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THE ETIOLOGY AND TREATMENT OF THE DIARRHEAL DISEASES OF INFANCY

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The prevention of infant mortality is one of the most important medical questions of the day. More babies die every year from diarrheal diseases than from any other one cause. These diseases are largely preventable, and in most cases respond to proper treatment, whereas many improperly treated patients die. It is, therefore, essential in any effort to reduce infant mortality that all physicians dealing with children should have as clear an idea as possible of these conditions.

Any diarrhea is caused by increased intestinal peristalsis. This increased peristalsis is caused by some irritant acting on the intestinal mucous membrane, and it is best to classify diarrheal conditions according to the type of irritant that is causing the trouble. Broadly speaking, according to this method of classification the diarrheal diseases of infancy may be divided into three groups: (1) mechanical diarrhea, due to mechanical irritation; (2) fermentative diarrhea, due to chemical irritation, and (3) infectious diarrhea, due to bacterial irritation.

In the first group, the irritation is mechanical and is caused by undigested pieces of food or by such things as fruit skins or seeds.

In the second group the trouble is caused by irritating products from fermentation or putrefaction of food in the intestine, brought about in several different ways, as we shall see later. There is no infection by bacteria of the intestinal mucous membrane in this condition; it is the intestinal contents which are infected.

In the third group there is actual invasion of the intestinal mucosa by bacteria, with catarrhal inflammation, or often actual ulceration. It is of great practical importance to bear in mind these distinctions, as the feeding for the different sorts of diarrhea may be entirely different; what is proper for an infectious case might be fatal in a fermentative case. I cannot emphasize too strongly that not all infantile diarrheas are the same, and that they should not all be treated in the same routine manner. The first essential is a correct diagnosis, and in order to arrive at this the etiology of the three groups must be thoroughly understood.

I. MECHANICAL DIARRHEA

This type of diarrhea is fairly common, and is more likely to be seen in children above the age of 1 year than in those younger. It is caused by mechanical

irritation of the delicate intestinal mucosa from such things as grape skins, cucumbers and raw fruit. It is a common practice among many ignorant people to feed all sorts of indigestible foods, particularly raw fruit, to small children from 1 to 5 years of age, long before they are ready for it. Some children seem to be able to stand it, but the majority cannot, and no raw fruits should be fed to any child under 5 years old. In many cases the mechanical irritation of the intestine paves the way for organisms to attack it in the irritated places so that often a mechanical diarrhea may change to one of the true infectious type. A typical case of mechanical diarrhea would run about as follows: A child of 2 is given a peach to eat, skin and all. The peach may be ripe, or it may not be. Soon after, the child is taken severely sick with vomiting and diarrhea. The stools are usually five or six in the twenty-four hours, and are likely to contain undigested peach pulp and skin. The vomiting may be so severe as to be uncontrollable, and it is in this type of diarrhea that gastric disturbance is most common. In some cases there may be a tremendous amount of toxemia, and not infrequently these children die, partly, I believe, from acidosis caused by the severe vomiting, and partly probably from the absorption into the circulation through the injured intestinal wall of toxic material or possibly bacteria from the intestine. Every practitioner of experience has seen cases such as this. Last summer I saw a boy of 6 at the Children's Hospital who died in forty-eight hours from eating a raw cucumber. In ordinary cases the child will be well in two or three days, and the diagnosis and treatment offer no difficulty save in those cases which develop infectious diarrhea.

The treatment consists simply in purging the child with castor oil or calomel, putting him to bed, giving him barley water or some other gruel for twelve hours, with plenty of water, and then starting him on a bland, nonirritating diet of cereal and boiled skim milk. This is the simplest and least important of the infantile diarrheas.

II. FERMENTATIVE DIARRHEA

This is a more complicated and important condition, and is the most common diarrhea of babies. It is most likely to occur in children under 1 year, but may be seen at any age. It is brought about by abnormal decomposition of food in the intestine, caused either by the bacteria which are already there or by bacteria introduced from without. The products of fermentation irritate the intestinal mucosa and cause a diarrhea, but the mucous membrane is not attacked by bacteria. The abnormal decomposition is usually that of sugar, and may be caused in several ways. In order for sugar fermentation to occur two conditions must exist: unab-

sorbed sugar in the intestine, and bacteria in the same portion of the intestine to attack it. Under normal conditions the small intestine is relatively sterile, the large intestine is swarming with bacteria. Therefore, any conditions that allow a considerable amount of undigested sugar to proceed lower than is normal in the digestive tract, or which will allow bacteria to flourish in the small intestine, where there is always unabsorbed sugar, will bring about sugar fermentation. Let us consider some of these conditions.

1. *Overfeeding with Sugar*.—If too high a percentage of sugar, or if too much food, thus giving a large amount of sugar, is fed to a baby, all of the sugar cannot be absorbed. What is not absorbed passes into the lower part of the intestine and the ever-ready bacteria there attack it and ferment it.

2. *"Parenteral" Infections*.—It is well known by every practitioner that babies suffering from such affections as rhinitis, bronchitis or otitis media are likely to have loose, greenish stools. The probable reason for this is that in these conditions the digestive juices are reduced in amount, so that sugar is not digested so well as normally, and thus is fermented; or that under the general debilitating influence of any extra intestinal disease the intestinal mucous membrane loses some of its antibacterial power and thus allows bacteria to flourish higher in the intestine than they would normally.

3. *Overheating*.—Overheating of the body is an important cause of sugar fermentation. This is well known clinically and has also been proved by animal experimentation. The practice of dressing babies too warm in hot weather is undoubtedly the cause of a good many cases of sugar diarrhea. The explanation of this is probably very similar to that for "parenteral" diarrhea. Owing to the debilitating heat the digestive juices are lessened in amount, and the efficiency of the mucous membrane is impaired in such a way that undigested sugar is permitted to pass down where bacteria can get at it, or the bacteria are allowed to come up and flourish where the sugar is.

4. *Nervous Exhaustion and Excitement*.—These may bring about sugar fermentation, probably in a way similar to that in which it is brought about in the last two conditions I have discussed. However, it is not a particularly frequent or important cause of sugar fermentation.

5. *Constitutional Weakness*.—There are certain babies who, on account of constitutional weakness, never seem to be able to take much sugar, or indeed much food of any sort, without diarrhea. It is probable that their digestive juices are inefficient, and that there is always a great deal more bacterial growth in the small intestine than there should be.

The types of sugar fermentation enumerated above are all brought about by the normal intestinal bacteria's taking advantage of the abnormal conditions of the host. The next and by far the most important type of sugar fermentation is caused by abnormal bacteria introduced from without in bad milk. Bad milk is, I believe, the most potent source of sugar fermentation that there is, and gives rise to the most severe cases of diarrhea. There is probably no specific organism that accomplishes this, although investigators have tried at various times to look on the condition as a specific infection. A great many different sorts of bacteria, when introduced into the small intestine, may bring it

about, and probably two of the most common offenders are the *Bacillus aerogenes-capsulatus* (gas bacillus) and the colon bacillus.

The foregoing will serve to show the main causes of sugar fermentation; let us now see what chemical processes are involved. When sugar is fermented by bacteria, acids are formed. These may be divided into two groups: the volatile acids, such as formic, acetic and butyric, and the nonvolatile acids, such as lactic. The volatile acids, particularly, are formed in large amounts, and are the ones which do the most harm. The nonvolatile acids are relatively harmless. It is surprising to see how much free acetic acid may be recovered from the stools of some babies with sugar fermentation, and when one takes into account its extremely irritating nature it is easy to see how much damage may be done. The volatile acids cause harm (1) by increasing peristalsis and causing a diarrhea by irritating the intestinal mucosa; (2) by injuring the mucosa in such a way that its antibacterial function is impaired, or to such an extent as to allow toxic material from the intestine to pass through into the general circulation, a thing which would never happen normally; (3) by drawing on alkali reserve of the body in an attempt to neutralize the excessive acidity, thus probably helping to cause an acidosis; and (4) by upsetting the normal chemical processes of digestion, most of which cannot go on satisfactorily in an excessively acid intestine.

DEGREES OF SUGAR FERMENTATION

In a rough way, sugar fermentation may occur in three degrees of severity, which vary a good deal in their chemical conditions and clinical appearance.

1. The condition may be of a very mild type, in which a normal baby has two or three very acid stools a day of a consistency rather looser than normal. These stools may be of the normal color, or slightly greenish, with usually only a little mucus. The baby is not sick, the condition is a very mild one and almost always clears up readily with proper treatment. Its importance lies in the fact that untreated, the condition may become severe, and may ultimately lead to most serious results. This may be seen at any time of year, and probably has nothing to do with bad milk.

2. It may be a more severe condition, usually seen in the summer during a "muggy spell," but may occur at any time. The baby will have from five to ten very loose stools a day, containing a good deal of mucus, and many small soft curds of undigested milk. He is fussy and irritable, but is not very sick in most cases. His buttocks are likely to be red and excoriated from the excess of acid in his stools. The temperature is usually from 99.5 to 101. In this section of the country, at any rate, I believe this type of diarrhea is caused more often by bad milk than in any other way. In other sections where all milk fed to babies is boiled as a routine, it may be more often caused by some of the other agencies already enumerated. The condition is a local intestinal one; the intestine has been irritated, the processes of digestion have been disturbed, but the baby's body chemistry as a whole has not been upset. The process has as yet caused no trouble further than in its original locus, the intestine. If the patient is properly treated, the disease should be arrested without difficulty; improperly treated or neglected, the baby may pass over into the state which I shall call Type 3, a much more serious condition ("alimentary intoxication").

3. In this case the baby is very sick. He usually has a high temperature, but in certain cases he may be so prostrated that the temperature is subnormal. The fontanel, abdomen and eyes are sunken, the skin hangs loosely on the flesh, and has lost its elasticity—all from a loss of water. There is a profuse watery diarrhea, ten to twenty stools in the twenty-four hours. The baby takes no interest in his surroundings, his mentality is very dull, and he may be roused with difficulty. The breathing is deep and sighing (hyperpnea), and the urine may show sugar and casts. This is the picture of "alimentary intoxication," and a most precarious and serious condition it is. Here the process originally starting as a local intestinal condition has progressed so that it has changed the general metabolism, and has perverted the chemistry of the entire body. There is a negative nitrogen and salt balance, there is loss of a large amount of fluid, very often severe acidosis, and last, but not least, it is probable that many injurious substances from the intestine are absorbed into the general circulation through the injured intestinal mucosa, thus adding to the severity of the condition.

I. TREATMENT IN VERY MILD CASES

Many normal babies are likely to have periods of mild sugar fermentation occasionally. In nearly all the following simple treatment will clear the condition up, often in twenty-four hours, and will prevent the development of a severe sugar fermentation. A purge is not necessary unless the baby has fever, and this is uncommon. All sugar should be omitted from the milk modification, and the solution boiled for three minutes. One teaspoonful of compound chalk mixture should be added to each bottle. Usually after twelve or twenty-four hours of this feeding the stools will return to normal, when sugar can be added gradually, and in two or three days the baby will be back on his regular modification.

II. TREATMENT IN THE MORE SEVERE CASES

Groups 2 and 3 may be considered together in the discussion of treatment.

1. *Purgation.*—It is a mistake to give a purge as a routine in every diarrheal disease. If there is any harmful material in the intestine which is not coming out as fast as it should, a purge ought to be given—otherwise not. It is not rational to purge a baby who is already having a great many loose stools a day and whose intestine is emptying itself of toxic material as fast as it possibly can. In such cases castor oil or calomel adds insult to injury. On the other hand, a baby who is seen at the onset, who has fever, and who has not as yet been emptied by diarrhea ought to be purged at once, and it is often striking to see how the temperature will drop and how much more comfortable the baby will be after a good cleaning out.

2. *Feeding.*—This is the most important part of the treatment, and it is in this that mistakes are most frequently made. After the initial purge the baby should be deprived of food for about twelve hours, being offered nothing but weak barley water. Many babies will take this readily when they will not take plain water. The object of the starvation is to empty the intestine as completely as possible and to discourage the further increase of bacteria by offering them no food on which to grow. The principles of feeding are the same in every severe case of sugar fermenta-

tion; the details may have to be modified according to circumstances.

The condition we are dealing with is caused by an excess of acid in the intestine from the fermentation of sugar by some organism or group of organisms which thrive on sugar. Such organisms are likely to be greatly diminished or to die out if their principal food supply is withdrawn. Therefore, the great principle in treatment is to offer a food which contains very little sugar, and a considerable amount of protein, for as a rule the organisms that thrive on sugar do not thrive on protein. Such a food can be prepared in a number of ways, depending largely on the resources of the people one is dealing with.

a. *Albumin Milk.*—This, or a modification of it, is the ideal food, and babies with sugar fermentation do better on it, I believe, than on any other. It is too difficult of preparation to be used among the ignorant, but an intelligent mother can make it satisfactorily. There have been numerous modifications of albumin milk, but the original preparation is probably as satisfactory as any. It is made by rubbing the curds from a quart of milk (prepared with essence of pepsin) through a fine sieve several times until they are in a finely divided condition. These curds are then mixed with a pint of buttermilk diluted with a pint of water. The resulting mixture contains fat 2.5 per cent., sugar 1.5 per cent., protein 3.5 per cent. Such a mixture as this offers practically no sugar for the sugar-splitting bacteria to grow on, and on account of its high protein content, it tends to make an alkaline intestine; in an alkaline intestine calcium soaps tend to be formed, which favor the formation of pasty, semi solid stools. The albumin milk should be fed in very small doses at first—perhaps one fourth as much albumin milk as the usual amount of milk the baby would take, with the balance made up of water. If it is borne well, the amount may be rapidly increased. As the baby improves and as the bowel discharges become less frequent, small amounts of sugar may be gradually added. The best sugar to use is some maltose-dextrin preparation, as it ferments less readily than lactose does. Albumin milk is only a temporary food and should not be continued longer than a few weeks.

In a large city where there is a milk laboratory it is usually simpler to have the milk prepared at the laboratory from cream, water and precipitated casein, as any amount of casein or of fat desired can be obtained in this way, thus better suiting the preparation to the digestion of the individual baby than when a stock formula is used.

b. *Skim-Milk with Powdered Casein.*—Another satisfactory feeding is with simple dilutions of skim-milk to which powdered casein has been added. There was until a year or two ago a product on the market which was a semisoluble calcium caseinate. It could be very readily mixed with skim-milk and water to form a gruel, and in this way it was possible to secure very low sugar percentages in combination with a high protein. In the summer of 1915 I fed a good many outpatients by this method, and got very good results, fully as good, I believe, as could have been obtained with the more complicated albumin milk. The chief advantage of the powdered casein method is its extreme simplicity. Since the war this preparation has been unobtainable, and, so far as I know, no other has been put on the market to take its place. There is an urgent

need for such a preparation, and it is a pity to see so many worthless proprietary foods on the market when powdered casein, which is really of great use, could be made so easily by almost any one of the proprietary food companies.

c. Lactic Acid Milk.—In some cases lactic acid milk or buttermilk feeding may be of value, the idea being that the lactic acid organisms of the buttermilk flourish in the intestine and supplant the organisms that are doing the damage. Buttermilk, also, is not very rich in sugar and contains a good deal of protein in an easily assimilable form. Unless fresh buttermilk can be obtained, it is best prepared at home, from skim-milk and cultures or tablets containing the lactic acid or Bulgarian bacillus. If it is desired to use the lactic acid principle, that is, flooding the intestine with lactic acid bacilli, it is a great deal better to use a lactic acid milk, than tablets or vials of the culture, as infinitely more bacteria can be given in the first way than in the second. It is worth while, however, if the baby will not take sour milk, to try the liquid cultures or the tablets. This plan of feeding is used a great deal. Some experienced pediatricians use the buttermilk principle constantly, some consider it of no value. As far as I know, there is no very good evidence one way or the other; some patients it helps, some it helps not at all, and it is time some one did some experimental work on the subject, for what little we really know about it has been handed down from the days of Metschnikoff, who first elaborated the idea.

d. Skim-Milk Dilutions.—The way most of us in the outpatient department of the Children's Hospital treat sugar fermentation is with skim-milk dilutions, usually beginning with a third or a half skim-milk, the rest barley water or water, and gradually increasing as the stools become better. By this method improvement is not so rapid as it is with albumin milk, but in most of the outpatient class of patients or with the ignorant part of one's private practice, complicated methods of feeding cannot be used, and simplicity is of paramount importance.

MEDICINAL AND OTHER TREATMENT

Colonic Irrigations.—If seen at the onset a high colonic irrigation with physiologic sodium chlorid solution may do a great deal of good by helping to empty the intestine. Later in the course of the disease, it does less good, and indeed is likely to do more harm than good by irritating and disturbing the child.

Water.—Next to the feeding, the free administration of water is of the greatest importance. The baby is losing a large amount of fluid from the body in the watery discharges, and it is vital to the chemistry of the body, for many reasons, that the blood and tissues should not be dehydrated. Therefore, as much water as possible should be given between the feedings, and if it cannot be administered in this way physiologic sodium chlorid solution should be given subcutaneously. Howland and Marriott believe that a large amount of the acidosis that is seen in these cases is caused by retention, owing to anuria, of acid sodium phosphate. Therefore, the free administration of fluid by keeping the kidneys active may prevent this complication or help to combat it when it has developed.

Sodium Bicarbonate.—We know now that a good many children with diarrheal disease die from acidosis. Acidosis is shown particularly by deep, tireless breath-

ing, resembling that of air hunger. If this sign develops, sodium bicarbonate should be given at once, either by mouth, or, if not well borne by mouth, intravenously in the form of a 2 per cent. solution. Certain chemical changes take place in sodium bicarbonate after it has been sterilized, which make it very irritating, if given subcutaneously, so that it is never wise to give it in this way, unless a sterile salt is used, and added to the water *after the water has been boiled*.

Other Drugs.—Compound Chalk Mixture: This is, I believe, of value in many cases, as it helps in neutralizing the irritating acids that have been found in the intestine. The soluble alkalis are useless to give for this purpose as they are probably largely absorbed in the stomach, and never reach the intestine.

Opium: It is sometimes difficult to know whether or not to give opium. It is contraindicated if the bowel movements are very foul and few in number or if there is much evidence of toxemia. It is always contraindicated at the onset of an attack, as it is essential to empty the intestine and not to tie it up. In other cases it is distinctly indicated, and it is not good therapeutics to slavishly follow a set rule and to refuse to give opium in any case of diarrhea, as an experienced practitioner did with whom I saw a patient in consultation last summer. The child had been sick over a week, and was having from twenty to twenty-five loose, watery movements a day, with a great deal of straining and discomfort. She was much exhausted from all this, and still the doctor refused to give the small doses of paregoric I suggested because he "knew that it was always wrong to give opium in any diarrhea." In such a case as this, opium in some form, preferably paregoric, is distinctly indicated, for although diarrhea is undoubtedly a conservative process, it may exhaust the child so much that it does him more harm than good.

Bismuth: This drug is sometimes highly recommended, and again many authors say it is useless. It probably does more good in the true infectious type of diarrhea, when there is actual ulceration of the intestine, than it does in the fermentative type which we are discussing; in those diarrheas due to sugar fermentation, I should much prefer chalk mixture.

Stimulants: Stimulants are often needed, and there is probably none better than brandy or caffeine. Epinephrin has been highly recommended by some, but its action is so transitory that its value seems somewhat doubtful, except to tide over a sudden collapse.

PROTEIN FORM OF FERMENTATIVE DIARRHEA

The protein form of fermentative diarrhea is not nearly so common as the carbohydrate form. In this condition the intestinal contents have been infected by bacteria which feed mostly on protein, and the resulting stools are brown and foul instead of being green and acid smelling. The general symptoms are similar to those of the carbohydrate form, but the differentiation of the two offers little difficulty owing to the difference in the stools. The treatment is the same as for the carbohydrate form, with the exception of the feeding. Here a low protein and a fairly high carbohydrate diet is needed. Ordinary milk modifications with low protein and high carbohydrate added in the form of lactose and starch sometimes work very well. This diarrhea is more likely to be caused by organisms introduced from without in bad milk than to any faulty digestion on the part of the baby.

III. INFECTIOUS DIARRHEA

In this disease we are dealing with a true infection of the intestinal mucosa, due to some specific organism, usually the dysentery bacillus, but occasionally the gas bacillus or streptococcus. Combined with infection of the mucosa, there may be also a certain amount of decomposition of the intestinal contents. The condition has been called by many names, but the term "infectious diarrhea" is the best one, as it serves to differentiate it from the fermentative group of diarrheas. Infectious diarrhea may arise in a number of ways, the most common one probably being direct infection of the mucosa by dysentery bacilli taken in per os. Or the process may in many cases start as a fermentative diarrhea, and for the first few days there may be no invasion of the mucosa. Then, if the organisms gain ascendance and are of the right variety, the mucosa is attacked, turning the fermentative diarrhea into one of the true infectious type. Occasionally a mechanical diarrhea, may change into an infectious, owing to the fact that the mechanical irritation of the intestine prepares the way and allows bacteria to invade the injured mucous membrane. There has been much discussion as to the organisms that cause infectious diarrhea, but the consensus of opinion seems to be that most cases are due to the dysentery bacillus. The streptococcus and the *Bacillus aerogenes-capsulatus* are also probably etiologic agents in some cases. Infectious diarrhea is a true epidemic disease, and is spread for the most part in the same way that typhoid fever is spread—by "fingers, food and flies."

In Boston, the epidemic usually starts the middle part of July, continues through August, and in especially hot summers into the first part of September. In the South it starts earlier, the last part of May and the month of June usually being the worst months. Young babies are by no means immune, but more cases of infectious diarrhea are seen in babies over 9 months old than in those under. The reverse is true for fermentative diarrhea. In fermentative diarrhea there is usually no demonstrable pathologic lesion of the intestine; in infectious diarrhea there may be a catarrhal inflammation of the mucosa of the ileum and colon, or innumerable small punched-out ulcers may be seen.

Symptoms.—The onset of infectious diarrhea is varied. It may be very sudden, and I have seen a case start with a convulsion and a temperature of 105, with no diarrheal symptoms until the next day. In most cases the onset is more gradual, however, and is first made known by diarrhea and moderate fever. There will usually be about eight or ten stools a day, but in some cases there may be as many as twenty or thirty. The stools may be very small, and often contain no fecal material, but consist merely of mucus, pus and blood. They are not usually offensive in character, and are more likely to be alkaline than acid in reaction, owing to the large amount of mucin they contain, which is a protein and decomposes rapidly. They practically always contain blood and pus intimately mixed with the mucus.

The condition varies a good deal in its severity; many patients do not have a temperature above 101, do not seem very sick, but still have many typical stools every day. Other patients will have extreme prostration, and may have a high temperature for a week or ten days. Nervous symptoms, such as twitching and retraction of the neck, are not uncommon, and are usually of bad prognostic significance. The body rap-

idly becomes drained of fluid on account of the diarrhea, and acidosis may develop, as shown by hyperpnea, in much the same way that it does in diarrhea of the fermentative type. In most cases gastric disturbance is not common, but occasionally there may be severe vomiting, which is very hard to deal with.

Diagnosis.—It is rare to have a case of infectious diarrhea without blood and pus in the stools, and for practical purposes this is the best way of distinguishing it from fermentative diarrhea. In the latter condition blood in the stools may be seen, but there is never much of it, and it never lasts for more than a day or two. Macroscopic pus is practically never seen in the stools in cases of fermentative diarrhea.

The temperature curve is also of considerable assistance in diagnosis. It may be high or low in either condition, but in fermentative diarrhea it rapidly drops as soon as the intestine is emptied and proper feeding instituted. In infectious diarrhea, on the other hand, the temperature is likely to continue elevated for several days, in spite of purgation and proper feeding.

Treatment.—The general treatment is the same as that for fermentative diarrhea, which has already been outlined. The principles of feeding, however, are quite different. As regards diet, cases of infectious diarrhea must be divided into two groups, for the feeding in the two groups is radically different. The first group includes cases caused by the dysentery bacillus or, more rarely, by the streptococcus. The second group of cases is caused by the gas bacillus.

As far as the symptoms and gross characteristics of the stools are concerned, it is impossible to tell into which group a given case falls. However, there is a simple stool test (see below) which serves to differentiate these groups. While the stool test is being made, or if for any reason it is not made, the case should be treated as a dysentery case, for this is by far the more common type. The therapeutic test is of some value, although rather haphazard, and if the child does not do well on the dysentery treatment, it should be changed to that for the gas bacillus. It is always best at the onset, however, to test the stools for the gas bacillus, as the test is simple and it gives much valuable information as to the proper feeding.

Technic of Gas Bacillus Test.—A U-shaped fermentation tube and a test tube are filled with concentrated nitric acid, and permitted to stand three minutes, when the nitric acid is poured out. Both tubes are rinsed thoroughly with tap water.

A small bit of stool, about a half teaspoonful of dextrin-maltose, and about 15 c.c. of hot tap water are placed in the test tube, and the mixture is boiled vigorously for half a minute. The contents of the test tube are now poured into the fermentation tube, care being taken that it is filled up to the top, and that no air bubbles remain in it. The tube is plugged with flamed cotton, and kept in a warm place for twenty-four hours.

Gas in the top of the tube indicates that the gas bacillus is present, in greater or lesser numbers, depending on the amount of gas formed. If the gas bacillus is present in sufficient numbers to be the etiologic agent of the diarrhea, the tube will probably be "blown out," that is, entirely filled with gas.

Another simple way of testing for the gas bacillus is to plant a portion of stool in half a test tube of boiled milk and incubate twenty-four hours. If the gas bacillus is present the milk will be coagulated, will smell like rancid butter and will be shot full of holes like Swiss cheese.

If the "gas test" is negative, assume that the case is one of dysentery infection, and treat it as such.

FEEDING IN DYSENTERY CASES

The feeding in these cases is based on the fact that when offered protein food the dysentery bacillus grows very readily and produces large amounts of toxin. It does not thrive so well on carbohydrate food, nor does it produce so much or such deadly toxin. Therefore, a baby with dysentery should be fed on a low protein and a high carbohydrate food. This works well in practice, and is probably the most successful feeding known for dysentery patients. A few years ago it was the practice to starve patients with infectious diarrhea, and we used to feed many exclusively on weak barley water or lactose water for a week or ten days. Many of these patients died, probably as much from starvation as from the disease. According to our present ideas, a year old baby with dysentery would be treated about as follows: Following a purge, we give nothing but barley water for twenty-four hours. For the next twenty-four hours we add 8 per cent. lactose to the barley water. After this period a mixture of one fourth boiled skim-milk and three fourths barley water, with 8 per cent. lactose may be started. The skim-milk may be gradually increased each day, as the baby gets better, until he is taking undiluted boiled skim-milk with 8 per cent. lactose added. At about this time he should also be getting three or four tablespoonfuls of barley jelly a day. The skim-milk may be gradually replaced by whole milk, and the sugar should be reduced in quantity. During convalescence, fat should be increased very slowly, as nearly all babies after infectious diarrhea have a very poor fat tolerance. The sugars and starches should be most relied on.

It is quite likely that the baby will not digest all the food that is given him under this regimen, but he will come through the disease in much better condition than if he is starved, as he was in the former method of treatment. Another very successful method of treatment, which is similar in principle, and which has been used at the Floating Hospital in recent years with a good deal of success, is to feed the child on one-half fat-free lactic acid milk, and one half water, with lactose up to 8 per cent., the amount of lactic acid milk being gradually increased, and finally starches and fats being added. This method has the advantage that the lactic acid bacilli in the preparation may thrive to such an extent in the intestine that they will hamper the growth of the dysentery organisms.

The feeding in the "gas cases" is different, and patients with this form of infectious diarrhea always do better on lactic acid milk with a low sugar content than they do with any other feeding. The lactic acid bacillus seems to be directly antagonistic to the gas bacillus, and drives it out of the intestine very quickly. Furthermore, the relatively low carbohydrate and high protein content of lactic acid milk is indicated, as the gas bacillus is an organism which thrives on carbohydrate food, but does poorly on protein. Albumin milk, which has already been discussed, likewise fulfils all the indications for feeding in these cases.

PROPHYLAXIS OF DIARRHEAL DISEASES

No raw fruit or vegetables should be given to children under 5 years of age, and care should be taken that all food ingested be in a finely divided form. Overfeeding should be carefully avoided in hot weather, especially overfeeding with sugar. It is always good practice during a hot spell to dilute the

baby's milk one third with water. Overclothing the baby is also to be avoided, and frequent bathing, avoidance of the sun, and providing him with water to drink between his feedings are all important. In the southern part of this country, during the summer, all milk fed to babies, no matter how clean it is, should be boiled. An ounce of orange juice daily will prevent scurvy.

In cooler parts of the country, during the hot weather, all milk should be boiled with the exception of certified milk, which can be given raw; but during very hot, sultry spells this should be boiled also.

There is really no valid argument against using boiled milk in the summer time. The only possible harm it can do is to produce scurvy. But we know that comparatively few babies who are fed on fresh boiled milk develop scurvy, and orange juice is practically certain as a prophylactic. Undoubtedly nature intended babies to have raw milk, but the dangers of unclean raw milk so greatly outweigh those of boiled milk, especially in the summer, that more and more physicians are ordering boiled milk as a routine, and it is the duty of us all to educate the laity as to the dangers of raw milk in hot weather.

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POSTINFLUENZAL PSYCHOSES*

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During the recent epidemic approximately 2,500 cases of influenza were treated in the Walter Reed General Hospital. In 435 of these cases pneumonia either had already developed before admittance to the hospital or was diagnosed here during the course of the influenza. The number of deaths from pneumonia was 226, making the death rate 52 per cent. This includes practically all deaths from influenza and gives a mortality rate of about 9 per cent. for all influenza cases admitted.

Delirium occurring during the height of the disease and clearing with the cessation of fever (fever delirium) was more frequent in the early part of the epidemic when the more severe cases were seen. The features of this delirium were in no way peculiar to influenza, but were such as mark a hallucinatory confusion arising in the course of any infectious disease. Cases of this sort are not considered in this report. Neurasthenic depression frequently persisted for a longer or shorter period after the subsidence of the acute symptoms. When this depression was not sufficiently deep to be considered as constituting a psychosis, and to need special treatment as such, the patient was not transferred to the psychiatric wards.

Of psychotic states persisting after the subsidence of the fever, and requiring special attention, there were only four in the 2,500 cases of influenza. Three of these four cases presented pronounced pneumonic consolidation.

During the epidemic or since, in addition to these four, sixteen cases have been admitted to the psychiatric wards in the causation of which influenza seemed to play a more or less important part. Keeping in mind the tendency to attribute to an influenzal infection everything out of the ordinary that happens during

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