STUDIES IN GASTRO-ENTERITIS

BY

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I.—CLINICAL ASPECTS OF INFANTILE DIARRHOEA

In spite of the great amount of work on the subject no satisfactory classification of the various gastro-intestinal disturbances of infancy has yet been agreed upon. All are more or less arbitrary, for no hard and fast line can be drawn between the several types of the syndrome. In this paper the simplest classification based on the clinical condition has been adopted.

Three hundred consecutive cases of diarrhoea and vomiting in children under two years of age admitted to the Royal Hospital for Sick Children between the years 1931 and 1934 have been studied. This series has been divided into two groups, viz.:—

1. Acute infantile diarrhoea and vomiting.
  - (a) Severe type.
  - (b) Mild type.
2. Chronic infantile diarrhoea.

The acute cases (severe type) comprise the type designated by various writers as anhydraemia¹, cholera infantum and toxicosis². In the mild type are included patients in whom the symptoms of general systemic disturbance such as fever, dehydration and toxæmia were less marked than in the severe type but who suffered from diarrhoea and vomiting of varying degree of severity. The chronic cases are those showing wasting with frequent attacks of gastro-intestinal disturbance, the type designated by Marriott¹ as athrepsia. At times it was difficult to decide whether a patient was of the acute or chronic type but the general condition on admission to hospital, the presence of fever, collapse or dehydration and the duration of the illness were the main points taken into consideration.

In the total of three hundred patients ninety-eight belonged to the acute diarrhoea group (severe type). Two of these died within a few minutes of admission to hospital. One hundred and seven were of the mild type and ninety-five were classified as cases of chronic diarrhoea and vomiting.

Not all the patients were admitted with a history of diarrhoea and vomiting. In thirty the complaint was of convulsions, 'not thriving' or

cyanosis; twenty were said to have vomiting and diarrhoea and thirteen diarrhoea without vomiting. In the patients with no history of alimentary disturbance definite evidence of diarrhoea or vomiting was forthcoming soon after admission; this with the absence of signs of disease elsewhere and, in some instances, with confirmatory evidence post-mortem justified the diagnosis of gastro-enteritis and their inclusion in this series.

Etiological factors

Age.—In the present series 65·2 per cent of the patients were under six months of age and only 12 per cent. over a year. The age period three to six months shows the highest incidence; possibly this is due to the fact that relatively few mothers can breast-feed their infants for more than three months and that after the age of six months artificial feeding is better tolerated. Parsons³ in his series found that most of the patients were under the age of three months. On the other hand, in the United States it appears that the disease affects children over a year of age more commonly than those under a year⁴ (table 1).

TABLE 1

AGE INCIDENCE

AGE	NO. OF CASES	PERCENTAGE OF TOTAL	DEATHS	PERCENTAGE MORTALITY
Under 1 month	19	6·3	14	73·6
1-3 months	59	19·6	24	40·7
3-6 months	118	39·3	62	52·5
6-12 months	68	22·6	29	42·6
Over 1 year	36	12·0	13	36·0

Season.—Most authorities are agreed that the disease is specially prevalent in the late summer and autumn months.

Thus Findlay⁵ found in the severe epidemic of 1921 that 64 per cent. of the cases in that year occurred during July, August and September and Nabarro⁶ in the same year found that the maximum incidence was in the third and fourth weeks of July and the first week of September. In America Marriott and others⁷ reviewing a series of three hundred and twelve cases found that non-dysenteric diarrhoea occurred most frequently in the early autumn months and especially in those children whose nutrition had suffered during the summer season. They also noted that an appreciable number of cases occurred during the winter months.

The present series shows a similar seasonal incidence. The majority of the cases (68·8 per cent.) occurred during the months of June, July, August,

September and October and almost half of the series of three hundred cases occurred during the months of August, September and October (table 2).

TABLE 2
SEASONAL INCIDENCE

MONTH	NO. OF CASES	PER CENT. OF TOTAL	PER CENT. MORTALITY	MONTH	NO. OF CASES	PER CENT. OF TOTAL	PER CENT. MORTALITY
January ...	8	2.6	50.0	July ...	33	11.0	42.4
February ...	10	3.2	60.0	August ...	47	15.6	51.0
March ...	13	4.3	38.4	September	46	15.3	41.3
April ...	12	4.0	66.6	October ...	47	15.6	31.8
May ...	19	6.3	52.6	November...	22	7.3	63.6
June ...	34	11.3	61.7	December...	9	3.0	22.2

Social conditions.—It is well-known that the disease is rare in the upper grades of society and that it is extremely prevalent in the slums of cities. Most of the present series of patients came from slum dwellings although this does not necessarily prove the rarity of the condition in the children of the well-to-do for when housing conditions are good the necessity for hospital treatment is often unnecessary. Overcrowding is probably an important etiological factor; 36 per cent. of the present series came from families of five or more children (table 3).

TABLE 3
RELATIONSHIP OF INFANTILE DIARRHOEA TO SIZE OF FAMILY

CHILDREN IN FAMILY	NO. OF CASES	PERCENTAGE OF TOTAL
1	58	21.5
2	48	17.7
3	42	15.5
4	25	9.3
5 or more ...	97	35.9
No data	30	—

Feeding.—It is well recognized that artificial feeding plays a major rôle in the development of infantile diarrhoea. In Findlay's⁵ series of three hundred and twenty cases only 9 per cent. were breast-fed. In the present series two hundred and ninety were artificially fed, nine breast-fed and one partly bottle and partly breast-fed prior to admission. Thus only 3 per cent. of the cases were breast-fed.

Symptoms

Of the three hundred patients, twenty-four had a history of illness of one day's duration and half had suffered from alimentary disturbance for more than a week. Others again had a history of intermittent diarrhoea and vomiting but on admission were so acutely ill that they were classified as acute cases (table 4). Dehydration, toxicity and cyanosis are the three

TABLE 4
DURATION OF ILLNESS

DURATION OF CONDITION	No. OF CASES	PERCENTAGE OF TOTAL	PERCENTAGE MORTALITY
1 day	24	8.1	54.1
1-3 days	34	11.4	41.1
3-7 days	91	30.6	45.0
Over 7 days	148	49.9	53.4
Not recorded	3	—	—

danger signs. All the acutely ill patients showed one or more of these. In the mild type these signs were much less evident while in the chronic type without exacerbation dehydration was absent (table 5).

TABLE 5
SEVERITY OF CONDITION ON ADMISSION

TYPE OF CASE	CLINICAL CONDITION	No. OF CASES	PER CENT. OF TOTAL	PER CENT. MORTALITY
Acute (severe) ...	Severe dehydration	38	12.0	71.3
	Cyanosed and ill	22	6.8	85.0
	Toxic and dehydrated	36	11.4	73.5
Acute (mild) ...	Moderate dehydration	40	13.7	47.5
	Slight dehydration	67	22.8	37.3
Chronic	Ill but not dehydrated	48	15.8	48.0
	Not ill, no dehydration	47	15.7	19.1
Acute	Died before admission	2	0.7	—

Fever.—One hundred and forty patients had a greater or less degree of fever, and in sixteen the temperature was subnormal; these latter were acutely ill, with all the signs of severe collapse (table 6).

TABLE 6
TEMPERATURE (RECTAL) ON ADMISSION TO HOSPITAL

TEMPERATURE	NO. OF CASES	PERCENTAGE OF TOTAL
Sub-normal	16	5.3
98° — 99° F.	30	10.0
99° — 100° F.	112	37.3
100° — 102° F.	100	33.3
Over 102° F.	40	13.3
Not recorded	2	0.7

Finkelstein⁸ has suggested that the fever is partly due to high carbohydrate diet and partly to negative water balance. Marriott⁹ although admitting the possibility of negative balance as a cause lays much stress on parenteral infection. Schoenthal and Morton¹⁰ favour the view that the fever in many cases arises from water depletion and demonstrated in a normal infant that it can be produced by limiting the fluid intake.

Parenteral infections.—It is well known that infections outside the alimentary tract are commonly met with in infants suffering from diarrhoea and vomiting. To what extent they are causative factors in the production of the disease is open to doubt. Karelitz¹¹ and Marriott and others⁷ favour the view that such infections play an important part in the etiology. The former showed that 50 per cent. of the patients in his series and the latter that 83 per cent. suffered from some form of parenteral infection. Of the present series one hundred and twenty-two (40.6 per cent.) had some form of parenteral infection (table 7), otitis media being by far the most common.

TABLE 7
INCIDENCE OF PARENTERAL INFECTIONS

PARENTERAL INFECTIONS	NO. OF CASES	PER CENT. OF TOTAL	PER CENT. MORTALITY
Otitis media	78	26.0	42.3
Bronchopneumonia	9	3.0	88.0
Pyuria	11	3.7	73.6
Furunculosis	5	1.7	60.0
Umbilical sepsis	3	1.0	66.6
Bronchitis	4	1.3	50.0
Throat infections	1	0.3	—
More than one infection	11	3.7	72.7
Total	122	40.7	52.0

Many of these patients, however, showed no evidence of parenteral infection on admission but developed the condition later. The possibility that the relatively low incidence of parenteral infection in the present series might be due to the fact that some were missed on clinical examination was recognized but as it is shown later there was no great discrepancy between the incidence arrived at by clinical and by post-mortem examination.

Clinically 40 per cent. were found to have parenteral infection while at post-mortem examination 48 per cent. showed this. Admittedly the condition was missed in a few cases but when it is borne in mind that more of the patients with parenteral infection died than those without this complication it would seem that the incidence arrived at on clinical grounds is probably fairly accurate.

Mortality

The mortality rate for the three hundred patients in the present series was 47·2 per cent. In the acute type with severe symptoms it was 76·6 per cent. and in the mild type 41·1 per cent.; in the chronic group it was 33·7 per cent. (table 8). The death rate among the acute cases does not compare favourably with the figures for similar cases given by other workers¹² except those of Hartman¹⁴.

TABLE 8
MORTALITY RATE

INFANTILE DIARRHOEA	NO. OF CASES	PER CENT. MORTALITY	TOTAL MORTALITY PER CENT.
Acute (a) severe type	98	76·6	4·72
(b) mild type	107	41·1	
Chronic type	95	33·7	

Age.—As a general rule it may be said that the younger the child the greater the risk of death. In this series the mortality rate in the first year of life was 48·8 per cent. and in children in the second year 36 per cent. In infants under one month it was 73·6 per cent. These figures demonstrate the seriousness of the prognosis in all infants and especially in the very young (see table 1).

Duration of symptoms.—The highest mortality occurred among the patients admitted with acute symptoms of only one day's duration and those with a history of illness of more than one week's duration showed only a slightly lower mortality rate. Probably the acuteness of the symptoms determined the early admission to hospital of some of the patients and it is likely that the resistance of many of the infants who had been ill for a week

or more had been impaired by prolonged gastro-intestinal disturbance (see table 4).

Parenteral infection.—It might be expected that the mortality rate would be highest among those patients with some infection outside the alimentary tract; the figures presented demonstrate this but not as strikingly as might be expected. Of one hundred and twenty-two cases showing parenteral infection sixty-four died giving a death rate of 52 per cent. compared to a rate in the uncomplicated cases of 43·7 per cent. The reason that a higher mortality rate was not met with among patients with parenteral infection was probably because otitis media, by far the commonest infection, did not seem to prejudice the outlook. Bronchopneumonia and pyuria which occurred with comparative rarity were the killing complications (see table 7).

State of nutrition.—Taking the percentage of expected weight for the age as a measure of the state of nutrition it will be seen from table 9 that a

TABLE 9
PERCENTAGE OF EXPECTED WEIGHT ON ADMISSION

PERCENTAGE OF EXPECTED WEIGHT	NO. OF CASES	PERCENTAGE MORTALITY	TOTAL MORTALITY PER CENT.
100 or over	17	23·3	36·5
90-99	30	40·0	
80-89	56	35·7	
70-79	78	35·8	
60-69	53	53·0	65·0
50-59	27	77·7	
40-49	11	81·8	
Under 40	3	100·0	
Not tabulated	26	—	—

large number of the cases showed a greater or less degree of malnutrition; indeed only forty-seven of them were within ten per cent. of the normal weight. No doubt in a considerable number nutrition had been interfered with by repeated attacks of gastro-intestinal disturbance but many of the patients classified as acute, whose symptoms had been present only for a few days, were badly nourished.

It will be seen from the table that the death rate among the under-nourished was higher than that observed in those who were more nearly of normal weight. The group of infants who were within 30 per

cent. of the normal weight showed a death rate of 36 per cent. while those who were less than 70 per cent. of their expected weight showed a death rate of 65 per cent. Fleming has found that the state of nutrition influences the mortality rate in primary pneumonia in a similar way (personal communication).

Pathology

It is recognized that the post-mortem findings sometimes show only slight evidence of pathological change in the various organs^{5, 6}. In some patients with severe and acute illness only slight erythema of the bowel may be apparent while in others with less acute symptoms the bowel may exhibit marked inflammatory changes. In the more severe cases, however, definite evidence of some fatty changes in most of the vital organs such as the liver, kidneys and heart may almost always be seen. The lesion most frequently found is a varying but at times extreme degree of fatty change in the liver.

Eighty-seven cases of the present series came to post-mortem examination; to these are added four cases of pyloric stenosis in which diarrhoea and vomiting developed after operation. The only parenteral infections disclosed post-mortem and not recognized before death were several cases of terminal bronchopneumonia and a few cases of otitis media. The post-mortem results show that in forty-four of the series there was no parenteral infection detected. Twenty patients were found to have pneumonia which in nine cases was terminal. In the remaining twenty-seven a variety of infective complications was found—otitis media, pyuria, sinus thrombosis. In the forty-seven patients with definite evidence of parenteral infection it was impossible except in nine cases of terminal bronchopneumonia to decide whether the condition had occurred prior to the development of the alimentary symptoms or whether it was of later onset. As others have found, so in this series the degree of inflammatory reactions shown by the bowel did not in many instances bear any relationship to the severity of the symptoms¹⁵. Fatty change in most of the organs, especially marked in the liver, was commonly found⁶.

Treatment

The high mortality rate from gastro-enteritis in infancy emphasizes the importance of any measures calculated to prevent its occurrence. The etiological factors concerned in this condition are numerous but one stands out above all others, viz., artificial feeding, for in the vast majority of cases (97 per cent. in the present series) the infants are artificially fed. It would appear therefore that breast-fed infants are almost immune and that by increasing the use of breast feeding the incidence of the condition would be greatly diminished. When artificial feeding cannot be avoided the greatest attention must be paid to nursery hygiene. With education in

this, better housing and improved facilities for the preparation of the infant's food it can be confidently predicted that there will be great reduction in the incidence of the disease.

Owing to the varying degrees of severity in the individual cases of the present series it is impossible with the data available to make a reliable comparison between the various types of treatment that have been utilized. All the patients admitted to the wards with a history of alimentary disturbance or exhibiting the signs and symptoms of such a condition were given as a routine bowel and stomach lavage provided they were not too 'shocked' and nothing but water or saline by mouth for periods varying between six and twelve hours. Stomach lavage was often found to be successful in controlling vomiting.

Administration of fluid.—Although the figures presented in a succeeding paper do not indicate any striking loss of water from the tissues, it should be emphasized that there may be a considerable loss of water from the body without much alteration in the water content of the tissues. In addition it is important to remember that there is clear evidence of loss of water from the plasma as indicated by a considerable rise in the serum proteins and of accumulation of waste products. Accordingly there is ample justification for the administration of fluid which has so long held an important place in the therapy of acute gastro-enteritis. The added fluid diminishes the concentration of the blood and thus by lessening its viscosity eases the circulation and promotes increased renal activity. This together with the increased interchange between intra- and extra-vascular fluids facilitates the excretion of waste products the accumulation of which almost inevitably leads to acidosis and toxæmia.

The nature of the fluid administered seems within limits to be a matter of little importance. Normal saline is certainly the most easily procured. Hartman¹⁴, however, prefers his buffer lactate solution. In the present series there was little difference between the therapeutic effects of normal saline and buffer lactate, a similar experience to that of Hoag and Marples¹⁵. There has not been a sufficient number of patients treated with the continuous intravenous drip method to make a useful statement as to its efficiency compared with single or repeated parenteral administration of fluid.

In cases of chronic infantile diarrhoea an important consideration is the improvement of general nutrition which is so often poor. There should be no hesitation in giving glucose solution intravenously for by this means it is possible to provide a readily-utilized food. In this type of case parenteral infection often plays an important part and such infections as otitis media and pyuria should be carefully watched for and adequate treatment adopted. In all patients in whom otitis media was detected, paracentesis of the tympanum was performed. It is impossible from examination of the case records to state if any benefit resulted from this procedure but in many cases a reduction in temperature followed the paracentesis.

Blood transfusion.—The place of blood transfusion in the treatment of diarrhoeal diseases of infancy is still disputed. Karelitz and Schick¹³ and Johnston¹⁷ have advocated its general use whereas Marriott and others⁷ condemned it. Certainly when there is already marked blood concentration the transfusion of citrated blood may, and often does, result in further increase in the plasma protein percentage and intensification of the anhydraemia. In a series of eighteen patients who received one or more blood transfusions the results were poor but it must be admitted that they afford no real argument against its use since it was almost exclusively in the infants who were very ill that this form of treatment was employed. Blood transfusion, if it has a place in the treatment of infantile diarrhoea, is probably of greatest use in chronic cases when there is malnutrition; in such a patient it would appear that a blood transfusion while not a specific cure, may turn the scale in a favourable direction.

Summary

1. The clinical findings in three hundred cases of diarrhoea and vomiting in infancy are reviewed.
2. Artificial feeding appears to be the most important etiological factor.
3. Parenteral infection was present in 40 per cent. of the cases; it did not have as marked an influence on the mortality rate as might be expected.
4. The mortality rate varied inversely with the age and state of nutrition.
5. The morbid anatomical changes in the bowel found post mortem did not in many cases bear any relationship to the severity of the symptoms.
6. The value of administration of fluid in the treatment is emphasized.

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