulty balance is the ultimate development of hyperchlorhydria in infants fed on whole milk, or unmodified dried milks; for a while they appear to thrive and do well, but if they can survive this monstrous liberty with their digestive and metabolic functions, they must, on grounds which are now thoroughly well understood, acquire an immense capacity for secreting hydrochloric acid, and they either die in an attempt to produce enough acid to overcome this buffer influence of the caseinogen, or suffer at a later date from the success of their early adaptability.

A considerable number of the dietetic misconceptions under which humanity is still groaning have their origin in the fallacy enunciated by the older physiologists that food subserves in the animal body the identical function that fuel subserves in the mechanical engine—namely, that of a potential source of kinetic energy and heat. The belief that the be-all and end-all of dietetics was to balance the intake and output by a careful adjustment of calorie values has put back the clock of scientific feeding by more hours than one cares to contemplate. It is perhaps hardly fair to describe the pioneer work of some of our greatest physiologists as wrong; their views and observations in these matters were true as far as they went; but they did not cover the whole ground—were in fact half truths, as the next generation of physiologists pointed out when they discovered the significance of balance, and when the present generation of physiologists further demonstrated the part which the accessory factors play in the utilization and combustion of the simple fuel foods.

The essential difference between the fuel required by a mechanical engine and the food which is shovelled into the furnaces of the animal organism is that, while the former should only contain sources of energy, food must contain either the ready prepared elements or the crude material out of which the latter can be elaborated for such

purposes as those of cleaning the machine, for lubricating it, for controlling its carburettors, its sparkers, its dynamos, its exhaust, and all the other elaborate mechanisms of the most complicated and perfect automatic engine. The mere supply of fuel to such an engine, no matter how well such fuel is mixed or balanced, is only a very small part of the duty of the stoker. And this is where the older physiologists, as well as the most modern percentage feeders, have gone so seriously astray; they have given infinite attention to the exact percentage relationships of the fats, the proteins, and the carbohydrates, and they have almost completely neglected the still more important duty—that of making provision for the control and running of the machine by providing the required accessory factors.

There are in milk, which one must regard as a complete and perfect food, three different classes of fuel, and there are also at least thirty-seven other elements or proximate principles, each one of which subserves some nutritional purpose which is of equal or perhaps greater importance, but is in no sense a fuel. We cannot believe that Nature, in her infinite wisdom, is so prodigal as to supply anything that is redundant or unnecessary, or so careless as to omit any essential in the food she supplies for the nourishment of the young; it is, indeed, implicit in the survival of the race that such must not be the case with respect to human milk. It is true that at present we do not know exactly how much of any of the vitamins or of the other accessory factors, such as iodine, or lecithin, or cholesterol, or iron, any baby or adult requires, but we are surely justified in believing that the representation of each in breast milk is of about the correct standard for the infant, as in the milk of other mammals their representation is correct for their respective progeny. It is possible that the representation in cow's milk is approximately the same with respect to most of them as it is in human milk, and if so the human infant ought to thrive when a given volume of cow's milk is substituted for a given volume of breast milk. But early experience taught the older physicians that whole cow's milk could not be digested like whole breast milk, and therefore cow's milk was diluted with one, two, or three parts of water, in order that the great excess of the indigestible constituent—that is, the caseinogen—might be watered down to the point of tolerance. A later school, recognizing that the infant suffered from the coequal dilution of the fat and of the sugar, added these to make up the deficit or supply the special requirements. A later generation recognized the need for making good the deficiencies of the vitamins and perhaps one or two other essential factors; but how many at the present time, when providing for these adjustments, think of the deficits of iron and iodine and perhaps a dozen other essential factors in nutrition? This, to my mind, is an explanation of some of the failures of feeding with cow's milk modifications, and of some of the apparent successes of whole-milk feeding, which on other counts has little to commend it.

Many years ago that great chemist Baron von Liebig enunciated his law of "the minimum," a law which to-day, in view of our more accurate knowledge of nutritional requirements, has more cogency than at the time of its formulation. This law is that the maximum degree of nutrition possible under any system of feeding or with any diet is determined by its greatest fault, and not by its greatest virtue. For instance, if we allow that some forty different constituents are requisite for a complete dietary, and that the faulty representation of any one of them in any particular diet allows only of a 50 per cent. realization of the possible maximum of nutrition, the net result will be only a 50 per cent. success, no matter what degree of perfection is attained by the thirty-nine other elements. It is quite easy to visualize such a hypothetical result in the case of such a default as that of a vitamin, but it is less easy to realize that the same catastrophe will follow faults in the supply of such little-considered elements as iodine, chlorine, fluorine, and many other constituents of diet which at the present time receive little consideration.

I have purposely included in the category of essential elements certain mineral constituents, for although it is well recognized by plant physiologists that for success in

agriculture or floriculture the supply of a considerable number of mineral elements is absolutely necessary, the same need is not by any means realized by those who concern themselves with the nutrition of developing human beings.

Soils which are deficient in certain mineral elements will not produce the maximum, or even a good crop, until the required balance is redressed. In animal nutrition there is not only a comparable need of many different minerals, but a far more comprehensive one. Owing to the fact, however, that when any form of milk diet is employed in the feeding of infants there is never a complete absence, but only a relative shortage, of any required element, defects in this respect never make themselves obtrusive. In this connexion I would observe that there is practically always a great deficiency of iron in the artificial feeding of infants when cow's milk dilutions are employed as the basis of their diet, and further, that there is often a grave deficiency of iodine, potassium, and ionic calcium. I do not propose to discuss this point further than to indicate that any one single defect in this respect will, in accordance with Liebig's law of the minimum, reduce the standard of nutrition to a degree which is proportional to the default.

Mistakes in respect of such niceties of balance are to a large extent excusable, for the reason that, owing to want of exact knowledge, no clearly defined rules are available with regard to the quantitative or qualitative requirements; but there should be no excuse for gross mistakes with respect to the balance of the fuel elements or their calorie value, because we have certain general indications for their adjustment. I do not want to flog a dead horse, but I cannot help making some passing comment on the argument which I constantly hear—namely, that in whole-milk feeding the large excess of nitrogenous elements is justified on the ground that such excess is required because, owing to the indigestible character of its contained caseinogen, the infant cannot assimilate an adequate supply unless it is proffered in massive amount. It is to my mind a strange argument to contend that, because a particular element is incapable of digestion, it should be supplied in excessive amount. It might be logical to suggest that it should be given in a more digestible form or replaced by some more digestible equivalent, but to maintain that it should be given in larger amount requires a good deal of justification.

As there is an optimum balance with respect to the combination of the energy-affording elements of an infant's food—namely, with respect to the combination of the proteins, fats, and carbohydrates—so also is there an optimum as regards their united calorie value. The tolerance of the animal organism in this respect is admittedly great, but any serious default, either in the direction of excess or inadequacy, must interfere with the attainment of that optimum result at which we should aim.

I do not claim that the age, or weight, or sitting height, or any other single factor taken by itself, will give us an accurate measure of the calorie requirements of any particular infant, but whatever means we may use to arrive at an approximate estimate of the energy value of the food required, we ought at least to be consistent, and not vary the amount when we find it necessary to change some unsatisfactory combination of foods for one we believe to be better. Inconsistencies of this character, in changing from one food to another, are my common experience; the following instance may illustrate my point.

An infant was ordered a milk mixture of a certain definite composition, and of a value of 600 calories; when this did not answer a diet of condensed milk was substituted of a calorie value of 150. Another infant was directed to be fed on a dilution of half cream ("cow and gate") with a calorie value of 400. When this method of feeding was found to be a failure, a diet of almata was substituted for it with a calorie value of 800. The law of the conservation of energy is either applicable or not in the feeding of infants; if it is applicable such transgressions must inevitably bring their Nemesis. I may add that these two dietetic mistakes were not made by inexperienced practitioners, but were the directions given at two children's hospitals in London, and are of the kind

of which I have made many myself in my unregenerate days, before I based my estimation of quantities on calorie values.

Speaking of quantities, I may be allowed to draw attention to the serious mistakes to which the employment of such indeterminate measures as teaspoonfuls and tablespoonfuls may lead the unwary. An ordinary tablespoon has a fluid capacity of about one ounce, and not half an ounce as is generally supposed, while the actual weight of a level tablespoonful of such a dry food as glaxo or "cow and gate" milk is about three drachms. The fluid capacity of an ordinary teaspoon is seldom less than a drachm and a half, while its capacity for a dry powder is little more than half a drachm. From this it is obvious that serious mistakes may arise when more accurate means of measurement are not employed. As an example of the sort of error into which the employment of such inaccurate measures may lead us I may quote the following instance:

An infant was brought to the Infants Hospital with serious symptoms of nutritional failure; it had been fed on condensed milk, and I was anxious to know the exact quantity which had been given it. On inquiry I was told that it had been given one teaspoonful in three ounces of water for six feeds, giving a total quantity of six teaspoonfuls in the twenty-four hours, with a face value of 80 calories in the twenty-four hours. The deficiency in food value seemed to me to be so great that I attempted to check the estimate by asking how long a tin of condensed milk lasted. The mother told me that she used, on an average, three tins (1 lb. by weight each) every week. Reckoning on this basis I argued that the infant was daily supplied with about 7 ounces of condensed milk with a value of about 700 calories. The discrepancy between the 80 calories as estimated in teaspoonfuls and the actual and true quantity as estimated in milk purchased and used shows unquestionably the fallibility of the domestic measure.

I could multiply pitfalls of a similar nature almost indefinitely, but perhaps I have said enough. I submit, however, that recent development in our knowledge of nutrition has not simplified the feeding of babies, but has rendered it an infinitely more responsible and difficult task.

THE SCHICK TEST:

A SCHEME FOR ACTIVE IMMUNIZATION AGAINST DIPHTHERIA
IN PUBLIC HEALTH PRACTICE.

BY

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ALTHOUGH most medical men are familiar with the Schick test, yet for the benefit of those who have not had practical experience of it the following explanatory note may be of assistance.

The Schick test is a definite quantitative test to demonstrate the amount of diphtheria antitoxin in any given person. Those patients in whom the test proves to be positive have only a small amount of antitoxin, and are therefore liable to contract diphtheria, whereas those in whom the result is negative have sufficient antitoxin to ward off the disease. Those who are positive to the test—in other words, those who are susceptible to diphtheria—can be rendered immune by the injection of a prophylactic mixture.

The following figures show that there is sufficient evidence of the efficacy of these procedures to warrant their more extensive use in combating the disease.

In New York City for the ten years preceding the introduction of Schick testing and immunization, the average number of deaths from diphtheria was 1,337; in 1919 the number of deaths was 1,239. Since 1919, when modern methods were first introduced on a large scale, the number has fallen to 663. Similarly, in Chicago, there has been a fall from an average of 797 deaths to 239 deaths. It has also been shown that in 23 representative American cities the death rate from diphtheria has fallen an average of 10.3 per cent. per annum.¹

In this country about 22,000 of the population have been Schick tested, and about 4,000 have been immunized. A large

proportion of these cases are the children and staffs in institutions.² On one occasion reported, the inmates in an institution remained free from diphtheria although exposed to infection at school and in constant contact with children amongst whom the epidemic continued.³ Dr. E. H. R. Harries of Birmingham has succeeded in entirely eliminating diphtheria among the nursing staff of the Birmingham fever hospitals.⁴ It has also been shown that in other fever hospitals where nurses have been adequately protected by immunization, the incidence of diphtheria among them has dropped practically to zero, whereas no such drop has occurred where nurses are not thus protected.

In the summer of 1925 I immunized the children susceptible to diphtheria in an orphanage in Surrey. Within the previous eighteen months there had been two outbreaks of the disease in the institution and among the children of the elementary school attended by the orphans. No case of diphtheria has occurred in the orphanage since this work was carried out, although a number of cases have occurred in the school. During the summer holidays in 1925 two of the immunized children slept for three nights in the same bed as a child who was incubating diphtheria, but neither of them contracted the disease.

In a training ship where diphtheria had been endemic the boys were tested, and those found to be positive were immunized. As long as all the new entrants were immunized (where this was indicated) no case of diphtheria occurred, although there were many profuse carriers of virulent diphtheria bacilli.

These are a few of the results obtained in this country, but up to the present Schick testing and immunization have only been carried out on a small scale, in comparison with what has been done in the United States.

So far as I am aware there have been no failures—that is to say, genuine diphtheria has never occurred in a Schick-negative person. A certain number of failures have been reported, but it has been found on careful scientific investigation that these are not true cases of diphtheria; or it has been found that the Schick test has been improperly carried out. To establish a diagnosis of diphtheria in a Schick-negative person three conditions must be satisfied—namely:

1. The clinical picture must be typical.
2. Virulent Klebs-Loeffler bacilli—that is, as tested in a guinea-pig—must be present in the throat or nose.
3. A sample of blood taken before a therapeutic dose of antitoxin has been given must show that there is sufficient natural antitoxin to ward off an ordinary attack of diphtheria.

Immunity.

Immunity may be active or passive. The process by which the production of antitoxin in the tissues of an individual is stimulated, whether artificially or otherwise, is called active immunization. The immunity produced by this process is much more lasting than the immunity produced by the introduction of artificially prepared antitoxin into the circulation. The former lasts for years, and potentially for life; the latter lasts only for a short time, generally three to eight weeks.⁵

Active immunity is produced by the injection, at weekly intervals, of 1 c.cm. doses of diphtheria prophylactic. This preparation consists of toxoid (prepared by treating diphtheria toxin with formalin) and antitoxin. Three or four weekly injections are usually sufficient to produce immunity, but some individuals require further injections if they are found to be Schick-positive three months after treatment.

Defects of Present System of Combating Diphtheria.

It may be as well to point out here the defects of some of the older methods of preventing the spread of diphtheria. The two most widely used of these methods are:

1. The swabbing of all contacts, and the isolation of those giving positive cultures, those with negative cultures remaining free.
2. The injection of a prophylactic dose of antitoxin (500 to 1,000 units) to all contacts.

As regards the first of these procedures, six types of subject may be met with, from the point of view of their immunity and infectiousness,⁶ and may be set out thus:

- A. Schick-positive, swab negative.
- B. Schick-positive, swab positive, bacilli avirulent.
- C. Schick-positive, swab positive, bacilli virulent.
- D. Schick-negative, swab negative.
- E. Schick-negative, swab positive, bacilli avirulent.
- F. Schick-negative, swab positive, bacilli virulent.