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Contemporary gastroenteritis of infancy: clinical features and prehospital management

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Abstract

In a prospective survey carried out over 12 months 447 children aged under 2 years were admitted to the Manchester Regional Infectious Diseases Unit for treatment of gastroenteritis. Comparison of the children with those in a survey 15 years previously in the same unit showed that the illness was milder than in the earlier series, with no deaths and with lower incidences of hypernatraemia (1%), uraemia (8%), and dehydration (14%).

These improved findings occurred despite several deficiencies of care in the prehospital phase of the illness, particularly poor compliance with the widely recommended guidelines for fluid and dietary management in infantile gastroenteritis.

Introduction

In a major study of children with infantile gastroenteritis admitted to this unit in 1967 Ironside *et al* showed that the disease was characterised by a significant incidence of dehydration, hypernatraemia, and death but that in only 16% of cases was a pathogenic organism identifiable.¹ Since then several new pathogens have been identified and there have been important advances in the techniques of infant feeding. Infectious gastroenteritis, however, remains a major cause of paediatric admissions to infectious disease units. A total of 339 cases had been admitted to the unit in 1967 as compared with 447 in 1982. During 1976-81 the total number of children admitted annually to five major Manchester hospitals rose steadily from 912 to

1520 (Hospital Activity Analysis data for North Western Regional Health Authority, 1983), despite a lack of increase in the population. This upward trend has been reported elsewhere—for example, from Southern Ireland.²

In view of these changes we decided to review the contemporary features of infantile gastroenteritis as experienced by the same unit serving the same community as in the survey by Ironside *et al*. This paper analyses the clinical findings in hospital and aspects of management before admission.

Patients and methods

Children aged under 2 years admitted with infectious gastroenteritis were entered into a prospective study over 12 months December 1981 to November 1982. The mother was interviewed on admission and a detailed verbally administered questionnaire completed. Particular importance was attached to obtaining information on how the child's diet was altered at the time of admission (see table III) and the nature of any supplementary fluids given with details of their composition (see table III). We also assessed the adequacy of the volumes of fluid actually taken by the child (see table III).

Clinical examination was followed by appropriate treatment and the child's condition monitored until discharge. Assessment of dehydration was based on the Medical Research Council's criteria, as described.¹ Faeces were routinely examined and cultured for pathogenic bacteria, viruses, and *Clostridium difficile* toxin (M E Ellis, B Watson, B K Mandal, *et al*, unpublished observations).

In a few cases some data escaped recording, so that figures presented in tables I-VI do not invariably refer to the whole series. We do not, however, consider that this materially affects the results.

Statistical analysis was by the standard χ^2 test or Fischer's exact test (for two dimensional tables). For three dimensional tables, log linear models were used to examine interactions between three variables. Contingency tables were used.

Results

CLINICAL

During the study period 447 children (including 21 with two admissions) were admitted. Most came from north east and eastern Greater Manchester and were of social class IIIb or below (table I). Three quarters of the children were aged less than 12 months.

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Other adverse features included a high incidence of low birth weight (14% $\leq$ 2500 g), a low prevalence of previous and current breast feeding (37%), and a substantial proportion who were underweight (20% at or below the third centile at discharge).

TABLE 1—Social and family profile

	Proportion of children
Area of residence north east and east of Greater Manchester ..	69%
Ethnic groups:	
White	76%
Indian subcontinent	19%
Other	5%
Age (months):	
$\leq$ 6	210
7-12	120
13-18	86
19-24	29
Social class $\leq$ IIIb	89% (66%)*1
Single parent	23%
Working mother	14% (64%)*2
Mother's age $\leq$ 19 years	11%
Family size $\geq$ 3 children	30% (8%)*2
Adverse family conditions†	20% (3.5%)*2

Figures in parentheses are for similar data for general population of that area of Greater Manchester. (Source: (1)—OPCS. Birth tape p 44. North Western Regional Health Authority Statistical Unit 1979); (2)—Office of Population Censuses and Surveys.)

†Either (a) poor washing or sanitary conditions—for example, outside lavatory with no handwashing facilities, no bathroom—or (b) overcrowding ($\geq$ 3 persons per bedroom).

In 335 cases (75%) one or more putative pathogenic micro-organisms were found. Rotavirus was the most common (34% of 447 cases). Other viruses were found in 53%, enteropathogenic *Escherichia coli* (6.9%), *Campylobacter jejuni* (5.1%), *Cl difficile* toxin (4.9%), *Salmonella* spp (4.3%), and *Shigella* spp (2%). In 257 cases (57%) viruses were identified alone, in 29 cases (6%) bacteria were identified alone, and in 43 cases (10%) viruses and bacteria were isolated; in six cases *Cl difficile* toxin was found alone. Details of the microbiological findings are reported elsewhere (M E Ellis *et al*, unpublished observations).

Table II summarises the clinical features. Boys predominated. The mean duration of diarrhoea was 8.0 (SD 7.6) days and that of vomiting 3.0 (SD 4.1) days. Moderate to severe dehydration occurred in 14% of patients, but acidosis was not a frequent finding. Hypernatraemia occurred rarely (five cases), and only 8% of patients had a raised serum urea concentration ($>$ 6 mmol/l; $>$ 36 mg/100 ml).

TABLE II—Clinical and laboratory features

	% of patients*
Lower respiratory tract infection	15
Upper respiratory tract infection	18
Maculopapular rash	13
Significant lymphadenopathy	21
Convulsions	1.2 (5 patients)
Secondary lactose intolerance	8
Temperature $\geq$ 38.5°C	8
Moderate to severe dehydration	14
Sodium concentration $\geq$ 150 mmol(mEq)/l	0.8 (5 patients)
Urea concentration $\geq$ 6 mmol/l ($>$ 36 mg/100 ml)	8
Bicarbonate concentration $<$ 15 mmol(mEq)/l	3
Stay (days):	
$\leq$ 7	62
7-14	28
$\geq$ 15	10

*Percentages refer to patients in whom variable was recorded and not necessarily to original number of 447 patients.

Thirty children (10 on admission and a further 20 within 48 hours of admission; 7%) required intravenous fluid replacement for one or two days in preference to oral rehydration in order to correct dehydration or overcome persistent or severe symptoms. The majority, including many with moderate to severe dehydration, were successfully rehydrated with a standard electrolyte preparation (Dioralyte) given for 24 hours combined with temporary withdrawal of solids and milk, followed by a graduated dilutional reintroduction of either normal milk feeds or solids as appropriate.

Antibiotics were not routinely prescribed for gastroenteritis.

There were no deaths during the study period, but complications were recorded in 85 patients. Five children had had a convulsion before admission, of whom four had a fever exceeding 39.5°C on

admission, which may have been the cause. One other child sustained a brief convulsion after admission and had been severely dehydrated on admission (plasma sodium concentration 164 mmol(mEq)/l; urea concentration 21 mmol/l (127 mg/100 ml)) but made a full recovery. Neither the type of intravenous fluid nor the rate of replacement was thought to have contributed to the convulsion. A more common complication was temporary lactose intolerance resulting in a recrudescence of diarrhoea, necessitating withdrawal of milk feeds containing lactose.

Some two thirds of the children were discharged within seven days.

MANAGEMENT BEFORE ADMISSION

Only 45 out of 406 parents (11%) had placed their child on a type 1 dietary regimen. Hence the great majority of children had received a diet which was unaltered or altered only slightly from normal (table III). There was a slightly higher prevalence of clinical dehydration and higher serum sodium concentrations among those who had received a type 2 or type 3 regimen, but this did not achieve statistical significance (tables III, IV), few patients having received the type 1 regimen. The higher incidence of uraemia, however, was significant (table IV).

TABLE III—Dietary regimen, volumes taken, and concentration of clear fluids administered: relation to dehydration. Data expressed as numbers of subjects (percentages in parentheses)

	Type 1 regimen*	Type 2 regimen*	Type 3 regimen*	Total	p Value
Total	45 (11)	159 (39)	202 (50)	406	
Dehydrated†	8 (18)	48 (30)	64 (32)	120 (30)	NS
Total given inadequate volume replacement	23 (10)	68 (30)	133 (59)	224	
Dehydrated	7 (30)	30 (44)	49 (37)	86 (38)	
Total given adequate volume replacement	24 (13)	91 (49)	69 (38)	184	
Dehydrated	1 (4)	18 (20)	14 (20)	33 (18)	0.001
Total given high concentration of clear fluids‡	3 (7)	12 (27)	29 (66)	44	
Dehydrated	1 (33)	3 (25)	9 (31)	13 (30)	
Total given low concentration of clear fluids‡	43 (12)	147 (40)	173 (48)	363	
Dehydrated	7 (16)	45 (31)	54 (31)	106 (29)	NS

*Type 1 regimen: milk feeds and solids completely withdrawn. Type 2 regimen: milk feeds diluted or solids thinned, or both. Type 3 regimen: usual diet continued unaltered.

†Dehydration at least grade 1.¹

‡High/low concentration of clear fluids based on arbitrary but widespread working definition of final concentration of glucose $\geq$ 1.278 mmol/l ($\geq$ 5 g/100 ml).⁸

Estimation of adequacy of volume replacement—Child's average daily fluid requirement was calculated from age, body weight, fever, and description of diarrhoea and vomitus. From further calculation of amount actually taken by child allowing for any vomited or refused, judgment was made about adequacy.¹⁰

TABLE IV—Dietary regimen and sodium and urea concentrations. Data expressed as numbers of subjects (percentages in parentheses)

	Total	Type 1 regimen	Type 2 regimen	Type 3 regimen	p Value
Serum urea {					
$<$ 3.0 mmol/l	231	26 (11)	95 (41)	110 (48)	
3.1-6.9 mmol/l	160	17 (11)	50 (31)	93 (58)	
$\geq$ 7.0 mmol/l	24	3 (13)	6 (25)	15 (63)	0.025
Serum sodium {					
$\leq$ 135 mmol/l	118	16 (14)	48 (41)	54 (46)	
136-144 mmol/l	285	29 (10)	101 (35)	155 (54)	
$\geq$ 145 mmol/l	10	1 (10)	2 (20)	7 (70)	NS

Conversion: SI to traditional units—Urea: 1 mmol/l $\approx$ 6 mg/100 ml. Sodium: 1 mmol/l = 1 mEq/l.

A total of 224 children (55%) were judged to have received inadequate volumes of fluid at home and 184 (45%) adequate volumes. A significant correlation existed between inadequate volumes administered and the proportion of children who were found to be dehydrated (table III). Forty four children had been given clear fluids of frankly high glucose concentration ($>$ 278 mmol/l; $>$ 5g/100 ml) and the remainder (n = 363) fluids of low glucose concentration ($<$ 278 mmol/l). The prevalence of dehydration in these two groups, however, was not significantly different (table III). Interestingly, all five children who were hypernatraemic on admission had

received at home a type 3 regimen and inadequate volumes of fluid, and in addition three had received high solute drinks or concentrated milk feeds, or both.

Table V lists 10 other identifiable adverse factors in management that were prevalent before admission to hospital.

TABLE V—Identifiable adverse factors in prehospital phase of illness

	% of patients in whom factor identified
(1) Self referral to casualty department	30
(2) Telephone advice was sole contact with general practitioner	10
(3) Lack of specific instructions given to stop feeds and give fluids	47
(4) Inappropriate use of antibiotics	18
(5) Inappropriate use of antidiarrhoeal agents	26
(6) Non-use of commercially available electrolyte preparations (usually Dioralyte*)	70
(7) Incorrect use of Dioralyte—parents continued to feed child and give Dioralyte at same time	51
(8) Lack of understanding of seriousness of gastroenteritis—for example, dehydration, mortality—or cause—for example, thought due to teething	43
(9) Delay in seeking medical help ≥ day 4	14
(10) Overestimation of clinical severity and dehydration by general practitioner	Very common

*Dioralyte: sodium chloride 200 mg, potassium chloride 300 mg, sodium bicarbonate 300 mg, dextrose 8 g.

Discussion

In 1967 the most commonly isolated micro-organism in infantile gastroenteritis was the enteropathogenic *E coli*, which accounted for 16% of cases.¹ In the vast majority of children no pathogens were isolated (non-specific gastroenteritis). In our study the prevalence of non-specific gastroenteritis was much less common. Rotavirus was the most common agent identified.

Hypernatraemic dehydration was a major complication of infantile gastroenteritis in the late 1960s and early 1970s and was linked to the administration of incorrectly reconstituted artificial milk feeds and high solute drinks during the diarrhoeal illness and to the widespread early introduction of mixed feeding.^{1 3 4} Anxiety over these practices resulted in efforts to encourage breast feeding, introduce modified (low solute) milk feeds, and discourage early solid feeding. By the mid-1970s a definite trend toward a declining incidence of hypernatraemic dehydration was becoming apparent.^{5 6} Our study confirms that infantile gastroenteritis is now a milder illness with a much lower incidence of complications such as dehydration, hypernatraemia, uraemia, and acidosis (table VI). This is so despite the widespread prevalence of factors contributing to suboptimal management before admission to hospital.

Many of these factors are preventable through educational methods—for example, instructing the mother that electrolyte mixtures are for replacement of fluid. In particular was the low compliance with the widely established (but unproved) guidelines relating to diet in acute gastroenteritis—namely, a period of withdrawal of solid and milk feeds coupled with the administration of a correctly reconstituted electrolyte fluid oral replacement regimen for one or two days, followed by gradual reintroduction of the infant's normal diet.

Given that the questionnaire used was a reasonably reliable means of obtaining information on feeding regimens before

admission there are two possible explanations for our findings. The first is that the disease had become milder. Alternatively, that the children came to hospital earlier in the illness (and received a regimen of withdrawal of milk and solids for 24 hours and replacement therapy with an electrolyte preparation) may have reduced the incidence of dehydration that would otherwise have occurred. Indeed, in our region the duration of symptoms is short before admission but does not appear to have decreased when compared with some studies (table VI). Furthermore both regional (Hospital Activity Analysis data for North Western Regional Health Authority, 1983) and other figures² have shown an increase in children admitted to hospital for infantile gastroenteritis despite a fall in the birth rate. Possibly general practitioners are reluctant to treat children at home. The reason may be connected with the advent of vocationally trained family doctors, many of whom will have had paediatric training in hospital and might reasonably be expected to be more aware of the possible adverse consequences of infantile gastroenteritis.

For most children with acute gastroenteritis the type of diet and fluids given apparently have little effect on the course and outcome of the illness; nevertheless, continuation of the child's normal diet and inadequate volume replacement appears to disturb adversely the biochemical and clinical parameters of dehydration, and in individual children this may be particularly noticeable. Our findings confirm the need for a well designed clinical trial to determine the most suitable fluid and dietary regimen in acute gastroenteritis.⁷

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TABLE VI—Comparative data from four studies

Reference	% aged:		% with moderate to severe dehydration	% with sodium ≥ 150 mmol (mEq)/l	% with urea > normal	% with bicarbonate ≤ 16 mmol (mEq)/l	% with convulsions	Mortality rate	% staying ≥ 15 days	% with preadmission symptoms ≥ 3 days
	< 6 months	< 12 months								
Ironside <i>et al</i> ¹	50	71	18	15	88	56	4	1.5	20	NA
Tripp <i>et al</i> ¹¹	69	NA	27	14	43	21	3	1.3	25	NA
Pullan <i>et al</i> ⁶	NA	64	19	13	NA	NA	0.7*	0.6	NA	62
Present study	47	74	14	1	8	4	1	0	8	52

*Only inpatient data available. NA = Data not available.