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ORIGINAL ARTICLES

Outbreak report

CRYPTOSPORIDIUM OUTBREAK LINKED TO INTERACTIVE WATER FEATURE, UK: IMPORTANCE OF GUIDELINES

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A need for national guidelines relating to interactive water features was highlighted following three outbreaks of cryptosporidiosis in the United Kingdom, all of which were related to public water features. In August 2003 the Health Protection Agency South West of England was notified of an outbreak of cryptosporidiosis associated with an interactive water feature designed for water play within an adventure park. The water feature was implicated following samples with a high coliform count and the presence of faecal coliforms.

A case was defined as any child (younger than 16 years of age) who had visited the park during August and who subsequently had gastrointestinal symptoms and a faecal sample positive for cryptosporidium. Seventy one children were identified in the cohort. This outbreak of cryptosporidiosis was characterised by a very high attack rate (89%), relatively severe in duration (median 8 days) and had a relatively high hospital admission (16% of cases). The epidemic curve was consistent with a point source of infection, which corresponded to the date 80% of the cohort visited the park. This outbreak has similarities to two other cryptosporidiosis outbreaks reported in England in 2003 that involved public water features. These outbreaks raise issues about the operation and maintenance of water-based recreational attractions that very often involve children. The paper reflects on the basic control measures that can be taken and highlights the need for guidelines, especially since such attractions are becoming increasingly common. The Pool Water Treatment Advisory Group has now produced guidelines.

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Key words: cohort, Cryptosporidium, interactive, outbreak

Introduction

In recent years there has been an increase in reported outbreaks of infectious diseases associated with public water features [1-6]. Cryptosporidium has been the principal pathogen in outbreaks in England and Wales [1,2]. However, *Shigella sonnei* [3], norovirus [4] and *Legionella pneumophila* [5, 6] have been implicated in similar outbreaks in other countries.

In August 2003 an outbreak of cryptosporidiosis was identified in children who had recently visited an adventure park in southwest England. The adventure park contained a number of activities involving contact with water (boats, log flume, interactive water features) and contact with farm animals. Following an earlier complaint from a visitor about the water quality of one of the interactive water features designed for water play, water sampling had revealed a high coliform count (2100 coliforms, 40 *E. coli* per cu mm). A cohort study was implemented to check whether there was any epidemiological evidence for a particular source within the adventure park.

Methods

The cohort population included all children (aged less than 16 years) among household members or friends of a probable or confirmed case who had visited the park with a case during August 2003. A probable case was defined as any child who had visited the park during August 2003 and who subsequently had gastro-intestinal symptoms including diarrhoea, blood in stools, vomiting, nausea, or abdominal pain. A confirmed case was defined as a probable case with a faecal sample positive for cryptosporidium. Children who had travelled abroad in the two weeks before the onset of symptoms were excluded from the study.

Cases were identified from laboratory reports to the Health Protection Agency (HPA). A standardised questionnaire was administered over the telephone with an adult in the family of a case. Exposure data included water exposure (contact duration, type of contact, type of water source), animal contact and food consumption. Data were analysed using Epi Info 6.04 [7]. A univariable analysis was run to assess the association between exposures investigated and onset of disease. As only one variable showed an association and as the numbers were small, multivariable analysis was not performed.

Ten-litre grab samples were taken from the various water features within the park for cryptosporidium oocyst detection by South West Water Ltd. Faecal samples from the farmyard animals were also submitted. Oocysts were detected by light microscopy. Positive specimens were sent to the HPA Cryptosporidum Reference Laboratory for genotyping.

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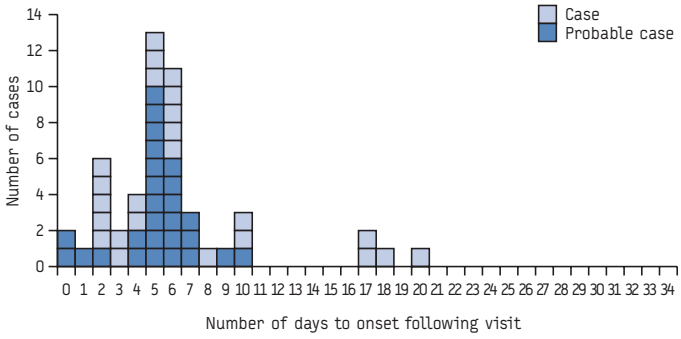
Results

Ninety one children were identified in the cohort, of whom 71 were contacted, giving a 78% response rate. Sixty three children (89%) met the case definition (27 confirmed and 36 probable cases). The sex distribution was even. Median age was 6 years (range 1-15). The most common symptom was diarrhoea (94%), followed by vomiting (64%), abdominal pain (62%), and nausea (51%). None of the children reported blood in stools. The median duration of illness was 8 days (range 1-18) and more than 30% of the children were still ill at the time of interview. Ten children (16%) required hospital admission.

Forty-six of the children who were cases (73%) had visited the park on 8 August, the date of symptom onset for the first case. Of the 51 children whose date of illness onset was known, 45 (88%) had a date of onset within one incubation period (1-10 days) of visiting the park [FIGURE].

FIGURE

Incubation periods for Cryptosporidium outbreak (n=51) in Devon, UK, August 2003



Dates of onset were between 8 and 29 August, and the outbreak peaked on 13 and 14 August. For two of the four cases with date of onset more than 10 days after visiting the park, other household members had had gastrointestinal symptoms in the 10 days before onset. The two probable cases with onset date on date of visit became ill during the evening after leaving the adventure park.

The exposure yielding the strongest association with illness was contact with the interactive water feature [TABLE] (RR= 1.8, CI 95% 0.45 to 7.31, p=0.06). No specific type of contact with this source of water was significantly associated with illness. This feature involved being sprayed with recirculated water. Children often entered the feature fully clothed and with their shoes on. Nineteen children drank the recycled water and one parent reported that the water 'smelt like drains'. The filtration and disinfection systems were not adequate to cope with high levels of contamination, and the water feature was closed on 21 August, soon after the start of this investigation.

Samples from 23 of the 27 confirmed cases were sent for genotyping. Sixteen yielded a result and 14 of these were *Cryptosporidium parvum* genotype 2. The initial sample from the interactive water feature contained a single oocyst that could not be genotyped. Although a subsequent sample from this feature when not in operation was positive and identified as *Cryptosporidium parvum* genotype 2, there was insufficient DNA for subtyping. Due to a failure of communication, faecal samples taken from animals resident in the park were not tested for cryptosporidium.

Discussion

This outbreak of cryptosporidiosis was characterised by a high attack rate (89% in the cohort studied), long duration of illness (median 8 days) and high proportion admitted to hospital (16%). The dates of onset were consistent with a common source of infection from an exposure in the adventure park. The analytical study showed an association between exposure to water in the interactive water feature and illness. Although the strength of the evidence was reduced due to the small numbers in the unexposed group, the finding was supported by the microbiological results and environmental observations. No association with other water sources or animal contact was detected. It seems likely that water in the interactive water feature became contaminated with faeces containing cryptosporidium oocysts, either from the footwear of users or from an unidentified primary case. These oocysts then continued to circulate in a viable condition as a result of ineffective filtration and disinfection.

In response to the outbreak, the park reviewed and revised health and safety risk assessments to manage and control the risk from protozoan parasites. The design of the water treatment and disinfection system was improved. The park also provided additional drinking fountains around the park and asked children to remove footwear before entering the interactive water feature. They improved signage, instructing visitors at all water-related attractions not to drink the water.

This outbreak has similarities to two others reported in England in 2003 involving public water features. The first, which also occurred in southwest England, involved four cases of cryptosporidiosis in children who had played in a fountain.

TABLE

Risk associated with exposures in adventure park (n=71), United kingdom, August 2003

Exposure	Risk among exposed	Risk among not exposed	Risk Ratio (CI 95%)	P
Animal contact	**36/40**	**27/31**	**1.03 (0.87 to 1.23)**	**0.7**
Small animal petting area	20/22	10/11	1.00 (0.80 to 1.23)	0.3
Small animal and reptile handling	8/8	18/20	1.11 (0.96 to 1.27)	1.0
Farm animal petting area	24/27	5/5	0.89 (0.78 to 1.02)	1.0
Young farm animal petting area	6/7	20/21	0.90 (0.65 to 1.23)	0.0
Water contact in park	**63/71**	**0 Not exposed**	**Not calculated**	**Not calculated**
Log flume	34/42	27/29	0.92 (0.79 to 1.08)	0.3
Boats	14/16	48/54	0.98 (0.80 to 1.21)	0.9
Interactive feature	62/68	1/2	1.82 (0.45 to 7.31)	0.06
River walk	12/13	48/54	1.04 (0.86 to 1.25)	0.7
Contacts in Log flume				
Hand/face	14/16	17/21	1.08 (0.82 to 1.43)	0.7
Body Only	20/25	7/7	0.8 (0.66 to 0.97)	0.6
Drank	4/4	24/29	1.21 (1.02 to 1.43)	1.0
Contacts in Interactive feature				
Hand/face	54/59	1/1	0.92 (0.85 to 0.99)	0.8
Body only	15/16	11/11	0.94 (0.83 to 1.06)	0.4
Drank	18/19	30/34	1.07 (0.91 to 1.26)	0.4

The water feature comprised two separate water bodies with separate holding tanks and water treatment systems using bromide and sand filtration. A large pool with water to a depth of 20cm was used as a paddling pool, although it was not intended for this purpose. Cryptosporidium oocysts were isolated from all four cases and detected in water samples taken from the fountain.

The second outbreak, which occurred in central England, was linked to a newly opened purpose-built interactive water feature, and involved 122 cases. More than 80% (102) of those infected were under 15 years old. Thirty five (85%) of 41 cases tested for cryptosporidium were positive. Indicator organisms of faecal contamination were identified from the water but no cryptosporidium oocysts were recovered.

These outbreaks raised issues about the lack of national guidance on operation and maintenance of water-based recreational attractions, which have now been addressed by the United Kingdom Pool Water Treatment Advisory Group [8]. The principal public health measure for preventing infections and outbreaks associated with these devices is risk assessment and management. The principal microbiological risks are cryptosporidiosis from inadequate filtration, and bacterial and viral infections, including legionella, from inadequate disinfection. This guidance proposes design and operational standards for filtration, chlorination and reducing contamination hazards.

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ORIGINAL ARTICLES

Outbreak report

OUTBREAK OF *E. COLI* O157 INFECTION IN THE SOUTH WEST OF THE UK: RISKS FROM STREAMS CROSSING SEASIDE BEACHES

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In August 2004 seven cases of Escherichia coli O157 infection were identified in children on holiday in Cornwall, southwest England, all of whom had stayed at different sites in the area. Isolates from all seven cases were confirmed as *E. coli* serogroup O157 phage type 21/28. We carried out a case-control study among holidaymakers who visited the beach. A standardised questionnaire was administered by telephone to parents. They were asked where on the beach the children had played, whether they had had contact with the stream that flowed across the beach, and about their use of food outlets and sources of food eaten. Cases were more likely to have played in the stream than controls (OR [1.72- undefined]). The time spent in the stream by cases was twice spent there by controls. Cases and controls were equally exposed to other suspected risk factors. PFGE profiles for all the cases were indistinguishable. Increased numbers of coliforms were found in the stream prior to the outbreak. Cattle were found grazing upstream. We suggest that the vehicle of infection for an outbreak of acute gastrointestinal illness caused by *E. coli* O157 was a contaminated freshwater stream flowing across a seaside beach. The onset dates were consistent with a point source. Heavy rainfall in the days preceding the outbreak might have lead to faeces from the cattle potentially contaminated by *E. coli* O157 contaminating the stream, thereby leading to the outbreak. Control measures included fencing off the part of the stream in which children played, and putting up warning signs around the beach.

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Introduction

Human infection with verocytotoxic *Escherichia coli* O157:H7 (*E. coli* O157) is associated with clinical illness ranging from non-bloody diarrhoea to haemolytic uraemic syndrome (HUS) and death. It is the most common cause of renal failure in children [1,2]. It is transmitted to humans through contaminated food, water, and direct contact with infected people or animals [2-4]. The infectious dose is very low, under 100 organisms [2,5]. *E. coli* O157 is one of the most commonly identified causes (25% in 2002) of recreational fresh water-associated outbreaks involving gastroenteritis in the United States [6].

In August 2004 seven cases of *E. coli* O157 infection were identified in children who had been on holiday in Cornwall (resident population 500 000), a popular holiday destination in southwest England. Initial investigations found that the patients had been camping at different sites but had all played in a stream flowing across the same beach within a period of a few days. Isolates from all seven cases were