Reported waterborne outbreaks of gastrointestinal disease in Australia are predominantly associated with recreational exposure

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Reports of waterborne outbreaks of gastroenteritis are rare in Australia,¹⁻³ and, unlike the situation in the US^{4,5} and the UK,^{6,7} there have been no reviews of water-associated outbreaks. OzFoodNet – an Australian national network for the surveillance of foodborne diseases⁸ – has collated information on outbreaks of gastroenteritis for all transmission routes since 2001. The purpose of collecting summary reports of outbreaks is to assist with policy development.⁸ The aim of this brief report is to review national data on waterborne outbreaks of gastrointestinal disease.

Methods

OzFoodNet epidemiologists in each State and Territory health department collected summary reports on all gastroenteritis outbreaks and these were entered into a Microsoft Access database – the Outbreak Register. Although it is recognised that there is inevitable non-uniformity in outbreak identification and classification, outbreak reports recorded as ‘waterborne’ or ‘suspected waterborne’ from 2001 to 2007 were extracted. Simple descriptive statistics were performed in Stata (Stata Statistical

Software, Release 10, StataCorp, College Station, TX).

The outbreaks were assessed for their levels of evidence using criteria developed by Tillett et. al. in 1998 for waterborne diseases outbreaks (Table 1).⁹

Results

During the seven-year period OzFoodNet recorded a total of 6,515 gastroenteritis outbreaks affecting approximately 136,000 people. The majority of these were classified as being transmitted person-to-person or from an unknown source. Fifty-four (0.83%) outbreaks were classified as either ‘waterborne’ (44, 81.5%) or ‘suspected waterborne’ (10, 18.5%).

Drinking water was the suspected source for 19% (10/54) of the outbreaks and 78% (42/54) were attributed to recreational water (Tables 2 and 3). The remaining two outbreaks were attributed to an unknown source and aquarium water exposure, respectively (Table 2). Most outbreaks occurred during the summer months (Figure 1).

Of the 10 gastroenteritis outbreaks attributed to drinking water, six occurred at camps, three in aged care facilities and one in a public rural bore water supply

Abstract

Objective: To examine the frequency and circumstances of reported waterborne outbreaks of gastroenteritis in Australia.

Method: Examination of data reported to OzFoodNet between 2001 and 2007.

Results: During these seven years, 6,515 gastroenteritis outbreaks were reported to OzFoodNet, most of which were classified as being transmitted person-to-person or from an unknown source. Fifty-four (0.83%) outbreaks were classified as either ‘waterborne’ or ‘suspected waterborne’, of which 78% (42/54) were attributed to recreational water and 19% (10/54) to drinking water. Of the drinking water outbreaks, implicated pathogens were found on all but one occasion and included *Salmonella* sp. (five outbreaks), *Campylobacter jejuni* (three outbreaks) and *Giardia* (one outbreak).

Conclusions: There have been few waterborne outbreaks detected in Australia, and most of those reported have been associated with recreational exposure. However, there are difficulties in identifying and categorising gastroenteritis outbreaks, as well as in obtaining microbiological and epidemiological evidence, which can result in misclassification or underestimation of water-associated events.

Implications: Gastroenteritis surveillance data show that, among reported water-associated gastroenteritis outbreaks in Australia, recreational exposure is currently more common than a drinking water source. However, ongoing surveillance for waterborne outbreaks is important, especially as drought conditions may necessitate replacement of conventional drinking water supplies with alternative water sources, which could incur potential for new health risks.

Key words: outbreaks, surveillance, waterborne, recreational, OzFoodNet, Australia.

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Figure 1: Months in which waterborne gastroenteritis outbreaks occurred from 2001 to 2007.

(Table 2). These outbreaks resulted in 189 cases of illness, three hospitalisations and one death. *Salmonella* sp. was implicated in five outbreaks, *Campylobacter jejuni* in three, *Giardia* in one, and one was due to an unknown pathogen. The median size of the outbreaks was 20 people (range three to 46). The median age of those affected by each outbreak ranged from seven to 87 years old (median of 14 years old) (Table 2).

Of the 42 outbreaks attributed to recreational water, 41 were reported to be due to *Cryptosporidium* contamination in swimming pools, and *Salmonella* Litchfield was implicated in the other. Forty of the outbreaks were recorded in Victoria, 30 of which were during

Table 1: Waterborne disease outbreak classification system (adapted from Tillett⁹).

Criteria	Association
A: Pathogen identified in clinical cases is also found in water.	Strongly associated if (A + C) or (A + D) or (B + C)
B: Water quality failure and/or water treatment problem of relevance but outbreak pathogen is not detected in water.	Probably associated if (B + D) or C only or A only
C: Evidence from an analytical (case-control or cohort study) demonstrates association between water and illness.	Possibly associated if B only or D only
D: Descriptive epidemiology suggests that the outbreak is water related and excludes obvious alternative explanations.	

Table 2: Drinking water and other waterborne outbreaks of gastroenteritis reported to OzFoodNet from 2001-2007.

State/Year	Definition	Source	Setting	Organism	Reported cases			Evidence	Level of evidence ^a
					Number	Lab confirmed	Median age		
QLD 2001	suspected waterborne	Unconfirmed	Aged care	<i>Salmonella Muenchen</i>	3	3	.	Microbiological (faeces)	probable
QLD 2004 ^a	waterborne	Aquarium	Private residence	<i>Salmonella</i> Para B bv Java	2	2	2	Microbiological (faeces + water)	strong
VIC 2004	suspected waterborne	Suspected tank water	Aged care	<i>Campylobacter jejuni</i>	7	3	82	Microbiological (faecal + below standard water)	possible
NSW 2005	suspected waterborne	Suspected rainwater tank or bore water	Health spa/resort	<i>Giardia lamblia</i>	12	3	7	Microbiological (faeces + below standard water)	probable
QLD 2005	suspected waterborne	Tank water	Aged care	<i>Salmonella</i> subsp IIIb 61.i:z35	8	8	87	Microbiological (faeces + water)	strong
QLD 2005	waterborne	Bore water	Rural town water supply	<i>Salmonella</i> Saintpaul	19	19	14	Microbiological (faeces + water) Epidemiological (case control study)	strong
VIC 2005	suspected waterborne	Suspected bore water	Camp	<i>Campylobacter</i>	22	8	15	Microbiological (faeces + water) Epidemiological (cohort study)	strong
QLD 2006	waterborne	Tank water	Camp	<i>Campylobacter jejuni</i>	46	11	11	Microbiological (faeces + below standard water) Epidemiological (cohort study)	strong
SA 2006 ^a	waterborne	Unspecified	Institution/ individual household	<i>Cryptosporidium</i>	19	4	–	Microbiological (faeces)	possible
QLD 2007	waterborne	Bore water	Camp	<i>Salmonella</i> Saintpaul	24	6	–	Microbiological (faeces + water)	strong
VIC 2007	suspected waterborne	Creek water	Camp	Unknown	21	0	17	Microbiological (water) Epidemiological (cohort study)	probable
VIC 2007	waterborne	Tank water	Camp	<i>Salmonella</i> Typhimurium	27	10	13	Microbiological (faeces + water) Epidemiological (cohort study)	strong

Notes: All outbreaks were identified on the basis of case series, unless otherwise stated in 'Evidence'.

Missing data = –

a) Not from a drinking water source.

2006. One large outbreak of cryptosporidiosis reported in NSW included several smaller pool-associated clusters. The median size of the outbreaks was five people (range two to 254) and the median age of those affected in each outbreak ranged from 1 to 24 years old (median of 5 years old). A total of 561 people were reported ill, 25 were hospitalised, and there were no deaths.

Epidemiological investigations were attempted for 50% (5/10) of drinking water-associated outbreaks as compared to 2.3% (1/42) of the recreational water outbreaks. Microbiological investigations identified pathogens from both faecal and water samples in five drinking water outbreaks, with three others reporting microbiological evidence of poor-quality water. All but three recreational outbreaks were reported on the basis of case series and faecal evidence alone.

Applying published criteria for levels of evidence developed for waterborne diseases (Table 1), six drinking water-associated outbreaks were 'strongly associated' with water, three were 'probably associated' and one was 'possibly associated'.⁹ Of the recreational water outbreaks, two (4.8%) were 'strongly associated', one (2.4%) was 'probably associated' and 39 (92.9%) were 'possibly associated'.

Discussion

Contaminated water has the potential to cause significant outbreaks of gastroenteritis due to the large numbers of people served by drinking and recreational water facilities.⁹ That few outbreaks were reported between 2001 and 2007 may be a testament to the quality of Australia's water supplies, the recognised importance of high-standard recreational and drinking water guidelines by Australian authorities,¹⁰ and the current risk management approach that the Australian water industry has adopted to prevent the occurrence of waterborne gastrointestinal disease.¹¹ The small number of drinking water outbreaks is particularly reassuring, especially since most of those identified were linked to small tank or bore water supplies.

It is, however, important to recognise some of the biases in the waterborne surveillance data. The outbreaks reported did not occur evenly over the years or by jurisdiction. The majority of outbreaks were recorded in Victoria during 2006, and were attributed largely to *Cryptosporidium* contaminated swimming pools. In 2006 Victoria experienced a community wide cryptosporidium outbreak that led to enhanced surveillance for outbreaks of cryptosporidiosis, and it is likely that the intensive investigation efforts contributed to the

Table 3: Recreational water outbreaks of gastroenteritis reported to OzFoodNet from 2001 to 2007.

State/Year	Definition	Source	Setting	Organism	Reported cases			Evidence	Level of evidence ⁹
					Number	Lab confirmed	Median age		
VIC 2001	suspected waterborne	Pool water	Public swimming pool	<i>Cryptosporidium</i>	31	13	7	Microbiological (faeces)	possible
SA 2002	waterborne	Public swimming pool	Child care	<i>Cryptosporidium</i>	24	24	3.5	Microbiological (faeces) Epidemiological (case control study)	strong
QLD 2004	suspected waterborne	Pool water sourced from dam	Camp	<i>Salmonella</i> Litchfield	2	2	8.5	Microbiological (faeces + below standard water)	probable
QLD 2004	waterborne	Pool water	Public swimming pool	<i>Cryptosporidium</i>	5	5	5	Microbiological (faeces)	possible
NSW 2005	suspected waterborne	Pool water	Public swimming pool	<i>Cryptosporidium</i>	254	254	5	4/33 implicated pools tested, 2 had high levels of oocysts (>600 oocysts/100L)	strong
VIC 2005	waterborne	Pool water	Public swimming pool	<i>Cryptosporidium</i>	9	9	6	Microbiological (faeces)	possible
VIC 2005	waterborne	Pool water	Unknown swimming pool	<i>Cryptosporidium</i>	6	5	3	Microbiological (faeces)	possible
VIC 2005 ^a	suspected waterborne	Pool water	Public swimming pool	<i>Cryptosporidium</i>	20	18	4	Microbiological (faeces)	possible
VIC 2006	suspected waterborne	Pool water	Public swimming pool	<i>Cryptosporidium</i>	18	18	6.5	Microbiological (faeces)	possible
VIC 2006	suspected waterborne	Pool water	Public swimming pool	<i>Cryptosporidium</i>	10	7	23.5	Microbiological (faeces)	possible
VIC 2006	suspected waterborne	Pool water	School swimming pool	<i>Cryptosporidium</i>	30	11	8	Microbiological (faeces)	possible
VIC 2006 ^b	suspected waterborne	Pool water	Unknown swimming pool	<i>Cryptosporidium</i>	134	134	5	Microbiological (faeces)	possible
WA 2006	suspected waterborne	Pool water	Public swimming pool	<i>Cryptosporidium</i>	14	14	8	Microbiological (faeces)	possible
NT 2007	suspected waterborne	Pool water	Private residence	<i>Cryptosporidium</i>	4	2	2	Microbiological (faeces)	possible

All outbreaks were identified on the basis of case series, unless otherwise stated in 'Evidence'.

a) Data combined from three separate outbreaks.

b) Data combined from 27 separate outbreaks.

increased number of outbreaks identified. Additionally, there was variability in classifications of outbreaks, with some outbreaks having only microbiological evidence of a pathogen in faecal samples being classified as 'waterborne', and other outbreaks with additional evidence of water contamination being categorised as 'suspected waterborne' or 'unknown'. Such variations in outbreak reports from different jurisdictions highlights that differing effort and experience among surveillance personnel may lead to non-uniformities in outbreak identification and classification.^{12,13}

Outbreaks of gastroenteritis may be difficult for health authorities to recognise, as illness is often mild and self-limiting.¹⁴ People do not usually seek medical attention or have a faecal specimen taken,¹⁵ and most faecal samples do not yield a pathogen.^{1,16} Additionally, it can be very difficult to detect waterborne outbreaks, as drinking water is widely distributed and recreational water bodies may be used by people from a large geographic area. Consequently, waterborne outbreaks are often widely dispersed and therefore less recognisable than, for example, point source foodborne outbreaks.⁹ Microbiological confirmation of a water source is limited by the often transient nature of water contamination, the large time period that has often elapsed before an outbreak is recognised^{9,17} and the low concentrations of pathogens in water.¹⁸⁻²² These challenges mean that many waterborne outbreaks are never identified. Even for identified outbreaks confirmation of the source is often lacking, as is highlighted by only six drinking water-associated outbreaks and two recreational water-associated outbreaks meeting Tillett et al.'s criteria of 'strongly associated' with water.⁹ The percentage of clinical cases confirmed by laboratory testing varies between outbreaks. As shown in Table 2, some outbreaks had virtually all ill people recorded as laboratory-confirmed cases. This is because these outbreaks were detected through notifiable disease surveillance, so cases who did not undergo testing would not have been ascertained or recorded. Where laboratory confirmation of a pathogen was required in order for a case to be counted, there is likely to be underestimation of the outbreak's impact.

In summary, common to waterborne outbreak surveillance data from other countries,^{4,7} it is important to recognise the limitations of the OzFoodNet data caused by difficulties in identifying, investigating and categorising waterborne outbreaks, as well as in obtaining microbiological and epidemiological evidence. Since only a small numbers of waterborne disease outbreaks were detected, limited conclusions can be drawn. However, the data is able to provide a snapshot of gastrointestinal waterborne outbreaks detected by Australian State and Territory surveillance systems and it does highlight the rarity of significant waterborne disease outbreaks in Australia. It is important to recognise the potential for devastating effects on communities from single waterborne outbreaks,²³ and the consequent importance of risk-based management of water quality in Australia to maintain protection of public health. Sensitive waterborne outbreak surveillance systems will remain especially important into the future with the current increase in recycled water use and the likely increase in extreme weather events due to effects of climate change.^{24,25}

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