A British Medical Association Lecture ON THE NUTRITIONAL DISTURBANCES OF INFANCY.*

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We have all frequently seen infants suffering from constipation or vomiting, or both, yet still not very ill, and we have been equally familiar, on the other hand, with children with the same symptoms or with diarrhoea and vomiting who are gravely ill. We have seen infants who failed to thrive on any food and simply wasted and died. It is these conditions into which we will inquire to-day, and see if there be now light where not so long since there was only too much darkness.

Because neither the pathologist nor the bacteriologist in the past was able to demonstrate pathological states or bacteriological causes commensurate with the symptoms of these infantile affections, it was ultimately left to the clinician to enunciate, after very careful observation, certain types of disturbances which appeared to be entities occurring in some infants which corresponded to symptoms and signs which were known quite well in the old gastro-enteritis days, but never properly understood as to actual causation. Still more so the relation of the symptoms of one type of case to another was certainly not clear. It was an immense step forward when Czerny and Finkelstein, after patient and laborious clinical observations and accurate deductions, demonstrated certain states in these sick infants, and Finkelstein finally formulated the nutritional or food disturbances of infancy under the four headings: (1) Disturbance of balance, (2) Dyspepsia, (3) Decomposition, and (4) Intestinal intoxication. It now became obvious why at necropsy only slight or no pathological changes were found after the very precise symptoms from which these infants had suffered, and opinion is gradually veering round, in the case of bacteriology also, to the point of view that, although doubtless of importance in the nutritional disturbances of infancy, it probably plays only a secondary and not a primary part.

Before we can properly enter upon the subject of nutritional disturbances of infancy, as described by Finkelstein, it is necessary that we pause and remind ourselves of certain physiological and biochemical facts in order that we can more fully appreciate how errors in the digestion, absorption, and metabolism of food and the cell activity of the various tissues can cause certain symptoms and affect the infant as a whole.

Milk is an ideal food and contains the percentages of protein, carbohydrate, fat, salts, and water best suited to the young of the particular species. Human and cow's milk show the following average analysis:

	Protein.	Lactose.	Fat.	Mineral Matter.
Human milk ...	1.25%	6.75%	3.23%	0.23%
Cow's milk ...	3.4%	4.6%	3.65%	0.7%

Recent chemical analyses which I have had conducted rather suggest a larger percentage of protein in human milk and a variability of the fat content often showing a higher percentage. Milk also contains ferments and vitamins. The analysis of the mineral matter is given further on.

Food is necessary for the purpose of the maintenance of tissues and repair of waste, for the production of heat and energy, and for growth. Food should be administered to each infant in such quantity that corresponds to the optimum tolerance. If we exceed the maximum the infant will lose weight, while below the minimum it cannot gain;

yet, if done cautiously for a very short period it often increases the tolerance. Protein is the great body builder, and the amino-acids, formed from it during the process of digestion, have been described as the building bricks of the body. We know that protein acts best in the tissues in the presence of carbohydrate. The child will not thrive long without carbohydrate, and therefore, in its absence from the diet, protein can provide a certain amount of carbohydrate if the former be present in sufficient quantity.

The carbohydrate helps to some extent in the growth and repair of the tissues, but chiefly in the production of heat and energy. If there be no fat in the food carbohydrate is capable of forming fat, but if this process be continued for too long a period the child is apt to suffer.

Fat should be present in the food of all infants, as it is very important for the production of heat and energy and is a saver of nitrogenous waste. The calorific values of protein, carbohydrate, and fat are 4.1, 4.1, and 9.3 calories per gram respectively.

Another important constituent of food for the growing child is mineral matter, which is necessary for the proper metabolism of the tissues, as well as for the formation of bones and teeth. We must remember that the mineral matter of human milk and cow's milk consists of:

	Human.	Cow's.
K ₂ O	31.4 per cent.	22.14 per cent.
Na ₂ O	11.9 "	13.91 "
CaO	16.4 "	20.05 "
MgO	2.6 "	2.63 "
Fe ₂ O ₃	0.6 "	0.04 "
P ₂ O ₅	13.5 "	24.75 "
Cl	20.0 "	21.27 "

(Mackenzie Wallis.)

Potassium and iron salts are thus present in larger amounts in human than in cow's milk, while calcium and phosphates exist in greater quantities in cow's milk. The human milk, however, must be the standard for the infant. Water is necessary as a means of introducing these various food-stuffs into the body and for purposes of metabolism and nutrition.

It is now known that vitamins are required for certain vital purposes, the fat-soluble A being necessary chiefly for growth and maintenance; it plays an important part in the prevention of rickets. Vitamin B seems to be associated with the metabolism of carbohydrates and with the chemical reactions and functional perfecting of all cells—particularly nerve cells. According to McCarrison, vitamin C appears to be associated with the metabolism of calcium and the chemical reaction of growing tissues. Its absence leads to scurvy.

In digestion the proteins are acted on by the pepsine of the gastric juice; then by the trypsin of the pancreatic juice, and lastly by the erepsin of the intestinal secretion, amino-acids being ultimately formed. These are rapidly absorbed through the intestinal mucous membrane and passed by the portal circulation to the liver. It is interesting to note what the liver does with the amino-acids. Definite normal percentages of each of the various amino-acids would appear to be present in the blood, and it is not improbable that, if further amino-acids be offered, the liver simply breaks down what is really the excess amino-acids into urea, which is passed out by the kidneys. Should there be a tendency in the blood towards the acid side, the liver will neutralize it by forming ammonium salts, and therefore, when in excess in the urine, these salts indicate acidity. The amino-acids in the blood provide the necessary building bricks for the cells of the various tissues and are at their disposal as required. In a normal state more of the amino-acid is provided than is requisite, and we may presume that the individual cells of the tissues are capable of taking up the nourishment provided by the amino-acids for the purpose of elaborating from them the various tissues. Bayliss has stated that there are three classes of enzymes known to be present in cells capable of effecting the processes of oxidation, hydrolysis, and reduction respectively. Should the cell through any reason be incapable of elaborating the necessary substances, growth is obviously interfered with. This, I suggest, is important to remember in connexion with the state known as decomposition.

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Carbohydrates occur in various forms: thus disaccharides ($C_{12}H_{22}O_{11}$) as cane sugar, lactose, and maltose; monosaccharides ($C_6H_{12}O_6$) as glucose, mannose, galactose, fructose; polysaccharides ($C_6H_{10}O_5$)ⁿ as starch, dextrin, glycogen. When carbohydrate is swallowed the ptyalin of the saliva (which, although found in much larger amounts in a child 9 months old, is yet present in a young infant) commences the change of the carbohydrates into maltose; the process, however, is soon stopped by the acid reaction of the gastric juice. When the food reaches the duodenum the amylase of the pancreatic juice and the maltase of the saccus entericus complete the change of carbohydrate into glucose, thus: $C_{12}H_{22}O_{11} + H_2O = 2C_6H_{12}O_6$. Bayliss states that the only carbohydrates utilized by the living cell protoplasm are the hexoses, glucose, galactose, fructose, and mannose. Glucose is conveyed to the liver by the portal vein, there to be stored up as glycogen until it is required to replenish the glucose in the blood, the normal amount of which is 0.09 to 0.11 per cent. The latter is thus available for the action of the cells in the tissues. Everybody is aware that insulin is necessary for the storing up of glycogen in the liver, and for the combustion of the glucose in the tissues into CO_2 and H_2O .

Normally no sugar should be passed out into the urine, but in certain of the nutritional disturbances lactose has been found. This possibly results from injury to the intestinal mucous membrane.

When fat reaches the duodenum the steapsin splits it into fatty acids and glycerin. The latter is readily absorbed, but bile salts are required to dissolve the fatty acids so that they can be absorbed by the intestinal mucous membrane, in which recombination takes place, neutral fats resulting again which pass into the thoracic duct. Should there be absence of bile salts, the fat absorption is therefore likely to be seriously interfered with.

Mineral matter is absorbed by the small intestine and so carried to the different tissues of the body, the excess being got rid of by means of the kidneys and the large intestine. In some cases of diarrhoea the mineral loss by the bowel may be comparatively so large as to be distinctly severe, and if not checked is likely to lead to fatal consequences. In some conditions there is a larger nitrogen and mineral loss than the amount absorbed into the tissues.

The belief has already been stated that strong wheys have a deleterious effect upon the mucous membrane of the small intestine, so that imperfectly digested and toxic substances may pass direct into the blood. Lactose is sometimes found in the urine. At the same time the interference with the intestinal secretion and bactericidal action of the mucous membrane of the small intestine would appear to lead to an invasion of the small bowel by bacteria from the large bowel. These bacteria, further, do not tend to disappear in the ordinary way after a meal, but, on the other hand, remain and come early into contact with the carbohydrate particularly, which it ferments, with the formation of irritating acids such as acetic, butyric, lactic, and formic; these are liable to cause diarrhoea through increased peristaltic action of the bowel.

Water is chiefly absorbed by the large bowel. It is obviously a very serious matter if the loss of water by the kidneys, lungs, bowel, and skin, or by one or more of these, is of such extent as to be greater than the intake.

Having now discussed the digestion of food and noted some of the abnormalities which may occur, with the deleterious effects upon the body likely to ensue, where the processes of digestion and metabolism do not proceed upon normal lines, we are in a better position to deal with Finkelstein's classification. This consists of four states: (1) Disturbance of balance (failure to gain weight); (2) Dyspepsia; (3) Decomposition (malnutrition, atrophy, marasmus); (4) Intestinal intoxication (summer diarrhoea, cholera infantum). In breast-fed babies dyspepsia is not at all infrequent, failure to gain weight occurs occasionally, while decomposition and intestinal intoxication are exceedingly rare. On the other hand, failure to gain weight and dyspepsia are fairly frequent in artificially fed infants, decomposition is not infrequently met with, while intestinal intoxication can become very serious in hot weather and take heavy toll if not efficiently dealt with. The

enormous advantage of breast-feeding is thus apparent. Failure to gain weight and decomposition are, generally speaking, more frequent during the winter months, and dyspepsia and intestinal intoxication during the warmer weather. Failure to gain weight is more usually found among children of the well-to-do classes, while decomposition and intestinal intoxication are most often seen among the poorer or hospital classes, and especially in slumland.

It is necessary for all children to have the best possible nursery conditions day and night, and adequate attention to cleanliness, light, fresh air, sufficient but not too prolonged outings, especially in unsuitable weather, and warmer clothing in the cold than hot weather, and vice versa. Very important is the necessity for the intelligent making of the milk-mixture, the scrupulous cleanliness of the bottles, teats, etc., and giving the milk-mixture at the required temperature. The mother or nurse in charge of the baby should not be excitable or careless, but quiet, reliable, of sufficiently cheerful manner, sensible, with a full knowledge of her responsibilities, and imbued with the delight of doing things well.

FAILURE TO GAIN WEIGHT.

The infant suffering from weight disturbance (disturbance of balance) shows less change from normal than in any of the other food states. Still it is most important that it be recognized as soon as possible in order that efficient treatment be carried out without delay, to prevent the appearance not only of dyspepsia but also of the serious food conditions such as decomposition and intestinal intoxication. A neglected case of the simpler condition can very easily drift into a serious condition in which death only too readily occurs.

Causes.—The administration of food beyond the infant's limit of tolerance. A disturbance of the balance in an otherwise well made milk-mixture, but with relatively too much fat and protein and too little carbohydrate. There is also the infant who experiences a natural difficulty in digesting milk, possibly of an anaphylactic nature.

Symptoms.—The child has probably done well up to a point, and possibly gained a little extra weight just prior to failing to gain weight. This is the most important of the symptoms, and it is wise in any of the food states to make daily charts of the weight. For this purpose the infant should be weighed at a certain time each day, and at a definite period after a certain meal, to make true comparisons. The infant is fat but looks pale, with an inelastic skin, and the muscles are soft and flabby. The nutrition, in short, is beginning to suffer a little. The child is often peevish, apt to be restless at night, and sleep is disturbed. There is marked constipation, and the motions are greyish, hard, and dry, easily broken apart, and not adherent to the napkins. Occasionally a particle of blood may be apparent on the motion, and the smell is sometimes unpleasant. The temperature is not usually affected, but at times it is half a degree either above or below normal. A rise of temperature, however, should always be closely watched in case there be a more serious food state developing. Eructations of gas may occur, and not infrequently regurgitation of food and sometimes vomiting. The abdomen is to some extent tympanitic. The urine is strong-smelling, irritating, and shows a real excess of ammonia in well defined cases. Indican is often found. Immunity to disease is decreased, and middle-ear disease, naso-pharyngeal, pulmonary, or urinary trouble, or, again, gastro-intestinal infections, may result. There is a tendency to the exudative diathesis; erythema of the cheek and inguinal region, and eczema, are not infrequent.

Diagnosis.—The diagnosis is, as a rule, rather easy. There is the failure to gain weight, which becomes stationary in a child which has previously been gaining regularly, the pallor of the skin, the fretfulness, and the constipated soapy stools. On investigation it is found that the infant has had sufficient food, but not a well balanced one. It is well to make sure that inanition is not present; a thorough inquiry into the case will usually exclude this. When a child who is suffering from failure to gain weight becomes affected with otitis media, intestinal intoxication may easily be diagnosed in error, but if the nutrition of the infant, respiration, and the content of the urine, etc., be fully weighed, together with the local condition of the ear, the error is hardly likely to occur.

Prognosis.—This is generally good. If cases are properly treated they do well, but the danger of complications such as otitis media, respiratory infections, skin trouble, etc., have always to be kept in mind. It is a good sign when there is an increase in weight, as then the constipation and other symptoms disappear. The danger is the development of the

more serious food states. Sometimes a condition of constipation follows after the child has become better. There is also a liability to rickets in some cases unless care be exercised.

Treatment.

There is no doubt that the best food is breast milk. The child should be put to the breast for five minutes every three hours, or six times in the twenty-four hours, for a few days until there be a gradual increase in the weight curve. It may then remain at the breast a minute longer each day until, all going well, it finally takes its full feed of about fifteen minutes. It will be remembered that the first portion of mother's milk contains less fat. This, together with the high sugar content, is an advantage in these cases. If the mother cannot feed her baby, and an efficient and suitable wet-nurse whose baby is about the same age be obtainable, it is often a wise plan to obtain her services.

Where human milk is not available a cow's milk-mixture is used, and if made up carefully the result is excellent. One part of milk is mixed with two parts of water, the sugar is made up to about 5 per cent. and gradually increased to 6 or 7 per cent. A careful eye should be kept on the weight chart, as, should too much sugar be given, there will be a distinct loss of weight, with green loose stools (see under Dyspepsia). For the first twenty-four hours skimmed milk is usually preferable to whole milk; after that period whole milk can be gradually introduced ounce for ounce in place of it. Ordinarily the infant requires about $1\frac{1}{2}$ oz. of cow's milk and one teaspoonful of sugar, or 45 calories to the lb. weight; this would of course be diluted with the suitable amount of water. What is desired is to cure the constipated state on the one hand, and prevent the onset of dyspepsia with its frequent motions on the other. The strength of the milk-mixture is gradually increased as the tolerance for food becomes established until at last the child is placed on a food with a sufficient number of calories for its weight, and in a few weeks ordinary milk-mixtures can be given again.

The necessity for efficient nursing, hygienic conditions, and cleanliness has already been dealt with.

DYSPEPSIA.

Although not by any means in itself a serious condition, dyspepsia should always receive efficient treatment without delay, lest it give rise to decomposition or intestinal intoxication. Dyspepsia may occur primarily, or secondarily to disturbance of balance, etc. It occurs very frequently in breast-fed infants as well as those artificially fed.

Etiology.—Too frequent or too large feeds, the use of impure milk, relative or absolute excess of sugar in the food, more especially if cane sugar be used, or too high a percentage of fat. The effects of hot weather, faulty hygienic conditions, a low tolerance for cow's milk must be borne in mind, also the fact that some children have naturally weak digestions during the first few months of life. The liability to this state is greater with children under three months of age. Where there is too much mineral matter in the milk-mixture in addition to the excess of sugar, this condition is specially liable to develop, causing fermentation with resulting acid products, as already mentioned. It is perhaps well to remember that lactose ferments more easily than cane sugar, and that dextri-maltose is the least fermentable of the three. Sodium, potassium, and calcium salts are excreted in increased quantities by the bowel.

Symptoms.—Weight is lost during the first few days—as a rule from about 4 to 8 oz. The child has a pale drawn face, and is fretful and restless. The appetite is diminished. There are some eructations of gas, and vomiting; the vomited matter has a fatty acid smell. The abdomen is distended, and the infant suffers from colic. The temperature is elevated by one-half to one degree. Consciousness is not interfered with, and sleep is usually normal. Four to eight thin, greenish, and watery motions are passed in the twenty-four hours. There may be curds present. The motions are apt to be acid and sour-smelling, and often contain mucus, and are frothy. The stools contain neutral fats and fatty acids and perhaps starch, and upon further investigation acetic and butyric acids are found to be present. The skin around the anus may be red. The urine does not contain albumin or sugar, but it shows an increased amount of ammonia. There may be nasopharyngeal complications.

Diagnosis.—Diagnosis has to be made from intestinal intoxication, also from pneumonia, otitis media, naso-pharyngitis, miliary tuberculosis, and congenital syphilis.

Prognosis.—The younger the child the greater necessity for care, but with efficient treatment the condition should readily be cured. It is essential to prevent the condition going on to decomposition or intoxication, and to prevent infection.

Treatment.

During the first twelve to twenty-four hours starvation should obtain, but the child must be given plenty of water to drink. The stomach and bowels become cleaned out. Then, if mother's milk be available, this should be given, the child being nursed for five minutes every four hours until the weight curve remains steady, when a slight increase of one minute is made in the time the infant remains at the breast for each feed. If the weight chart shows an increase, a minute is added daily or every second day to each feed until the normal time obtains for a full meal.

Where there is no human milk it is best to use a one-in-three cow's milk and water mixture after the twelve to twenty-four hours' starvation period. Plenty of water, or weak tea-water, sweetened with one grain of saccharine to the quart, should be given to the child to drink. For the first twenty-four hours skimmed milk is used, but then, if all goes well, it is replaced ounce for ounce by whole milk. The carbohydrate must not be allowed to exceed 3 per cent. Dextri-maltose is the most suitable sugar. Six 1 to $1\frac{1}{2}$ oz. feeds are given in the twenty-four hours, and in addition a sufficiency of water to drink. After the weight curve has become steady in a few days $\frac{1}{2}$ oz. is added every day or second day to the amount of each feed until the normal amount for the child's weight is reached. Dextri-maltose is very cautiously increased by $\frac{1}{2}$ per cent. up to 5 per cent., but should it be expedient the amount would be immediately reduced.

It is not necessary to give any medicine, although some physicians are in favour of tannin 1 to 3 grains thrice daily. The importance of good nursing, cleanliness, etc., is obvious, and infection must be kept away from the infant.

If the infant does not respond to treatment there will be reason to suspect the onset of decomposition, intoxication, or perhaps of an infection.

DECOMPOSITION (ATROPHY, MALNUTRITION, MARASMUS).

Decomposition is a very serious condition. It may result from the state of dyspepsia, disturbance of balance, or intoxication. The malnutrition has become chronic; resistance to disease is lowered. In this state there would appear to be some degree of defective metabolism. Also it seems as if the cells have defective power of assimilating pabulum. The conditions likely to cause this state have probably been present in the infant before it was three months old. There is intolerance for all food elements, with a distinct loss of mineral salts and nitrogen from the tissues, so that cell starvation is present. Although there is intolerance of all the food elements, this is less marked towards the protein. The giving of condensed milk is one of the causes. Excess of carbohydrates in a badly balanced diet, and insufficient food, are predisposing causes. Weakly and premature infants are liable to this condition, also children living in poverty and under distinctly unhygienic conditions. Interference with function is so serious that unless the state be efficiently treated it is likely to be followed by death. Quite a number of cases occur in the winter.

There are various parenteral affections liable to give rise to this condition, such as infectious diseases, congenital syphilis, tuberculosis, respiratory complaints, pyelitis, otitis media, etc.

The younger the infant the longer reparation takes; still if efficient treatment be maintained there is likely to be ultimately a steady, though slow, gain in weight, gradually increasing to normal. There is always the possibility of collapse occurring suddenly, in which the rectal temperature falls to about 96° F. and the pulse is 60 or 70. The skin looks cyanosed, dyspnoea is present, and there may be convulsions. Eight ounces can be quickly lost in weight. In marasmic cases which go on for some time the infant becomes very weak, apathetic, and seems to be almost incapable of movement. Death may be ushered in with purpura and oedema, or with convulsions or pneumonia.

Symptoms.—If the case be a mild one, the loss of weight may not be very great and little change may be evident for some weeks, although small daily variations are likely to be seen. In a distinctly serious case the loss of weight is more or less continuous until death finally occurs. Emaciation becomes marked, and a paradoxical reaction to food is present. There may be vomiting. The child is very anxious for its food and obviously hungry. The fingers are thrust into the mouth, which appears large. The temperature is subnormal, being often 97° F. in the morning. The pulse is slow and usually

weak. Respiration also becomes slow and irregular. The infant looks anxious, cries much, and is sleepless. There is very obvious wasting of the subcutaneous fat, so that the child may present a picture of wrinkled skin on bone. The sucking pads in some cases appear prominent. The skin is greyish-white or brownish. The lips and fingers are cyanosed, the cheeks hollow, and the tissues flabby, the muscles being in a hypo- or hypertonic state. The abdomen may be distended. As a rule there is a tendency to constipation, although in the more severe cases there may be a certain degree of diarrhoea with the passage of mucus and perhaps blood. The urine shows nothing of importance.

Diagnosis.—This is usually easy: the history, the great wasting, the weight chart, the subnormal temperature, etc., with paradoxical reaction to food, leave little doubt, but hypertrophic stenosis of the pylorus, congenital syphilis, tuberculosis, congenital heart disease, and pyelitis would have to be excluded.

Prognosis.—This is always grave, but there is quite a good chance of recovery providing the case has not gone too far and that suitable treatment be adopted without delay and intelligently carried out. If collapse occur, or, again, should there be continued loss of weight or diarrhoea, the outlook is very bad.

Treatment.

As this disease is such a grave one everything possible should be done to prevent its occurrence by correct feeding, good nursing, and sanitary conditions; also efficient treatment should be given to all ailments of infancy, even minor ones.

In treating decomposition the best hygienic conditions are essential. Infections must be absolutely kept away from these children. If there is no diarrhoea, six hours' starvation is allowed, in which the child is given plenty of water to drink, but if there be any diarrhoea there should be no starvation period. Three ounces of half-strength normal saline solution should be given by mouth, in small quantities at a time, during the twenty-four hours. If the child is very weak, camphor in sterile olive oil should be injected immediately and continued in $\frac{1}{4}$ -grain doses every four hours for as long as may be necessary. If the child is very dehydrated, fluid in the form of normal solution must be immediately given, either subcutaneously, per rectum, intravenously, into the superior longitudinal sinus, or intraperitoneally. The last mentioned is the easiest method for quickly introducing two or three hundred cubic centimetres of fluid. The solution must be absolutely sterile and carefully introduced (at blood heat) into the peritoneal cavity at a point about one inch below the umbilicus. This can be repeated once or twice daily for as long as may be necessary.

If breast-feeding be available the infant should be so fed, but the first part of the milk only ought to be used on account of its smaller fat content. The infant is given the breast first of all only for two minutes every two hours, or ten times in twenty-four hours. If necessary the milk would be drawn off and given by a medicine dropper, a spoon, or a feeding bottle. The breast can then be emptied by a healthy child or the milk drawn off. The infant is given one minute longer at the breast in a day or two and provided no further loss of weight occur. As soon as the weight chart has definitely straightened out, the infant is fed for five minutes and then for gradually longer periods until the full feed is taken again.

Where breast-milk is not available, ten $\frac{1}{2}$ -oz. to 1-oz. feeds of albumin milk (or Mead's powdered protein milk) are given in the twenty-four hours. Obviously the infant must drink a sufficient amount of water between the feeds. There is a gradual increase by $\frac{1}{4}$ oz. at a time until $1\frac{1}{2}$ oz. of the food are taken per lb. of body weight. If the curve has straightened out or there be a slight gain of weight, further $\frac{1}{4}$ oz. additions can be made every few days up to 3 oz. per lb. weight of infant, which is the maximum. Finally, when there has been obvious improvement, dextro-maltose is gradually increased from 3 to 5 per cent. In the end an ordinary milk-mixture is given again to the infant. As larger amounts are taken the interval between the feeds is lengthened from two to two and a half and then to three hours.

With improvement, which may take some weeks, the general appearance and the nutrition of the child become more satisfactory, the pulse increases, and the temperature rises to normal. Should the child after progressing well have a relapse the treatment has to be commenced all over again. If the vomiting be very severe, lavage is most useful. Where collapse occurs the application of heat to the extremities is called for, and camphor should be injected.

INTOXICATION.

This may develop from disturbance of balance, dyspepsia, or decomposition. It is a secondary nutritional disturbance. Infectious and weakening diseases are predisposing causes as well as inefficient artificial feeding. Hot weather

especially and unhygienic conditions often play a part in causation. Cases may occur during the first or second summer. Badly made and infected food, too high percentage of carbohydrate or fat, and strong whey salts are only too liable to cause this complaint in certain individuals.

Symptoms.—With a sudden onset, a temperature of 103° to 106°, often with vomiting and a watery diarrhoea, the infant shows a quick loss of weight of $\frac{1}{2}$ lb. to 1 lb. or more. There may be further loss or the weight may become stationary. The loss of weight is accounted for by the quantity of water and salts depleted from the body. The skin is hot, pale, wrinkled, dry, and inelastic. The respirations are frequent, pauseless, and deep; the pulse is also frequent. The infant looks very ill, the mouth is open, the lips are dry, the nose pinched, the eyes are sunken and have a distant stare, and there is a fixed expression. The child is apathetic to its surroundings, semi-comatose, occasionally quite comatose. Looking completely worn out, it moves slowly and with apparent effort. Not infrequently there is noticed what is called the "prize-fighter's attitude" of the arms. Twitching may be seen at the angles of the mouth. The infant may appear as if about to cry yet does not do so. There may be strabismus or even convulsions. There are likely to be from ten to forty watery, greenish or yellowish motions in twenty-four hours. Meteorism is present. There is a leucocytosis of 20,000 to 30,000. The liver is slightly enlarged. The urine is decreased in amount and contains albumin; glycosuria frequently occurs in the form of lactose; casts are often found, and acetone frequently.

Diagnosis.—The history, onset, mental state, diarrhoea, together with the other chief symptoms, and the great improvement of the condition if proper treatment be immediately employed, make the diagnosis fairly easy. Dyspepsia, decomposition, otitis media, typhoid fever, pneumonia, tuberculosis, and meningitis have to be excluded. Bronchopneumonia and pyelitis may occur as complications.

Prognosis.—Although a distinctly serious state, the prognosis is likely to be favourable with efficient treatment; more especially, of course, if the child is not less than 3 months old, nor unduly weakened, and the condition be not a particularly severe one; also if complications are absent, and the temperature falls to normal and remains so after the first twenty-four hours' treatment. A case, however hopeless it may look, should be persevered with.

Treatment.

The great thing is to prevent this condition arising by encouraging mothers to breast-feed their children and seeing that hygienic conditions are maintained in the nursery. In the actual treatment of a case the child is only allowed food after twelve to twenty-four hours, but during the first twenty-four hours it is given plenty of water to drink or weak tea, as already described; also 1 to 3 oz. of the half-strength normal saline previously referred to. The stomach and bowel are thus emptied. Normal saline injections will be used as may be necessary; the same remark applies to subcutaneous injections of camphor.

The best food is breast-milk. The child should be allowed to remain at the breast for two minutes every two hours at first, but in some cases it would be wise to make the intervals three or four hourly. The time allowed at the breast is cautiously increased by a minute until, if all goes well, and the weight curve has straightened out, five-minute feeds are allowable; the time is gradually increased up to ten minutes. Where breast-feeding is not available, protein milk is used in the form of ten $\frac{1}{2}$ -oz. feedings daily, at first every two hours. The amount of the feeds is gradually increased by $\frac{1}{4}$ oz. daily until it reaches $1\frac{1}{2}$ oz. Then if the curve has straightened out the increase can be cautiously made to 3 oz. per lb. of body weight. The infant is given as much water to drink between feeds as it will take. With a definite improvement in the nutrition and general state of the child the carbohydrate is increased little by little from 3 to 5 per cent., and in favourable cases in three to four weeks the ordinary milk-mixture may be used again.

Should stimulation be required, camphor can be administered, or 3 minims of 1 in 1,000 adrenaline solution subcutaneously every three or four hours for a time, or 8 to 12 drops of brandy in water given every four hours by the mouth. Where there is collapse a mustard bath is useful. For acidosis 2 per cent. sodium bicarbonate solution in normal saline can be injected in the superior longitudinal sinus or else administered per rectum. A 5 per cent. glucose solution may be required. For convulsions an ice-cap may be applied to the head and bromide and chloral solution injected into the rectum. For the diarrhoea pulv. creta. aromat. in 5 to 10 grain doses every four hours is sometimes used; occasionally $1/12$ minim of tincture of opium is added to it. The injection of warm water into the rectum is very valuable for the relief of meteorism.

PARENTERAL AND ENTERAL INFECTIONS.

In addition to the enteral causes of the nutritional disturbances of infancy there are parenteral ones, such as bronchitis, otitis media, pyelitis, etc., in which the intestinal mucous membrane and the secretions are probably so affected that nutritional states develop.

The treatment for parenteral affection consists, generally speaking, in treating the parenteral state, such as a catarrh of the lungs, after the disappearance of which the nutritional disturbance subsides. If in doubt as to whether the enteral nutritional state or the parenteral infection is the more important, it is essential to be guided chiefly by the weight curve, and treat the case accordingly as already explained. Of enteral infections which have to be distinguished from the nutritional disturbances are typhoid fever, dysentery, etc. The infectious diarrhoeas will not react to food as do the nutritional disturbances.

CONCLUSION.

Reviewing the nutritional disturbances from the first conception of clinical entities to the present well defined states, we are impressed by the necessity for the closest possible observations of clinical facts, the dovetailing of which into their suitable pigeon-holes needs infinite care, patience, and accurate deduction. In the future as in the past much will be learned from scientific investigation as to the importance of metabolic processes with regard to a single substance (like urea) in one of the food states; but it would appear as if, generally speaking, more inductive information is likely to ensue from careful clinical and biochemical methods applied to all four states in the same investigation. This would make a valuable comparison between the four states themselves and normality. Slight or marked differences between these states are likely to suggest new lines of investigation on a broader scale, which may lead to a clearer conception of the processes involved than the one substance investigated. Ultimately we may find the necessity for increasing the number of states of nutritional disturbances.

The Harveian Lecture

ON

THE HEART BEFORE HARVEY.

DELIVERED BEFORE THE HARVEIAN SOCIETY ON
MARCH 20TH, 1924,

BY

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"... les opinions de son siècle, parce que ce sont les préjugés qu'on oublie le moins."—*Sénac*.

WHEN I had the honour of receiving your invitation to give this lecture it seemed to me that Harvey, apart altogether from the nature of that work which made his name immortal, provides some good examples of human limitations. It is a common defect in observation that we do not see or appreciate things for which we are not looking; in other words, we are the slaves of preconception, or of prejudice, if we use the word in its true sense. The preconception may be fundamental, so deep down under our actions that it does not appear on the surface, but it is there all the same; and it has sometimes seemed to me that part, at any rate, of genius, when applied to research, is the power of seeing things as they are, more or less, and not as they might be expected to be. A preconception leads, among other things, to lessened appreciation, or even complete want of appreciation, of points which tell against itself, and in the course of time it becomes almost part of ourselves, a sort of natural law or fact, about which there is no doubt whatever and no question possible.

It was a preconception of such a nature that had to be overcome by Harvey. He found the old belief to be incomplete, in discordance with facts, and opposed to reason, whereas the system proposed by him was complete and in absolute accord with fact and theory. But he was striving against a most ingenious and coherent—though false—belief concerning the functions of the heart and the vascular

system in general, and this belief had held the field unchallenged for fifteen hundred years. I fancy that there are many medical men who, if they were suddenly faced with the necessity of giving grounds for their belief in Harvey, would find it difficult to answer convincingly: it is enough for them that it is the accepted view, that it fits in with all they know of physiology and medicine, and that it serves its purpose very well. In the same way the pre-Harveian physicians had found that the prevailing beliefs on the vascular system met all their requirements, in medicine and in biological science, and they found it very hard to admit that they were unreasonable. Moreover, they had the sanction of at least fifteen hundred years of medical experience—a respectable period of time which completely eclipses any claim to consideration on the same score that might be made by the modern man. The modern and the ancient are alike prejudiced in favour of the current view of their period, and unable to see any need for change; we, to-day, hold of course that fundamental change in the matter is unthinkable, because we now have the proper conception of the circulation, but let us not forget that that standpoint was also the one occupied by the men who were Harvey's antagonists. Their honesty of purpose was shown by their later whole-hearted acceptance of his views, but their obstinacy of opposition was only due to their strong preconceptions. It is with the nature of their belief that I want to deal, and at the same time I will try to show how it was that this wrong belief held its ground for so many centuries before it was overthrown by Harvey.

Modern physiology and medicine are boundless subjects, but they had their origin in the science and philosophy of ancient Greece, and it is not necessary for us to go further back or further afield than to Greece if we wish to see this origin; nor is it necessary to say anything about Hippocrates, as the views of his time were expanded later by Galen, but something may be said about Aristotle's teaching, which was seemingly not in accord with the general belief. He looked on the heart as the source of "vital heat" which, though not the soul, was an absolutely necessary concomitant or agent of the soul; and the aorta and vena cava served similar functions in that they carried this "vital heat" in the blood to the left and right sides of the body respectively. Aristotle's view of the structure of the heart is well known: he describes it as having three cavities, and much argument has centred round this description in the laudable endeavour to understand what he meant by it; we need not go into the matter, but every now and then, during the succeeding centuries, the idea cropped up in one form or another.

When Alexander the Great died, some three hundred years before the Christian era, his generals seized his several possessions. Egypt fell to the share of Ptolemy, who seems to have been a man of foresight and discrimination. He conceived the idea of making Alexandria the leading city of the world in learning and in commerce. His immediate successors carried on this policy, and the city became a centre to which the leading minds naturally gravitated, and in which all that was best in philosophic thought was undoubtedly represented. The medical sciences were fostered like the other branches of learning, and it was in Alexandria, in the reign of Ptolemy Soter, that Erasistratus enunciated his theory of the carriage of "vital spirits" by the arteries throughout the body. This idea of the arteries containing "air" has been wrongly attributed to Aristotle: it is purely Erasistratean, and, according to Galen, seems to have resulted from his difficulty in accepting Aristotle's teaching, in which two main vessels were supposed to do work which might be done by one only. Whatever we may think about it, it must not be forgotten that the idea itself was not unreasonable from the standpoint of the vascular physiology of the day, as we will see shortly. We depend on Galen for what we know of the work of Erasistratus, for his writings have not been preserved, but he certainly described with accuracy the valves of the heart, indicating the directions in which they opened; yet he had no notion of a circulation of any sort, and, like his followers, he seemed to be more concerned with making the facts he described consistent with the philosophical conceptions of his time than with altering the theories to bring them into line with the facts.