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A mixed outbreak of cryptosporidium and campylobacter infection associated with a private water supply

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SUMMARY

In an outbreak of gastroenteritis affecting 43 people, cryptosporidium and campylobacter were isolated from stool specimens and in two cases dual infection was found. All the cases had drunk unboiled water from a private untreated water supply.

Investigations revealed the carcasses of three lambs in a collection chamber connected with the water supply, and these, or run-off of slurry from surrounding fields, were the presumed source of contamination. Issues relating to the maintenance and monitoring of private water supplies are discussed. Problems with such supplies include old piping, proximity of livestock, inadequate knowledge of the layout and limited resources for monitoring and maintenance.

INTRODUCTION

Campylobacter infection is the commonest laboratory reported bacterial cause of diarrhoea in humans in England and Wales [1]. Infection with cryptosporidium is another important, though less common, cause of diarrhoea [1]. Both infections are believed to be transmitted by the faecal-oral route following contact with infected animals, or by the ingestion of contaminated water or foodstuffs [2, 3]. Person-to-person spread of cryptosporidium has been documented [4, 5], but is thought to be unusual for campylobacter [6]. However, in many cases the epidemiology is unclear, and sources of infection are seldom identified.

The investigations of outbreaks of infection with either of these agents may provide useful insights into the spread of these organisms. Outbreaks of dual infection are particularly interesting in that they may implicate a common source or mode of transmission for both pathogens. Such outbreaks are rarely reported, however [7]. We describe an outbreak of gastroenteritis in which both campylobacter and cryptosporidium were isolated from the faeces of infected individuals, and where contaminated water was implicated as the vehicle of infection.

THE OUTBREAK

On the 20 May 1993 a general practitioner requested the Department of Public Health Medicine in Northumberland to investigate an outbreak of diarrhoea and vomiting affecting a party of foreign students staying in self-catering accommodation in a wing of a mediaeval building. Forty-five students and nine tutors were resident in this building; meals were taken communally by students and tutors on week days, with students preparing meals in an organized rota. At weekends, students and staff were self-catering using the same facilities, or eating out at local commercial establishments. A private water supply

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served the mediaeval manor, which contained a cafeteria open to the public and residential accommodation for the landowner and the students and tutors, in addition to a number of estate houses.

METHODS

Epidemiological methods

Enquiries to the local general practitioners and the single local microbiology laboratory did not reveal any concerns about the incidence of gastroenteritis in the general population of the twon. The case definition was therefore initially restricted to anyone resident in the accommodation wing who had developed symptoms of diarrhoea and/or vomiting in the week beginning 15 May 1993.

The student residence was visited and general enquiries about catering arrangements and hygiene practices were made. A kitchen inspection was carried out and details of menus prepared in the previous week were obtained. Food histories were taken from those individuals who had been symptomatic. It was noted that the private water supply had been routinely tested in February 1993 and had been found to be satisfactory.

Faeces microbiology methods

Where possible, stool specimens were collected from all symptomatic people. The day after the investigation began, the majority of resident students left on holiday and were thus unable to provide faeces samples. Faeces samples were cultured for salmonella, shigella and campylobacter, examined for cryptosporidium cysts using a phenol-auramine stain, and submitted for electron microscopy and cell culture to detect viruses.

Environmental methods

Water specimens from the building were collected, and 100 ml aliquots were examined by the membrane filtration technique [8], to identify and quantify *Escherischia coli* as a marker of faecal contamination. Following the isolation of cryptosporidium and campylobacter from several of the cases, three 10 l water samples were tested specifically for the presence of campylobacter by a similar filtration technique, and a 400 l sample of water was examined for the presence of cryptosporidium cysts. This involved filtering the sample through a 1 μm cartridge filter (Cartouche Filtrante), followed by examination of the filtrate by an immunofluorescent monoclonal antibody test (Shield Diagnostics).

Information was obtained concerning the nature and extent of the private water supply. Later in the course of the investigation, when there were indications that the outbreak was water-borne, detailed inspections of the water supply were carried out.

RESULTS

Epidemiological results

The first 4 cases were on 16 May 1993; on every subsequent day for the next 10 days more people became ill (Fig. 1). By the end of the outbreak, 32 students and 6 tutors living in the accommodation block had reported illness, as had 5 other people resident elsewhere in the estate. Symptoms ranged from mild abdominal discomfort with nausea to severe vomiting and diarrhoea. No bloody diarrhoea was reported. Three young women were admitted to hospital for rehydration therapy. The duration of symptoms was 2–14 days with a median of 6 days.

In total, 200 residents were served by the private water supply, and the overall attack rate was 22%. One hundred and twenty people live or work in the mediaeval building, and 30 of these became ill (an attack rate of 32%); 80 people were resident in other properties served by the water supply, and 5 of these became ill (an attack rate of 6%).

Faeces microbiology results

Of the 20 stool specimens submitted for examination from symptomatic cases, 11 contained pathogens: *Campylobacter jejuni* was isolated in 5 cases, cryptosporidium was isolated in 4 cases, and in 2 cases both organisms were isolated (Table 1). No viruses were isolated from the faeces samples submitted. No other cases of campylobacter or cryptosporidium infection were reported in May 1993 in the surrounding local authority district which has a population of 30000.

Results of environmental investigations

The water system dated from the 19th Century, and drew its supply from several springs in the locality

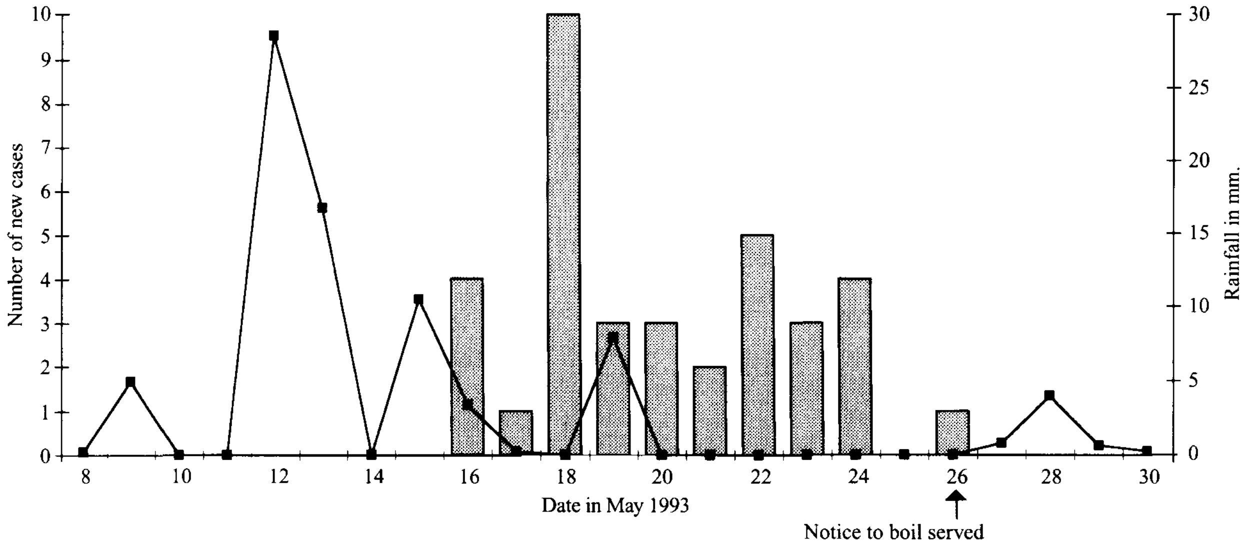

Fig. 1. Epidemic curve of outbreak, showing number of new cases per day, and daily rainfall (millimetres).

Table 1. *Microbiological investigations of patients and water samples*

Location (see Fig. 2)	*E. coli* count per 100 ml	Number of residents	Number of cases of gastroenteritis	Microbiologically confirmed cases of infection*
Spring	0	0	0	—
Farm 1	1	31	0	—
Farm 2	1	20	0	—
Farm 3	0	4	0	—
Storage chamber	13	0	0	—
Farm cottages 1	85	4	1	—
Farm cottages 2	Not available	21	4	—
Mediaeval manor	112 (highest of several counts)	120	38 (including 1 workman)	5 cases campylobacter, 4 cases cryptosporidium, 2 cases dual infection, (20 samples submitted)

* —, Not appropriate, or no samples submitted.

(Fig. 2). Much of the Victorian piping had been replaced in 1986 with modern plastic pipes; some of the springs were also disconnected from the system at this time. The original Victorian cast-iron pipes had been left in place, and a plug in the collection chamber shown in Figs 2 and 3 served to disconnect them from the part of the system still in use.

High *E. coli* counts were obtained from water samples taken from the student residence and adjacent buildings. Following the isolation of *E. coli* from water samples taken in the mediaeval building, further samples were taken from several points served by the same supply. These yielded high counts of *E. coli* at and downstream from the large storage chamber (see Table 1, Fig. 2); with very low or zero counts in samples from above this. This suggested contamination in or near the storage chamber. A search of the area by environmental health officers and estate workers revealed three dead lambs in a collecting chamber of a spring (Fig. 3). This collection chamber contained the plug which was intended to disconnect the spring and the old piping from the new system: this plug was found to have perished. A marker was added to the water in the collection chamber and confirmed the connection between the spring and the storage chamber 70 m away. Unfortunately, the carcasses of the lambs were destroyed before microbiological specimens could be obtained. No campylobacters or cryptosporidia were detected in the water samples examined.

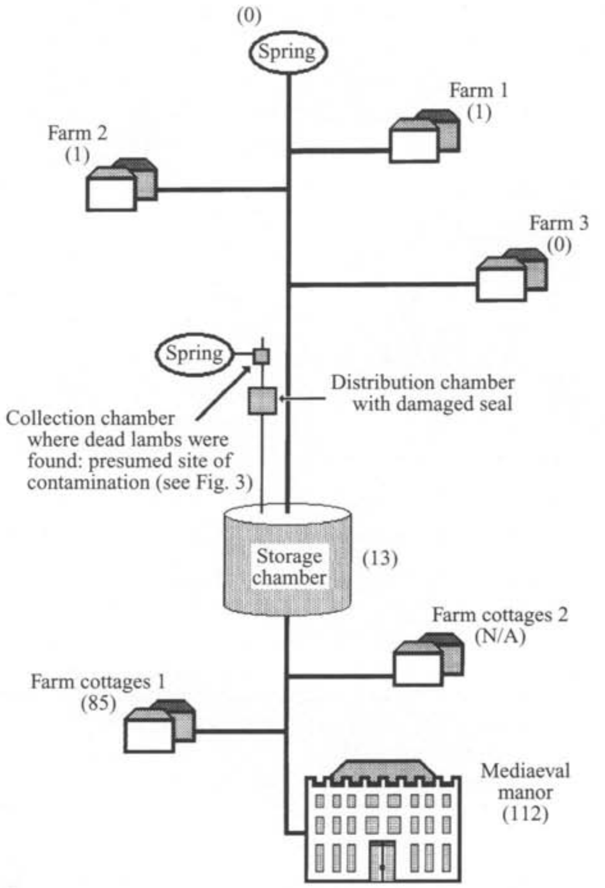

Fig. 2. Diagram of the estate water supply with *E. coli* counts at different sampling points, and indicating the presumed point of contamination. The numbers in brackets refer to the *E. coli* count per 100 ml in the water sample at each site. Not to scale: the distance from the main spring to the mediaeval manor is approximately 7 km.

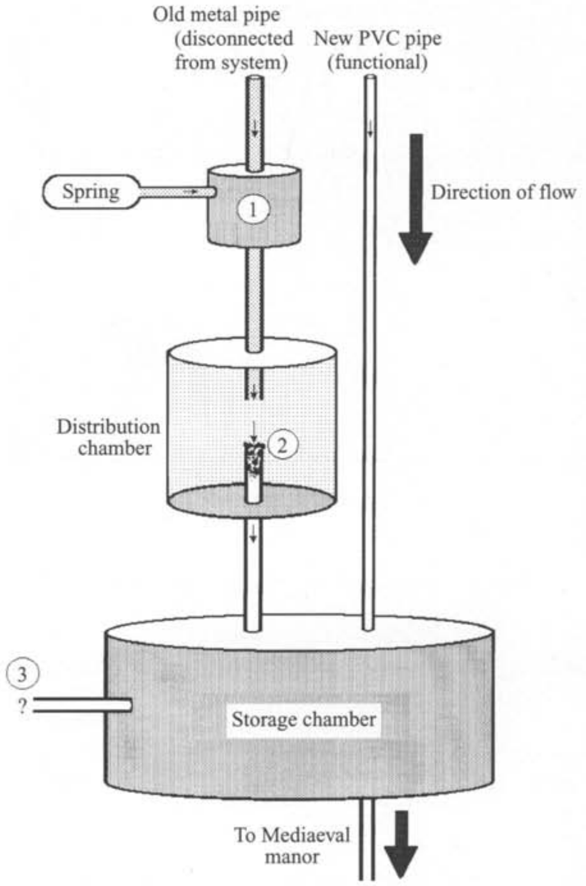

Fig. 3. Diagramatic representation of the layout of water supply at the point of contamination (not to scale). *Key*: 1, Collection chamber where dead lambs were found; 2, Damaged plug in distribution chamber; 3, Additional inlet into storage chamber of unknown origin.

During the course of the subsequent operations to decontaminate the water supply, a further inlet into the large storage chamber from an unknown source was discovered (Fig. 3). It also emerged that the pasture surrounding the storage and collection chambers had been spread with slurry 5 days before the first cases became symptomatic, just before a period of unusually heavy rainfall (Fig. 1); this suggested that contaminated surface water may have polluted the water supply.

There was some variation in the number of *E. coli* isolated from the various outlets below the storage chamber and the presumed point of contamination, with the highest levels found in the kitchen in the student accommodation. For people consuming water below the point of contamination, the overall attack rate was 30% (43 out of 145 residents). In the student accommodation wing the attack rate was much higher at 70% (38 out of 54 residents). An explanation for the variation in the level of contamination and in the subsequent clinical attack was sought.

Water outlets in the student residence and in the cafeteria were protected by a 5 μm filter and an ultraviolet light. However, the UV light at the outlet in the students' kitchen, where the highest *E. coli* count was found, had a brown deposit coating the inner quartz sleeve, reducing UV transmission into the water. Another outlet in a lavatory within the building was untreated. One of the estate workers, symptomatic with campylobacter infection, had regularly drunk from this source.

The manufacturers of the water sterilizer units, in their instructions on the maintenance of this equipment, emphasize that sterilization of water by UV light depends on adequate penetration, which is not possible if the water is cloudy or the glass dirty. Thus they recommend that the quartz tube encasing the ultraviolet light source is kept clean, and that the filter is replaced when water flow becomes unacceptably low. If the light source is switched on permanently, they recommend routine replacement ever 6 months. In this outbreak, it would appear that the filters and lamps were replaced appropriately, but due attention was not paid to the build-up of deposit on the quartz tube.

CONTROL MEASURES

Following the results of the water microbiology, a notice to boil water was issued to all properties served by the private water supply. Subsequently only one further person became ill, and this was within one day of the issue of the boil notice. The land owner arranged for a private contractor to empty and desludge the water chambers, and to disinfect the water supply, a process which took a number of weeks. This was followed by regular monitoring of the water supply.

DISCUSSION

This outbreak was attributed to water borne infection involving a private water supply. The epidemic curve supports the hypothesis of a continuing source of the infective agents, although secondary person-to-person transmission of cryptosporidium infection has been described [5] and may also have occurred amongst the resident students. Contamination of the water supply at a level just above the storage chamber was indicated by the presence of *E. coli* below this level. We could not distinguish whether the infection originated from the lamb carcasses or slurry runoff, both being equally plausible sources of campylobacter and cryptosporidium [5]. Whatever the source, contamination of the drinking water supply probably occurred through the damaged plug during heavy rainfall during a 2-day period in mid-May, although we cannot exclude contamination via the additional inlet into the large reservoir. The failure to isolate campylobacter or cryptosporidium from the water supply may be explained by the technical difficulties in isolating these organisms from water, and also by the interval between the presumed time of contamination and the collection of specimens.

The failure of the water sterilizers emphasizes the need for thorough routine maintenance of such systems, including removal of any deposit which may reduce UV light penetration. A well maintained system would be expected to make water bacteriologically safe; however, even with adequate maintenance, 5 μm filtration and standard treatment with UV light will not remove or sterilize cryptosporidium oocysts (D. P. Casemore, written communication). These oocysts have also been shown to be resistant to the routine chlorination procedures used in treating public water supplies [9]. Thus the best way to prevent water-borne cryptosporidium infection is to prevent any initial pollution of the water system with contaminated surface water or livestock waste. Because of the difficulties in the detection of cryptosporidium oocysts in water, routine testing is not recommended [10].

This outbreak highlights some of the difficulties associated with private water supplies. The same microbiological standards apply to public and private water supplies [11–13]. However, such standards may be more difficult to achieve, maintain and enforce in private supplies because of their varied history and nature. Difficulties encountered in maintaining the quality of private water supplies include old piping and seals, inadequate information on the layout of the systems, inadequate resources for maintenance, and the close association with livestock, with the consequent risk of contamination by animal faeces or carcasses. These problems are of course not unique to private supplies: the report of Smith and colleagues [14] describes a similar outbreak in a treated public supply, with old, inadequately documented piping and problems of slurry run-off. Although the Private Water Supply Regulations [11] impose a duty on local authorities in England and Wales to monitor private water supplies, limited resources and large numbers of supplies to be tested mean that testing is infrequent. In Northumberland, three local authorities have over 1500 private water supplies to monitor: ideally these are tested at least once a year, but even this is sometimes difficult to achieve. As this report demonstrates, routine testing in accordance with the regulations may still fail to guarantee against episodic contamination, for example by surface water at times of heavy rainfall. In addition, once a private supply is identified as unsatisfactory, the active cooperation of the land-owner is necessary if improvements are to be made. Such cooperation was readily forthcoming in this outbreak, however this may not always be the case, as the recommended improvements may involve considerable expense.

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