An outbreak of *Campylobacter* enteritis on an island resort, north Queensland

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Abstract

An outbreak of *Campylobacter* enteritis among staff on a resort island in north Queensland is reported. Untreated rainwater and food from the staff dining room were initially suspected as possible sources of infection but *Campylobacter* species were not isolated from any environmental samples. Faecal contamination was detected in four rainwater tanks. A case control study involved a total of 23 cases (7 confirmed and 16 probable), 3 of whom required hospitalisation. There was a strong association between gastrointestinal illness and consumption of water from a dispenser in the staff restaurant that had probably been filled from one of the contaminated tanks. We conclude that this was probably a waterborne outbreak and postulate that *Campylobacter* species were introduced into one or more of the tanks by contamination with the faeces of wild animals. *Commun Dis Intell* 1999;23:215-219.

Introduction

Campylobacter is a common cause of gastrointestinal illness in Australia[1] and overseas,[2,3] and while the majority of cases are sporadic in nature, outbreaks are occasionally detected. This report describes an outbreak of *Campylobacter* enteritis among staff on an island resort in north Queensland for which untreated rainwater was the likely source of infection. Waterborne outbreaks of *Campylobacter* enteritis are well documented[2-10] but, to the best of the authors' knowledge, have not previously been reported in Australia.

The setting for this outbreak was a large island off the north Queensland coast. The only population centre on the island was a tourist resort that had over 600 staff and 900 guests resident at the time. Food was available to guests from 14 restaurants and four cafes, and there was one staff restaurant. A reticulated water supply distributed a mixture of chlorinated dam water and the output from a reverse-osmosis plant, and staff also had access to a number of untreated rainwater tanks. Staff were accommodated in a variety of widely separated quarters, some of which had food preparation facilities. Domestic animals were banned on the island but birds, bats and other native animals were abundant.

The Tropical Public Health Unit (TPHU) was notified on 17 June 1997 when *Campylobacter* was isolated from the faeces of a resort employee admitted to the district hospital. Preliminary investigations identified a further two staff members who had been admitted with abdominal pain and diarrhoea in the preceding week, both of whom subsequently had *Campylobacter* isolated. The resort's medical practitioner identified over 20 additional staff members who had presented with gastrointestinal illness during the same period. No visitors with gastrointestinal illness were seen. Further environmental, microbiological and epidemiological investigations were then initiated by TPHU staff to define the circumstances of the outbreak.

Investigations

Environmental investigations

Environmental Health Officers (EHOs) arrived at the resort on 19 June. The staff restaurant and all guest restaurants were inspected and, in the staff restaurant, swabs from bench tops and samples of pre-cooked diced chicken and chicken leg were collected.[11] These were forwarded to the Centre for Public Health Sciences, Brisbane (CPHS) for *Campylobacter* isolation. Samples were analysed using Prestons *Campylobacter* broth and subsequent subculture onto Prestons Agar.[12] There were no food samples remaining from the meals served prior to the outbreak.

Seven functioning rainwater tanks were identified (designated Tanks 1 to 7). All tanks drained directly from adjacent rooftops and none were routinely treated. Water samples were collected from as many as possible between 19 and 22 June. Samples for routine microbiological analysis were collected from Tanks 2, 3 and 4 and from the reticulated supply. A separate collection of up to 1,000 mL was obtained from Tanks 2, 3, 4, 5 and 6 for *Campylobacter* isolation. Samples were collected directly from taps into sterile containers and were transported on ice to CPHS to arrive within 24 hours of collection. Taps were not flamed prior to sample collection. Where there was sufficient volume, *Campylobacter* isolation was attempted using two different methods:

(i) filtration through a 45 micron filter followed by suspension of the filter in Prestons *Campylobacter* broth; and

(ii) centrifugation of the water to produce a concentrated sample which was then placed on a 65 micron filter overlaid on a blood agar plate.

The plate was incubated at 37^{0}C for 20 minutes then the filter paper was removed. The blood agar plate was then incubated in a special atmosphere (80% nitrogen, 10% hydrogen, 10% carbon dioxide) at 37^{0}C. This second method was designed to detect non-thermophylic *Campylobacter* species.

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Tank 1 had been emptied on 19 June, prior to the arrival of the EHOs, but they were able to obtain a sample of sludge from the bottom of the tank, which was submitted to CPHS for *Campylobacter* isolation. In addition, the Water Treatment Officer on the island had collected water from the tank immediately prior to the tank being emptied. It was subjected to routine microbiological analysis at a private laboratory used by the resort, and a portion was subsequently forwarded to CPHS for *Campylobacter* isolation.

Staff also had access to drinking water from dispensers at several locations. These were inverted clear plastic containers with a capacity of approximately 20 litres that were available commercially but were capable of being refilled from other sources. One such dispenser was available in the staff restaurant. Water samples were not collected from these dispensers because they were not suspected as potential sources of infection during the initial investigation.

Microbiological investigations

The EHOs requested faecal specimens from all staff with a recent history of gastrointestinal illness. Eleven samples were obtained and transported on ice to CPHS for *Campylobacter* culture. Isolates of *Campylobacter jejuni* were then further analysed. Penner sero-groups were determined using specific *Campylobacter jejuni* antisera (Mast Diagnostics) by extracting the heat-stable lipopolysaccharide O antigens from the isolates and reacting these against sensitised chicken red blood cells. In addition, the genetic relatedness of isolates was compared with Pulsed Field Gel Electrophoresis (PFGE), using Sma1 as a cutting enzyme.[13]

Epidemiological investigations

A case control study was initiated on 7 July as initial testing did not identify a source of infection. Potential cases were identified using the list compiled by the EHOs on their initial visit, from other staff being questioned, and from a complete review of records maintained by the medical practitioner on the island. Resort management had written to all staff at the time of the outbreak requesting that those with gastrointestinal symptoms immediately attend the doctor. People who developed their illness after a household member were considered to be secondary cases and were therefore excluded. In addition, because Tank 1 had been emptied on 19 June, those who became unwell after 24 June were also excluded.

Confirmed cases were defined as staff members with onset of a compatible clinical illness between mid-May and 24 June who had *Campylobacter jejuni* isolated from their faeces. Probable cases were staff members who became unwell between mid-May and 24 June with an illness consisting of either diarrhoea for two or more days or at least four of the following; diarrhoea for one day, nausea, vomiting, stomach pain, fever, headache, myalgia or malaise. Diarrhoea was defined as two or more loose watery stools per day. Controls were adult staff members who had been at the resort during the outbreak but did not meet the criteria for cases and had not shared a room with a case. They were nominated by cases or approached directly at their place of residence to ensure that the different staff accommodation areas were equally represented among cases and controls.

The following details were collected: name, date of birth, sex, accommodation, occupation, symptoms, treatment, and time off work. Potential exposures were sought from cases for the week prior to their illness and from controls for the week prior to the onset of illness in a case from the same accommodation area. Potential exposures sought were: source of water for drinking, dining at the staff restaurant, other sources of food, contact with animals and use of swimming pools. All who had eaten at the staff restaurant were asked about specific foods consumed there. Detailed menus for this period were unavailable, however the restaurant served a limited number of dishes on a weekly cycle and it was possible to establish a generic list of dishes served. This list was used to aid recall.

Cases and controls were not individually matched but were grouped by accommodation area and unmatched analyses

Table 1. Bacterial isolates from analyses of water samples, by water source

Water source	*Campylobacter* isolation	Routine microbiological analysis	
		Coliform count (colonies per 100mL	*E. coli* count (colonies per 100ml)
Tank 1	Not isolated*	500#	55#
Tank 2	Not isolated	51	13
Tank 3	Not isolated	Positive♦	Positive ♦
Tank 4	Not isolated	Positive♦	27
Tank 5	Not isolated	Not tested	Not tested
Tank 6	Not isolated	Not tested	Not tested
Tank 7	Not tested	Not tested	Not tested
Reticulated supply	Not tested	Not detected	Not detected

*Two samples tested: a water sample forwarded from a private laboratory and sludge from the bottom of the tank

result from private laboratory (all other results were from the CPHS)

♦ Detected but no count was possible due to the presence of confluent growth.

were performed using Epi Info.[14] Matched analyses were also performed.

Results

Environmental results

Significant food hygiene problems were identified in the staff dining room kitchen. Food residues had collected on several bench surfaces as a result of inadequate cleaning and few staff understood the correct storage temperatures for food or the dangers of cross-contamination. There was also no quality assurance program in place to monitor the safe handling and preparation of food.

Microbiological results

Campylobacter species were not isolated from the bench swabs or the food samples from the staff restaurant, nor from any of the water samples. However, Tanks 1 to 4 all showed evidence of faecal contamination, with particularly high coliform counts noted in Tank 1 (Table 1). There was no evidence of faecal contamination of the reticulated water supply.

Campylobacter jejuni was isolated from seven cases and all isolates were subjected to further testing. Two genetically distinct 'pulsovars' were identified by PFGE. Within each pulsovar isolates were genetically indistinguishable. All 5 isolates in one pulsovar were Penner sero-group O(19), and of the 2 in the other pulsovar, 1 was Penner sero-group G(8) and the other was un-groupable. There were therefore at least 2 distinct strains of *Campylobacter jejuni* involved in this outbreak.

Epidemiological results

The case control study identified 23 people who met the case definition (7 confirmed and 16 probable cases), all of whom were resort staff. Twenty-four controls were interviewed.

Most cases had their onset in the period 7 to 17 June, but there were a few cases in late May (Figure 1). The most common symptoms were nausea (100%), diarrhoea (96%), abdominal pain (96%) and fever (87%). Other symptoms included headache (61%), vomiting (39%), joint pain (22%) and blood in faeces (17%). Symptoms lasted from 1 to 28 days, with a median duration of 4 days.

Nearly three-quarters (74%) of cases required time off work, ranging from 1 to 28 days (median of 2 days and an overall total of 93 days). Three cases were admitted to the district hospital, one of whom had an appendicectomy. There were no deaths.

Cases and controls had similar age characteristics. The median age of cases was 25.5 years (range 19.4-60.4), and for controls was 25.3 years (range 17.9-57.7). No

Figure 1. Cases of illness included in the epidemiological investigation, by date of onset and confirmation of *Campylobacter* diagnoses

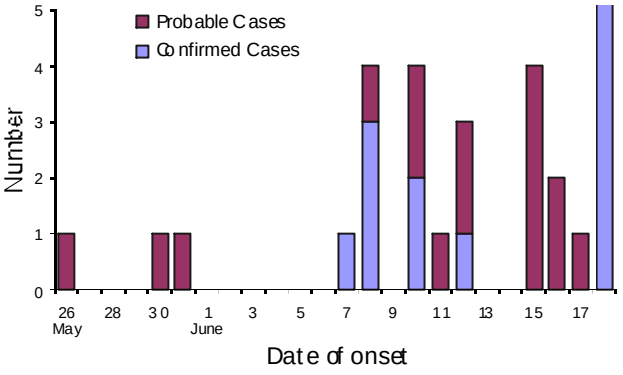

Table 2. Number of cases and controls, by exposure to potential sources of infection, contains matched and unmatched analyses

Exposure	Confirmed cases (n = 7)	Probable cases (n = 16)	Total cases (n = 23)	Controls (n = 24)	Unmatched OR (for total cases)	Cornfield 95% CI	Matched OR (for total cases)	Exact 95% CI
Staff restaurant dispenser	7	10	17	6	8.5	1.92 - 40.8	12.0	1.78 - 512.97
Tank 1	5	15	13	8	2.6	0.68 - 10.28	7.0	0.9 - 315.48
Tank 2	0	2	2	1	2.19	0.14 - 67.33	-	
Tank 3	0	1	1	2	0.5	0.02 - 8.03	-	
Tank 4	0	4	4	2	2.32	0.3 - 21.14	2.0	0.29 - 22.3
Tank 5	0	4	4	5	0.8	0.15 - 4.28	0.75	0.11 - 4.43
Tank 6	0	2	2	1	2.19	0.14 - 67.33	-	
Tank 7	0	0	0	0	-			
Any tank water	5	15	20	14	4.76	0.93 - 27.34	4.5	0.93 - 42.8
Tank 1 sources	7	12	19	10	6.65	1.45 - 33.06	11.0	1.60 - 473.47
Contaminated sources	7	14	21	12	10.5	1.71 - 83.27	-	

children were affected. There were more females among cases than in the control group (69.6% vs. 45.8%, p=0.1)

The strongest association between gastrointestinal illness and a single water source was with the water dispenser in the staff restaurant (OR 8.5, CI 1.9-40.8) (Table 2). All 7 confirmed cases and 10 of the 16 probable cases recalled drinking from the dispenser in the week prior to their illness. Restaurant employees reported that the dispenser had been filled from a rainwater tank in the period prior to the outbreak, however it is not possible to be absolutely sure which tank was used for this purpose. Tank 5 had been the usual source of water for the dispenser, but it had twice run dry during this time. Records from the Bureau of Meteorology are consistent with this. Rainfall totals for the island for the months of March, April and May were 402.1 mm, 71.3 mm and 73.4 mm respectively and for the fortnight starting 17 May a total of only 15.2 mm of rain was recorded. One employee reported that Tank 1, which was the closest tank to the restaurant, had probably been used in early June and it is thus possible that the dispenser was filled with water from Tank 1 immediately prior to the outbreak.

Drinking water obtained directly from any one rainwater tank was not significantly associated with illness but associations were also tested for 'grouped' sources of untreated drinking water. Tank 1 and the staff restaurant water dispenser were grouped as 'Tank 1 sources' on the basis that the dispenser was probably filled from this tank. A second group of 'contaminated sources' included each of the four tanks with demonstrated faecal contamination (Tanks 1 to 4) and the staff restaurant water dispenser. Being a case was associated with drinking water from either the 'Tank 1 sources' (OR 6.65, CI 1.45-33.1) or from the 'contaminated sources' (OR 10.5, CI 1.7-83.3).

Analysis of the association between illness and eating food at the staff restaurant was confounded by the presence of the water dispenser. For those who did not drink water from the dispenser, there was no significant association between illness and eating at the restaurant (OR 2.0, CI 0.2-21.7). No significant associations with specific foods were identified. No unpasteurised dairy products had been consumed.

Staff with access to cooking facilities were asked to identify the source of any food used when preparing their own meals. No associations between illness and food sources were identified.

None of those questioned reported contact with pets and there was minimal contact with other animals.

Response to the outbreak

Resort management cooperated with efforts to investigate and curtail the outbreak. They wrote to all staff in the main accommodation areas on 17 June to advise them of the outbreak and to warn that rainwater was a suspected source of infection. Staff were advised not to consume rainwater and to empty any existing containers. All those with symptoms were requested to immediately attend the island doctor. Island staff drained and removed Tank 1 on 19 June, and several other tanks had taps locked or removed. Management subsequently agreed that water dispensers should not be filled from rainwater tanks.

In response to the food handling issues identified, a number of staff were immediately replaced and a series of staff training sessions run by EHOs were initiated. These commenced in July 1997 and involved one of the first 'Foodsafe' food handler training programs in Australia. This joint development by the Australian Institute of Environmental Health and Healthway (Western Australia) was designed to improve food safety practices in commercial premises and may be implemented on a nationwide basis. In addition, management has instigated an extensive program of structural improvement within food premises on the island.

Discussion

The epidemiological and microbiological data from this investigation indicate that untreated rainwater was the most likely source of *Campylobacter* infection in this outbreak. Outbreaks of *Campylobacter* infection have been traced to contaminated water sources in Europe,[2,6,8,9] North America,[4,5,7] New Zealand[10] and elsewhere, but the authors are not aware of any previous reports from Australia.

The epidemiological evidence that this was a waterborne outbreak is strong. Gastrointestinal illness was significantly associated with drinking water from each of the following:

(i) the 'contaminated sources' (that is, the staff restaurant water dispenser and Tanks 1 to 4);

(ii) the 'Tank 1 sources' (that is, the staff restaurant water dispenser and Tank 1); and

(iii) the staff restaurant water dispenser alone. This dispenser was being refilled with tank water prior to the outbreak.

The microbiological evidence is not conclusive but the presence of faecal contamination in Tanks 1 to 4 supports the possibility that *Campylobacter* species were also present in one or more of these tanks. However, *Campylobacter* species were not isolated from any of the water samples in this investigation and other outbreaks of *Campylobacter* enteritis presumed to be waterborne on epidemiological grounds, have had similar difficulties.[2,4,5,10] These factors all underline the need to develop more sensitive detection techniques. *Campylobacter* species are notoriously difficult to culture from food and environmental sources, partly due to their ability to enter a non-cultivatable state.[15] The development of specific molecular-based methodologies for detection of *Campylobacter* species in such samples, and the demonstration of viability when they are detected, will offer more accurate identification of these organisms than currently available with standard cultural detection methods.

The source of faecal contamination in Tanks 1 to 4 is not known but possibilities include birds, bats and possums whose faeces could have collected on the roofs or in the gutters associated with these tanks. *Campylobacter* have been found in the intestines of many domestic and wild animals including rodents and a variety of birds,[16,17] and faecal droppings from such infected animals can introduce *Campylobacter* into water supplies.[5,6] We postulate that the droppings of wild animals contaminated one or more of the rainwater tanks with *Campylobacter* and that the dispenser was filled from a contaminated tank. Tank 1 was the most likely source, but this cannot be proven.

At least two distinct strains of *Campylobacter jejuni* were involved in this outbreak. Multiple strains have been

reported in other outbreaks[7,8,9] and this may reflect contamination by animals carrying more than one strain.

Other potential sources of infection were considered, including food from the staff dining room, food prepared by self-catering staff, direct contact with animals and swimming pools. No significant associations with illness were identified for any of these factors.

This outbreak resulted in substantial morbidity and time off work and raises a number of additional public health issues. It is a reminder that untreated rainwater is a potential source of infection for pathogens such as C*ampylobacter* and is a risky source of drinking water. Furthermore, while food was not implicated in this outbreak, the investigation did identify food handling practices that posed a considerable risk for foodborne illness. These were directly addressed at the staff restaurant and a broad ongoing program is being introduced at this resort and others like it.

This investigation was subject to a number of limitations. The delay between onset of illness and the case control study was over four weeks for some cases, and this may have affected the accuracy of recall for food and water consumed. This was, to some extent, mitigated by the use of food lists when the questionnaire was administered and by the publicity given to both the restaurant food and rainwater tanks as possible sources of infection at the time of the outbreak. Most cases and controls were certain about which water sources they had used and whether they had eaten at the staff restaurant. There was less certainty about specific foods consumed. The fact that *Campylobacter* were not isolated from any environmental samples and that no water sample was available from the water dispenser in the staff restaurant were also problematic.

In summary, untreated rainwater contaminated by the faeces of wild animals appears to have been the source of infection in this outbreak of *Campylobacter* enteritis.

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References

1. Crerar SK, Dalton CB, Longbottom H, Kraa E. Foodborne disease: current trends and future surveillance needs in Australia. *Med J Aust* 1996;165:672-675.
2. Pebody RG, Ryan MJ, Wall PG. Outbreaks of *Campylobacter* infection: rare events for a common pathogen. *Comm Dis Rep CDR Rev* 1997;7:R33-R37.
3. Lane L, Baker M. Are we experiencing an epidemic of *Campylobacter* infection? *Comm Dis NZ* 1993;93:57-63.
4. Alary M, Nadeau D. An outbreak of *Campylobacter* enteritis associated with a community water supply. *Can J Public Health* 1990;81:268-271.
5. Sacks JJ, Lieb S, Baldy LM, et al. Epidemic Campylobacteriosis associated with a community water supply. *Am J Public Health* 1986;76:424-429.
6. Palmer SR, Gully PR, White JM. Water-borne outbreak of *Campylobacter* gastroenteritis. *Lancet 1983*;i:287-290.
7. Taylor DN, McDermott KT, Little JR, Blaser MJ. *Campylobacter* enteritis from untreated water in the Rocky Mountains. *Ann Intern Med* 1983;99:38-40.
8. Melby K, Gondrosen B, Gregusson S, Ribe H, Dahl OP. Waterborne Campylobacteriosis in northern Norway. *Int J Food Microbiol* 1991; 12:151-156.
9. Jones IG, Roworth M. An outbreak of *Escherichia coli 0157* and Campylobacteriosis associated with contamination of a drinking water supply. *Public Health* 1996;110:277-282.
10. Stehr-Green JK, Nicholls C, McEwan S, Payne A, Mitchell P. Waterborne outbreak of *Campylobacter jejuni* in Christchurch: the importance of a combined epidemiologic and microbiologic investigation. *NZ Med J* 1991;104:356-358.
11. Davey JA. Sampling for microbiological analysis. In: Buckle KA, Davey JA, Eyles MJ et al, editors. Foodborne microorganisms of public health significance. 4th ed. Pymble: Australian Institute of Food Science and Technology, 1989.
12. Australian Standard 1766.2.13. Food microbiology: examination for specific organisms –*Campylobacter.* Sydney: Standards Association of Australia, 1991.
13. Tenover FC, Arbeit RD, Goering RV et al. Interpreting chromosomal DNA restriction patterns using pulsed field gel electrophoresis: criteria for bacterial strain typing. *J Clin Microbiol* 1995;33:2233-2239.
14. Dean AG, Dean JA, Coulombier D et al. Epi Info, version 6: a word processing, database and statistics program for epidemiology on microcomputers. Centre for Disease Control and Prevention, Atlanta, Georgia, USA, 1994.
15. Rollins DM, Colwell RR. Viable but nonculturable stage of *Campylobacter jejuni* and its role in survival in the natural aquatic environment. *Appl Environ Microbiol* 1986;52:531-538.
16. Pearson AD, Healing TD. The surveillance and control of *Campylobacter* infection. *Comm Dis Rep CDR Rev* 1992;2:R133-R139.
17. Blaser MJ. *Campylobacter* and related species. In: Mandell GL, Bennett JE, Dolin R. Principles and practice infectious diseases. 4th ed. New York: Churchill Livingstone, 1995:1948-1954.