INFANTILE DIARRHOEA*

BY

A. V. NEALE, M.D., M.R.C.P.

PHYSICIAN TO OUT-PATIENTS, CHILDREN'S HOSPITAL, BIRMINGHAM

Judged from the available statistical reports¹ on fatal diarrhoea in infants, the incidence has fallen considerably. In 1905 in England and Wales the death rate in diarrhoea and enteritis in infants aged from three to twelve months was 62. In 1928 the same record shows a rate of only 23, and it would appear that the overcrowded areas of the big cities are largely responsible at present, the relative rates from infantile diarrhoea in Birmingham² being 26.5 in the crowded central wards and only 8.5 in the outer wards. Thus from the public health aspect much has been achieved by way of improving the general hygienic factors concerned in the problem—more particularly regarding regulations of better and cleaner food supplies, especially in the case of milk. Certain uncontrollable factors, however, periodically cause great fluctuations in the incidence of diarrhoeal disease—for instance, the abnormally hot dry summer of 1921.

Clinically diarrhoea in the infant is a common and frequently a most important sign of ill-health. The complex functions of the alimentary tract are easily thrown out of rhythm by a wide variety of causes, some apparently trivial, others grave in themselves. Physiologically the infant's alimentary tract is only capable of dealing with a narrow range of food; hence nature's arrangement for a nearly complete food in one medium—milk.

Clinically we recognize certain principal causes operating in infantile diarrhoea, such as abnormal reactions to food; irritants, bacterial or chemical, ingested with food; irritants produced in the bowel by fermentative changes; specific enteral infections and parenteral infections generally. Excessive carbohydrates or fat is sometimes responsible alone, but intolerance to protein is extremely rare, and the probable reasons for this I will note later.

Of the specific infections of the alimentary tract causing acute diarrhoea in infancy, dysentery bacilli (*Sonne and Flexner varieties*), and typical and atypical forms of the paratyphoid bacilli are not infrequently responsible, and specific agglutinins may be detected in the blood afterwards.

Various strains of streptococci and the pneumococci are recognizable in some outbreaks. A period of acute diarrhoea is frequently seen at the commencement of an acute exanthem, often, in fact, several days before any other clinical features appear, this being a good illustration of the ease with which the alimentary functioning in the infant is disturbed. Outbreaks of summer diarrhoea may or may not have a recognizable bacterial cause, but several factors in the environment are related, atmospheric humidity and temperature being foremost. The prolonged hot dry summer of 1921 was coincident with a great rise in the incidence of infantile diarrhoea. Blackfan's (Boston) investigations on humidity and temperature in large room-incubators have shown that there is definitely an optimum level for the well-being of the infant, and any rapid or marked variations in the temperature and moisture in the air frequently cause outbreaks of diarrhoea.

Certain physiological conditions which are peculiar to the normal infant have been demonstrated by Klumpp and Neale.³ The normal reactions of the contents of the small intestines is slightly acidic—pH 6.5—and probably any great change is not tolerated. The gastric secretion in the

infant is remarkably small, and any infection or minor disturbance is often accompanied by a rapid and complete diminution of the gastric secretions. The enzymes in the pancreatic secretion are present in such small quantity as to be easily minimized below a functionable level, this being specially so concerning the lipase and amylase which are in low concentration during the first year of life. The trypsin ferment, however, is always, from the earliest days of life, present at a high level. These facts may be linked with the rapid intolerance to carbohydrate and fat in the acute enteral dysfunctions of infancy. The ease with which such food substances, which would normally be digested and absorbed, fail to be digested and utilized, may explain many of the parenteral causes of diarrhoea. Pyrexial and infective disorders no doubt adversely affect the digestive ferments and render the food material in the intestine ready prey for putrefactive bacteria, with the result that a highly toxic pabulum replaces the normal healthy contents. Infants vary considerably in their susceptibility to minor intestinal physiological variations—for instance, as seen in the ease with which the so-called "catarrhal" or the "eczema" individual develops diarrhoea. Deficiency in vitamins—more especially in A and B—renders the alimentary tract unstable, and diminishes local resistance to infection.

EFFECTS OF DIARRHOEA

The rapid depletion of tissue fluids is remarkable in infantile diarrhoea, and loss of the normal intestinal secretions is a serious matter to the infant. Ketosis, together with disturbance in the acid-base equilibrium, is soon effected, and a variable degree of acidaemia or alkalaemia occurs. General disturbance of tissue functions ensues, and soon the whole illness may assume much greater import through the secondary effects of the diarrhoea. The delicate protective mechanisms in the bowel are quickly removed, and, by absorption, highly toxic or bacterial or undigested food products may enter the body. Secondary bacterial infections of the bowel may supervene which render matters worse. The absorption of undigested protein substances through the damaged bowel may be responsible for some of the clinical features of the acute intestinal intoxication and anaphylactic phenomena seen, and such may be the explanation of certain cases of protein sensitization producing allergic states in children. Renal and hepatic functions are often seriously disturbed by the dehydration and intoxication, and in fatal cases necropsy reveals evident acute degenerative changes in the parenchymal cells. Failure of the functions of these important organs may directly determine a fatal issue. The myocardium similarly shows the general toxic effect, tachycardia and sometimes unusual rhythm appearing. The marked apathy and the depression of the normal reactive state of the infant indicates the damage to the nervous system, and in severe cases coma may supervene.

CLINICAL VARIETIES

Acute ileo-colitis has a characteristic sudden onset with diarrhoea with or without vomiting. The stools are very frequent, mucus and blood being visible usually. Clinical evidence of abdominal pain and tenesmus is present. The temperature is not usually much raised, but a rapid pulse is a feature and acute severe toxæmia is evident. The usual cause of this type of disease is the dysentery group of bacilli, particularly of the *Flexner* or *Sonne varieties*, and occasionally coliform bacilli, resembling but not identical with the paratyphoid group, are present, the latter being probably not at all uncommon infecting microbes in infants and children as judged by routine bacteriological examination of the stools and agglutination tests in the blood. The

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disease is due to a local infection of the bowel and absorption of the powerful bacillary toxins into the circulation. The local intestinal damage varies from simple acute catarrhal changes to a diphtheritic form of necrosis of the mucosa, but even in the very serious cases remarkably little damage may be visible when the bowel is seen.

Fermentative diarrhoea is associated with acidic, gaseous, frothy, highly irritating, offensive stools causing troublesome excoriation of the skin; gaseous distension of the bowel is evident, and powerful peristaltic movements may be seen preceding the explosive passage of stools. Dehydration is sometimes extreme and becomes a very serious matter. Pyrexial reaction may be minimal or absent or even subnormal. The infant is essentially suffering from starvation, dehydration and much physical discomfort. The intestinal fermentation may arise from irregular feeding or overfeeding with carbohydrates and fats, or may be directly due to a temporary depletion of the normal digestive enzymes as occurs in a parenteral infection. Associated septic and oïdial infections in the mouth are commonly seen. There is a gross disorder of the alimentary physiology affecting equally its digestive, defensive and motility functions.

Acute alimentary intoxication is a serious disorder which may arise from the ingestion of bacterial or chemical toxic material or occurs as a result of absorption of decomposition products from intestinal fermentation. It may seriously aggravate the clinical course in simple fermentative diarrhoea. Very severe diarrhoea with watery stools, vomiting, marked general collapse, subnormal temperature, rapid feeble pulse, scanty urine, clammy skin, pallor, and sighing respiration is the more typical clinical picture. Convulsive movements may appear and terminate the scene. Many of the characters of this illness strongly suggest acute anaphylactic shock, and in great probability the cause is of this nature. Boyd⁴ has demonstrated the presence of highly toxic substances in the bowel of this type of case, and portal blood from patients contained the toxic material. Dehydration rendered experimental animals much more susceptible to the toxic substances. Frequently surprisingly little morbid anatomical changes can be seen in the bowel in acute intestinal intoxication with severe diarrhoea (cholera infantum), but intense degeneration is evident in the kidneys and liver, and occasionally suprarenal haemorrhage is present.

DIAGNOSIS

An accurate history of the diarrhoeal disorder, including information concerning the qualitative and quantitative feeding, is helpful. By careful examination of the stools much useful information can be obtained. Pyrexia and tachycardia are indications of an infective origin. Rapid anaemia, with occasionally purpura and a variable degree of cyanosis, are signs of the toxæmia. Depression of the fontanelle, dry inelastic skin, sunken eyes, rapid loss in weight and small urinary secretion denote at a glance the degree of dehydration. Excoriation of the buttocks indicates a diarrhoea of some duration. Careful and complete examinations of the infant must be made to determine parenteral infections of all types. Meningismus may appear and acute pyelitis and cystitis may be recognized as a cause or effect of the enteral disease. An acute intussusception may arise due to the irregular intestinal movements.

TREATMENT

The profound and complex upset of tissue metabolism consequent upon the dehydration, ketosis and toxæmia renders the treatment of infantile diarrhoea a matter of urgency. First-class nursing attention is essential, and the child must be handled with meticulous care. Fluids must be introduced into the body to replace the excessive loss

occurring. In a mild case all milk should be stopped for twenty-four hours and replaced by the use of pure water, quarter strength physiological saline, weak tea. Ringer's solution of 2 per cent. pure glucose solution by this route is indicated. All these substances require no digestion and are absorbed rapidly in the upper part of the small bowel, thus affording rest to the lower. Gentle rectal lavage with warm saline during this period will relieve gaseous distension and afford comfort to the patient. In severe cases, especially with associated vomiting, sterile fluids must be given by parenteral routes. Rest to the alimentary tract and the injection of fluids parenterally allays the diarrhoea and lessens the tissue dehydration, and affords establishment of normal kidney and hepatic function to aid in the detoxicating and eliminative processes.

Overcoming the problem of conveying water and glucose to the blood and the tissues plays a great part in the therapy. Water is the drug, *par excellence*, in these disorders. Sterile pure saline can be introduced into the lax subcutaneous tissues in the proportion of about 10 c.cm. per pound of body weight once or twice during twenty-four hours. In expert hands it is a simple matter to introduce, by slow injection, 5 per cent. glucose solution into the superior longitudinal sinus at the anterior fontanelle, or in some cases it may be more convenient to inject the fluid into the internal saphenous vein. Intraperitoneal injection of saline or glucose solution is a useful method also. The methods may be combined in individual cases. It is a matter of vast importance to use perfectly freshly made pure glucose solution for these procedures. Blood transfusion is an invaluable measure in some cases and often seems to determine the recovery of the most serious clinical case of infantile diarrhoea and dehydration. Whole blood from a suitable donor is given, 15 c.cm. per pound of body weight being a useful guide, but slow introduction to the longitudinal sinus or a vein is essential, as too rapid injection may cause over-distension over the right side of the heart.

A matter of some importance, often overlooked, is the loss of protein contained in the fluid escaping from the body by way of the intestine, even in stools in which blood is not detectable. The efficiency of blood transfusion may have a relationship to this.

Parenteral infection must be dealt with, and everything done to check the infection. Pus should be evacuated where possible. Anti-dysentery serum given intramuscularly is efficacious in some cases of acute dysenteric ileocolitis.

The use of drugs forms a very small part in the management of infantile diarrhoea. Morphine is dangerous, but small doses of belladonna may be used to check intestinal spasm and pain. On account of the ease with which the body temperature is affected in the infant a warm room with average humidity is a point of importance. In some severe cases the thermo-regulatory mechanism appears to be thrown out of gear, and in such instances the placing of the infant in an open self-regulating warm incubator of the "Hess" type is of distinct value. Since the return of intestinal digestive power is probably slow, the diet in the recovery stages must be very carefully controlled—always remembering that protein is probably the most easily digested and fat the least so at this age. Breast milk if available at this stage is of high value. Easily assimilable forms of carbohydrates, as pure glucose or dextro-maltose preparations, and buttermilk foods are usually satisfactory until the child gradually reassumes tolerance to a more full and varied diet.

We see, therefore, in the study of infantile diarrhoea, many problems concerning disturbances of the intricate physiology and biochemistry of the tissues, and how a

knowledge of these changes, however meagre such may be at present, controls and guides us in the treatment of this common but really complex disorder in infancy.

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AN ATROPINE TEST IN ASTHMA

BY

MARJORIE GILLESPIE, M.D. GLAS.*

(From the Department of Physiology, King's College, London)

Among the drugs used in the treatment of asthma, atropine has always held a prominent place, but its therapeutical value has been found to be much less constant than that of adrenaline. Atropine acts, presumably, by paralysing the nerve endings of the vagus, and so preventing stimuli from the vagus centre reaching the bronchial muscle. Broncho-constriction has been shown to result from stimulation of the upper respiratory tract—that is, reflex stimulation of the bronchial muscle through the vagus centre. In many cases of asthma the treatment of nasal abnormalities has been sufficient to abolish attacks, which would suggest that these attacks were of "nervous" origin. It is also acknowledged that psychical stimuli in some patients play a considerable part in inaugurating a spasm. Since atropine prevents nervous stimuli from reaching the bronchial muscle, it has been thought that it might be used to differentiate between broncho-constriction due to reflex stimulation of the vagus and that due to direct stimulation of the bronchial muscle—that is, between nervous and chemical stimulation.

By using the method introduced by McDowall and Thornton (1930) for recording the movements of the isolated bronchi, it has been shown that contraction of the bronchial muscle follows the injection of pilocarpine, and that a small dose of atropine immediately after produces complete dilatation. A second dose of pilocarpine now produces no result, but a very small dose of histamine still causes the muscle to contract. Histamine is supposed to act directly on muscle, while pilocarpine acts through the nerve endings. Similar contractions are obtained by injecting other substances known to act directly on the muscle. The amount of atropine injected was small (0.13 mg.), as larger doses may paralyse the muscle itself.

The usual method of administering atropine in asthma is as tincture of belladonna in a mixture to be taken by the mouth, but the unpleasant dryness of the mucous membranes and the effect on the pupil prevent its continuous use. As a method of estimating the part played by nervous stimuli in inaugurating broncho-spasm, a full dose of atropine might be injected subcutaneously at the onset of an attack. In those cases where contraction of the bronchial muscle is due to direct chemical stimulation of the muscle, atropine would be expected to have no effect, whereas, in the truly nervous type the attack would be aborted. In this way the patients whose attacks are due to psychical stimuli alone could be differentiated from those who owe their symptoms to a fundamental chemical alteration of the blood.

I wish to express my thanks to Professor R. J. S. McDowall, who suggested this method of differentiation.

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Memoranda

MEDICAL, SURGICAL, OBSTETRICAL

FOUR GENERATIONS OF HETEROSEXUAL TWINS WITH PREPARTUM AMENORRHOEA IN TWO GENERATIONS

The genealogical tree shown below is that of a woman who was admitted to hospital on account of twin pregnancy and a mild degree of albuminuria. She was 22, and had never menstruated. Her twins were of opposite sex. Inquiry revealed that this was the fourth generation of heterosexual twins, and that the patient's mother had also had amenorrhoea up to the time of her first pregnancy at the age of 20.

I am indebted to Dr. C. J. Penny for permission to publish this case.

C. E. TAYLOR, M.A., M.R.C.S.,
L.R.C.P.

Bromley, Kent.

House-Physician, Royal Hants
County Hospital.

BILATERAL HERPES ZOSTER

Since Darier has stated that herpes zoster is almost invariably unilateral (*Précis de Dermatologie*, 1918) and Sutton (*Diseases of the Skin*, 1928) makes the same observation, but notes that bilateral cases have been described by Fordyce (*Journ. Cut. Dis.*, 1915, 319) and Howard Fox (*ibid.*, 1915, 492) this case which—was recently under my care would seem worthy of publication.

A healthy man, aged 21, consulted me on June 15th, 1931. He stated that on June 12th he felt ill, had a sore throat and a headache, and thought that he had a temperature; as he felt no better on the following day he stayed in bed. On June 14th he had some pain behind the right ear, and later in the day noticed the eruption on account of which I was asked to see him. At this time there were well-marked herpetic vesicles on an area the size of a florin over the right parotid gland and over the outer surface of the pinna of the right ear; he had a temperature of 101° F. He was ordered to stay in bed, and was given sodium salicylate internally and a dusting powder for external application.