Cryptosporidiosis in England and Wales: prevalence and clinical and epidemiological features

Public Health Laboratory Service Study Group

Abstract

In a two year study carried out by 16 public health laboratories in England and Wales 62 421 patients with presumed infective diarrhoea were investigated. Cryptosporidium infection was identified in 2% (1295), ranging from 0·5% to 3·9% among laboratories. The positivity rate for cryptosporidium was highest in 1-4 year olds, and in children cryptosporidium was the second commonest pathogen after campylobacter. Illness was usually limited to abdominal cramps and watery diarrhoea with six motions/24 hours at worst and lasting seven days. Fewer than half the patients reported fever or vomiting. More severe illness with fever, abdominal cramps, vomiting, and watery diarrhoea of frequency greater than five motions in 24 hours was reported by only a tenth of cases but with a significantly increased prevalence in young adult males.

One hundred and fifty five patients (12%) probably acquired their infection abroad; 102 (9%) of patients who acquired their infection at home reported drinking raw milk in the month before onset, and 253 (22%) reported close contact with farm animals. Most laboratories experienced sudden infrequent increases in incidence in the community, only one of which was attributed to a recognised outbreak, which occurred in a nursery.

Cryptosporidium should be routinely sought by laboratories investigating acute infectious diarrhoea, especially in children; up to a quarter of cases may be directly zoonotic, and the remainder may be due to person to person spread and waterborne infection.

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Introduction

Cryptosporidium, an intestinal parasitic protozoon, was first identified as a human pathogen in 1976.[1] Up to 1981 only seven cases of cryptosporidiosis in humans had been published.[2] Since then the AIDS epidemic has stimulated interest in this important cause of severe intractable diarrhoea in immunocompromised patients.[3] Subsequent surveys in selected groups of immunocompetent patients with acute diarrhoea showed cryptosporidium to be one of the commonest causes of infectious diarrhoea, although wide variations in prevalence have been reported.[4-7] One possible explanation for differences in prevalence that must be considered is differences in laboratory identification methods, experience, and skill.

To establish the importance of cryptosporidium as a human pathogen; to describe age, sex, and seasonal and geographical trends; and to record clinical and epidemiological details of cases the Public Health Laboratory Service set up a two year surveillance study beginning in July 1985, in which 16 laboratories in England and Wales participated. Standard protocols were used both for screening and for confirmation of infection.

Methods

Fifteen laboratories undertook to examine all faecal samples from patients with presumed acute infectious diarrhoea for cryptosporidium oocysts. The remaining laboratory (Leeds) screened faecal samples submitted on one day of each week.

The protocol required that all samples be examined for salmonella, campylobacter, and shigella by routine methods. When the study was set up no generally agreed screening method was used for cryptosporidium; new techniques were being developed. We therefore decided to allow laboratories to choose one of the following three screening methods for staining faecal smears, which we considered to be of comparable sensitivity: (*a*) the modified Ziehl-Neelsen method,[8] (*b*) the auramine-carbol fuchsin method,[8] and (*c*) the carbol (phenol) auramine method.[9] All faeces positive for cryptosporidium by methods (*b*) or (*c*) on screening were confirmed by the modified Ziehl-Neelson method. At the outset of the study laboratories agreed to submit the first 10 positive faecal samples identified to Rhyl Public Health laboratory for confirmation. The Rhyl laboratory also supplied positive facecal samples for comparison. Each week laboratories reported the number of patients (rather than samples), investigated by age and sex, to the Communicable Disease Surveillance Centre. Laboratory staff sought to complete a questionnaire for each patient with cryptosporidiosis, which until January 1987 included clinical details.

The positivity rates[10] (number of patients with infection/total number examined) reported here are confined to patients investigated through their general practitioners, although clinical and epidemiological data were obtained from questionnaires from community and hospital cases.

Results

Fourteen laboratories continued the study for two years, and two laboratories continued for 10 months and 13 months respectively. Data were missing for only 14 (1%) of the 1548 laboratory weeks of reporting. Eleven laboratories used the modified Ziehl-Neelsen screening method, three used the auramine-carbol fuchsin method, and two used the carbol (phenol) auramine method.

Over the two years of the study 62 421 patients with presumed acute infectious diarrhoea were investigated through their general practitioners; 1295 (2%) were excreting cryptosporidia, 4775 (8%) campylobacter, 2050 (3%) salmonella and 437 (0·7%) shigella (table I). Twenty five patients with cryptosporidiosis were also excreting campylobacter, four were excreting salmonella, 10 giardia, one shigella, and two enteropathogenic *Escherichia coli*. The positivity rate for cryptosporidium by laboratory varied from 0·5% to 3·9% and was not correlated with the screening method. Higher rates tended to be reported by laboratories serving a more rural population. The number of cases of cryptosporidiosis identified by laboratories correlated significantly with isolations of campylobacter ($r=0·82$; $p<0·01$) and also salmonella ($r=0·79$; $p<0·01$) in those laboratories, but not that of shigella ($r=0·28$; $p>0·05$).

The positivity rate for cryptosporidium was highest in children aged 1-4 years (5%), whereas that for campylobacter was highest in 15-24 year olds (11%), for salmonella was highest in 15-44 year olds (4%), and for shigella was highest in 5-14 year olds (2%) (table II). In children cryptosporidium was the second commonest pathogen to campylobacter, and was almost twice as common as salmonella and four times as common as shigella.

A clear seasonal incidence was not found in either the number or proportion of cryptosporidium infections, in contrast to the distinct summer peaks in incidence of campylobacter (July) and salmonella (August) infections. Three peaks of identifications of cryptosporidium occurred: in June 1986, December 1986, and June 1987. When monthly incidence patterns were examined for each laboratory (excluding Leeds and Middlesbrough) four laboratories (Dorchester, Salisbury, Shrewsbury, and Wolverhampton) had fairly constant monthly rates of isolation of cryptosporidium, with fewer than 10 cases in any month. In the 10 other laboratories there were one or two sharp peaks over the two years of the study, but in only one did a peak coincide with a defined outbreak (in a nursery). The other peaks represented community wide increases.

Questionnaires were completed for 1283 patients with cryptosporidiosis, which included 79% of patients not admitted to hospital and 77% of those in hospital. Overall, 241 (19%) of all patients with cryptosporidiosis from whom a questionnaire was received were admitted to hospital, including 26 (35%) infants, 96 (19%) 1-4 year olds, 49 (22%) 5-14 year olds, and 11 (52%) patients aged 65 and over. Only 23 (2%) patients were reported to be immunocompromised, and only two were reported to be positive for HIV antibody.

Clinical data were reported for 1041 patients identified before January 1987. The predominant symptoms were watery diarrhoea and abdominal cramps. About half the patients reported vomiting and anorexia, and only a third reported fever (table III). Vomiting was commoner in children, and abdominal cramps and fever were commoner in teenagers and young adults. The severity of diarrhoea as measured by the maximum frequency of bowel motions in a 24 hour period increased from six in children to nine in 25-34 year olds (table IV). The average duration of diarrhoea was nine days (range of 1 to 90 days). Infants and patients aged 65 and over had the longest mean duration of diarrhoea (12 days); the lowest duration (7 days) was in patients aged 15-24 and 45-54. Full clinical details were available for 20 immunosuppressed patients, whose mean duration of diarrhoea was nine days (range 2 to 36 days) and mean maximum number of stools was nine in 24 hours.

More severe illness, as defined by the presence of watery diarrhoea with at least six (median) bowel motions per 24 hours, abdominal cramps, fever, and vomiting was reported by 107 (10%) patients, including only two patients reported to be immunosuppressed. The mean duration of diarrhoea in these cases was eight days. A disproportionate number of more severe cases was reported in adults aged 15-44; of 107 patients, 47 (44%) reported more severe illness compared with 279 (30%) of the remaining 934 patients ($\chi^2=8\cdot2$; $p=0\cdot004$). This increased proportion was confined to males (25/58 patients *v* 107/477, $\chi^2=10\cdot8$; $p=0\cdot001$). Prolonged diarrhoea (>21 days) was reported in only 45 (4%) patients, 27 (60%) of whom were aged 1-4 years. There was no correlation between

TABLE I—*Two year study of patients with presumed acute infective gastroenteritis investigated by general practitioners, England and Wales*

Laboratory	Type of population	No of patients investigated	No (%) of patients positive for: Cryptosporidium	Campylobacter	Salmonella	Shigella
Bath	Mainly rural	9140	132 (1·4)	614 (6·7)	227 (3·0)	72 (0·8)
Brighton	Mainly urban	3703	81 (2·2)	297 (8·0)	117 (3·2)	23 (0·6)
Coventry	Mainly urban	6142	146 (2·4)	430 (7·0)	176 (2·9)	15 (0·2)
Dorchester	Mainly rural	2202	59 (2·7)	248 (11·3)	80 (3·6)	6 (0·3)
Epsom	Mainly rural	3775	125 (3·3)	455 (12·1)	112 (3·0)	28 (0·7)
Leeds	Mainly urban	2165	19 (0·9)	143 (6·6)	82 (3·8)	10 (0·5)
Middlesbrough	Mainly urban	578	3 (0·5)	7 (1·2)	12 (2·1)	8 (1·4)
Nottingham	Mainly urban	6996	144 (2·1)	547 (7·8)	246 (3·5)	42 (0·6)
Poole	Mainly urban	4978	75 (1·5)	451 (9·1)	164 (3·3)	14 (0·3)
Rhyl	Mainly rural	2451	95 (3·9)	239 (9·8)	177 (7·2)	24 (1·0)
Salisbury	Mainly rural	2285	59 (2·6)	150 (6·6)	41 (1·8)	6 (0·3)
Sheffield	Mainly urban	3723	57 (1·5)	368 (9·9)	129 (3·5)	3 (0·1)
Shrewsbury	Mainly rural	4597	120 (2·6)	402 (8·7)	168 (3·7)	10 (0·2)
Stoke on Trent	Mainly urban	5237	73 (1·4)	251 (4·8)	165 (3·2)	134 (2·6)
Tooting	Mainly urban	2832	78 (2·8)	75 (2·6)	57 (2·0)	36 (1·3)
Wolverhampton	Mainly urban	1617	29 (1·8)	98 (6·1)	47 (2·9)	6 (0·4)
Total		62421	1295 (2·1)	4775 (7·6)	2050 (3·3)	437 (0·7)

TABLE II—*Positivity rate for cryptosporidium, campylobacter, salmonella, and shigella by age of patient, as assessed by PHLS laboratories, England and Wales*

Age (years):	<1	1-4	5-14	15-24	25-34	35-44	45-54	55-64	≥65	Not known
Total No investigated	4090	9880	4822	8235	9048	6710	4492	3846	5432	5866
No (%) patients positive for:										
Crypto spordium	79 (1·9)	480 (4·9)	210 (4·4)	160 (1·9)	155 (1·7)	83 (1·2)	32 (0·7)	12 (0·7)	21 (0·4)	63 (1·1)
Campylobacter	123 (3·0)	551 (5·6)	368 (7·6)	905 (11·0)	875 (9·7)	672 (10·0)	378 (8·4)	311 (8·1)	262 (4·8)	330 (5·6)
Salmonella	99 (2·4)	221 (2·2)	157 (3·3)	358 (4·3)	359 (4·0)	280 (4·2)	155 (3·5)	119 (3·1)	114 (2·1)	118 (2·0)
Shigella	14 (0·3)	96 (1·0)	100 (2·1)	42 (0·5)	62 (0·7)	43 (0·6)	26 (0·6)	18 (0·5)	8 (0·1)	28 (0·5)

TABLE III—*Main symptoms of cryptosporidiosis. Figures are numbers (percentages) of patients*

Age (years):	<1	1-4	5-14	15-24	25-34	35-44	45-54	55-64	≥65	Not known	Total
Total No of patients	59	422	179	130	128	58	24	7	21	13	1041
Diarrhoea:											
Watery	47 (80)	317 (75)	154 (86)	103 (79)	113 (88)	48 (83)	22 (92)	7	18 (86)	10 (77)	839 (81)
Loose stools	12 (20)	93 (22)	19 (11)	23 (18)	13 (10)	8 (14)	1 (4)	0	2 (10)	2 (15)	173 (17)
Fever	16 (27)	146 (35)	65 (36)	44 (34)	53 (41)	35 (60)	7 (29)	2 (29)	5 (24)	1 (8)	374 (36)
Abdominal cramps	14 (24)	198 (47)	134 (75)	107 (82)	97 (76)	46 (79)	16 (67)	3 (43)	6 (29)	8 (62)	629 (60)
Vomiting	33 (56)	212 (50)	104 (58)	61 (47)	58 (45)	23 (40)	10 (42)	1 (14)	4 (19)	4 (31)	510 (49)
Nausea	8 (14)	59 (14)	73 (41)	77 (59)	80 (63)	36 (62)	12 (50)	2 (29)	8 (38)	5 (38)	360 (35)
Anorexia	21 (36)	217 (51)	98 (55)	58 (45)	74 (58)	36 (62)	14 (58)	3 (43)	7 (33)	5 (38)	534 (51)

TABLE IV—*Duration of diarrhoea and maximum frequency of bowel motions in patients with cryptosporidiosis*

Age (years):	<1	1-4	5-14	15-24	25-34	35-44	45-54	55-64	≥65	Not known	Total
Duration of diarrhoea (days)											
Mean	12	11	9	7	8	9	7	11	12	13	9
Range	1-50	1-90	1-40	1-30	1-70	1-34	2-19	1-20	1-24	1-50	1-90
Median	10	7	7	5	5	7	5	10	10	6	7
Mode	7	7	7	2	2	3	3	1	1	1	7
No of patients	39	308	127	84	83	42	15	2	14	9	723
Maximum frequency of bowel motions per 24 hours											
Mean	6	6	6	8	9	7	8	3	6	11	7
Range	2-20	1-24	1-20	1-30	1-50	1-30	2-20	1-6	2-20	4-20	1-50
Median	3	5	6	5	6	4	2	1	2	10	5
Mode	6	5	5	6	7	5	6	3	5	10	6
No of patients	45	319	129	90	97	48	20	5	15	7	775

more severe illness and hospital admission once the increased admission rate for infants and the elderly was taken into account, and duration of diarrhoea in patients in hospital was on average 1·5 days shorter than other patients (8·2 days *v* 9·7 days, $p<0·05$).

One hundred and fifty five patients (12%) had been overseas in the month before onset of the diarrhoea and had probably acquired their infection overseas. Of the remaining 1087 cases acquired in the United Kingdom, 102 patients (9%) reported drinking raw milk in the month before onset, of whom 68 (6%) reported close contact with farm animals in the month before onset, as did an additional 185 (17%). Of cases acquired in the United Kingdom, 31% of the children aged 1-4 and 37% of those aged 5-14 reported exposure to farm animals or raw milk. Of the patients on whom clinical data were reported, 20 of 136 who acquired the disease overseas reported severe illness compared with 87 of 818 others ($\chi^2=2·8$; $p=0·09$). There was no difference in the severity of symptoms in patients who had acquired the infection from exposure to farm animals or raw milk compared with other patients.

Of the 1283 patients from whom questionnaires were received, 335 (26%) were followed within 2 weeks after onset by 527 other household cases of diarrhoea, but in only 6 (13%) of these was cryptosporidiosis confirmed. There were five nursery outbreaks (24 confirmed cases) reported, one outbreak associated with a child minder (four confirmed cases), two school outbreaks (two confirmed cases), two school trip outbreaks (two confirmed cases), one family centre outbreak (one confirmed case), and one playschool outbreak (one confirmed case).

Discussion

In this study cryptosporidiosis usually occurred in immunocompetent people who developed abdominal pain and watery diarrhoea. The diarrhoea was fairly mild with an average of nine motions per day, lasting for nine days. We did not find any correlation between severity of symptoms and duration of diarrhoea. More severe illness was commoner in young adult men but we cannot say whether this was due to a greater susceptibility, perhaps due to underlying HIV infection, or whether younger men were possibly less likely to consult their general practitioner for less severe disease. Only two patients, however, were reported to be positive for HIV antibody. In the few patients reported to be immunosuppressed the symptoms were similar and no more severe. We did not see the life threatening continuous diarrhoea that has been reported in patients with AIDS[3] nor did we find that the elderly had more severe disease as has been reported.[11] The severity of the disease was not different in cases in which infection was presumed to be directly zoonotic and in others. Infections acquired overseas tended to be more severe, but the difference was not significant. A fifth of patients identified as having cryptosporidiosis were admitted to hospital, but this seemed to be related to extremes of age rather than severity of symptoms, which were no worse than in patients who were not in hospital.

Our study showed that infection with cryptosporidium was almost as common as that with salmonella and almost three times more so than that with shigella. About 2% of all patients and 4% of children investigated were excreting cryptosporidium oocysts. This finding should encourage all diagnostic laboratories to screen faecal samples routinely for cryptosporidium, especially those from children. The percentage positives for campylobacter, salmonella and shigella are almost identical to those reported by Skirrow in a survey of six English laboratories in 1983-4.[10]

We found considerable variation among laboratories in the prevalence of cryptosporidium infection. Such comparisons must take into account differences in screening methods and the period of the year during which screening occurred. Furthermore, in our experience different laboratory staff have preferences for different screening techniques, and sensitivity and specificity of techniques depend partly on the experience and skill of the technician. To minimise laboratory variation in techniques the laboratories in our survey used one of three screening methods of broadly comparable sensitivity.[12] As screening methods were new to most laboratories at the start of the study we encouraged all laboratories to confirm their first identifications with staff at Rhyl Public Health Laboratory, who have developed special skills in laboratory diagnosis and who provided control positive faecal samples for comparison. More sensitive but laborious methods have been developed, including the use of monoclonal antibodies.[13]

Positivity rates for cryptosporidium correlated closely with isolation rates for campylobacter and salmonella but not with the rate for shigella, suggesting that the eightfold difference in positivity rates for cryptosporidium is not due to laboratory methods but to geographical variation in prevalence, which generally is higher in more rural areas. Cryptosporidium has epidemiological features in common with campylobacter, and 2% of patients were also excreting campylobacter. Common sources of infection may be possible, as was shown by an outbreak of dual infection in north Wales.[14]

Cryptosporidium is found in many species of animals and birds, but differences in pathogenicity for humans of isolates recovered from different species have not yet been evaluated. Zoonotic transmission from direct contact with infected animals has been reported.[15] We found that in 23% of cases acquired in the United Kingdom contact with farm animals was reported, and, although these were uncontrolled data, zoonotic sources might explain these infections. Spring and autumn peaks have been reported by some laboratories,[5,7,16] and these might be related to excretion patterns in animals such as cattle and sheep and possibly to farming practices such as sludge spreading. For example, Casemore found a significant association between spring cases of cryptosporidiosis and direct contact with newborn lambs.[17] When we plotted dates of onset of cases derived from questionnaire data, however, there was no consistent seasonal pattern for cases in which contact with farm animals had or had not been reported. A clear seasonal pattern, however, would not be expected, given the observation that most laboratories experienced infrequent and irregular sudden community wide increases in cryptosporidiosis. Such outbreaks are hard to explain by faecal-oral spread, and the possibility of common source infection must be considered. Outbreaks due to waterborne infection have been confirmed,[18-21] and this possibility is of growing concern in the United Kingdom.

Once introduced into a human population, cryptosporidium can spread readily by the faecal-oral route, especially in nurseries. Our data showed that up to a quarter of cases were followed by other cases of gastroenteritis in household members, which could have been due to secondary spread, although, unfortunately, faecal samples were often not submitted in these cases to confirm the nature of the infection. Transmission in households after infection of index cases from direct farm animal contact has been described.[22] Surveillance to identify community clusters and prompt investigation should be undertaken to identify sources of infection and possible preventive measures.

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Coronary arteriography in a district general hospital: feasibility, safety, and diagnostic accuracy

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Abstract

Objective—To determine the feasibility, safety, and diagnostic accuracy of coronary arteriography in the radiology department of a district general hospital using conventional fluoroscopy and videotape recording.

Design—Observational study of the feasibility and safety of coronary arteriography in a district general hospital and analysis of its diagnostic accuracy by prospective within patient comparison of the video recordings with cinearteriograms obtained in a catheter laboratory.

Setting—Radiology department of a district general hospital and the catheter laboratory of a cardiological referral centre.

Subjects—50 Patients with acute myocardial infarction treated with streptokinase who underwent coronary arteriography in a district general hospital three (two to five) days after admission. 45 Of these patients had repeat coronary arteriography after four (three to seven) days in the catheter laboratory of a cardiological referral centre.

Main outcome measures—Incidence of complications associated with catheterisation and the sensitivity and specificity of video recordings in the district general hospital (judged by two experienced observers) for identifying the location and severity of coronary stenoses.

Results—Coronary arteriograms recorded on videotape in the district general hospital were obtained in 47 cases and apart from one episode of ventricular fibrillation (treated successfully by cardioversion) there were no complications of the procedure. 45 Patients were transferred for investigation in the catheter laboratory, providing 45 paired coronary arteriograms recorded on videotape and cine film. The specificity of the video recordings for identifying the location and severity of coronary stenoses was over 90%. Sensitivity, however, was lower and for one observer fell below 40% for lesions in the circumflex artery. A cardiothoracic surgeon judged that only nine of the 47 video recordings were adequate for assessing revascularisation requirements.

Conclusions—Coronary arteriography in the radiology department of a district general hospital is safe and feasible. Nevertheless, the quality of image with conventional fluoroscopy and video film is inadequate and will need to be improved before coronary arteriography in this setting can be recommended.

Introduction

Vascular imaging is performed routinely in the radiology departments of many district general hospitals. Coronary arteriography, however, is restricted to specialist centres equipped with a catheterisation laboratory. Waiting lists are often long and patients with suspected coronary artery disease may have to