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THE SYDNEY WATER INCIDENT: JULY–SEPTEMBER 1998

Recent events in Sydney have highlighted the difficulties of understanding and managing the risks posed by the water-borne parasites, *Cryptosporidium* and *Giardia*. Here we present a brief history from a health perspective of what followed the detection of these parasites at very high levels in treated drinking water and some preliminary analyses of the search for illness associated with this.

FIRST EPISODE

On Monday, 27 July 1998, the Sydney Water Corporation reported that it had detected a possible local ingress of contaminated material into the water pipes that served a small section of the eastern Sydney central business district. This report followed the detection of unusual levels of cryptosporidium oocysts and giardia cysts in drinking water in the same area (and not elsewhere) over the previous weekend. Initially, these were thought to be dead organisms that had collected in the biofilm (the material that collects over time in the lining of the pipes) and had been released by flushing of the pipes.

The presence of the protozoan parasites, *Cryptosporidium* and *Giardia*, in treated drinking water presents a difficult public health issue. There is no scientific consensus on the minimum levels of the parasites in water that may cause a health hazard, and guidelines for public health action are not available. In addition, these parasites are much more resistant to conventional water disinfection methods than traditionally used indicators of contamination (such as faecal coliforms). Although sufficient levels of chlorine in the distribution system will kill giardia after a few hours, cryptosporidium parasites are highly resistant to chlorine at levels that, practicably, can be achieved in drinking water. In the absence of a clear association between the detection of parasites in treated water and risk to public health, the trigger for public health action has usually been the finding of other water-system problems that might signal exposure of consumers to inadequately treated water. These include failures of the water-treatment process or breaches in the integrity of the treated-water distribution system.

In response to the finding of a possible source of contamination, an urgent teleconference of experts in public health, communicable-disease epidemiology, microbiology and water systems was called.

continued on p. 92

CONTENTS

The group recommended that Sydney Water issue an alert advising persons living in or visiting the affected area of Eastern Sydney not to drink tap water unless it had been boiled for at least one minute. Meanwhile, Sydney Water continued an intensive search for the likely source of the contamination. Subsequent testing found levels of parasites decreasing in the affected area.

Two days later, on Wednesday night, 29 July, the Sydney Water Corporation reported the detection of parasites across a much wider area of the system. *Cryptosporidium* and *Giardia* were found in water supplying a large part of Sydney, between the harbour and the Georges River (approximately 1 million people). That night the boil-water alert was extended to cover this area.

Further data received the following day suggested that the water supplied to an even wider area of the city could be affected, and the alert was extended to areas north of the harbour and south of the Georges River (approximately 3 million people).

An expert panel was formally convened to advise the Chief Health Officer on the lifting of the water alert over the next few days as uncontaminated water from Warragamba Dam was flushed through the system. The all-clear had been given across the city by 4 August.

SECOND EPISODE

In mid-August, Sydney's drinking water catchments received extremely heavy rainfall, resulting in an unprecedented rapid filling of the Warragamba Dam from around 58 per cent capacity to 100 per cent within a few days. On 25 August, the Sydney Water Corporation reported detecting up to 1079 cryptosporidium oocysts and 347 giardia cysts per litre at different sites in the distribution system. After consultation with the expert panel and others, the NSW Health Department issued a renewed boil-water alert, covering most of Sydney, that night.

Two days later, the Sydney Water Corporation reported the detection of cryptosporidium and giardia parasites in water from the previously unaffected Orchard Hills and Warragamba treatment plants, which supply water to the lower Blue Mountains and Penrith on Sydney's western fringe. Consequently, the alert was extended to cover these areas.

By 1 September, however, water treated by all the plants was proving consistently clear of parasites, allowing a progressive lifting of the boil-water alert as each postcode area was shown to be receiving clear water.

Four days later, on 5 September, while the progressive lifting of the alert was still under way, the Sydney Water Corporation reported detecting more than 500 cryptosporidium oocysts and more than 3500 giardia cysts in treated water from the Prospect plant. Positive results were also obtained at the Orchard Hills and Warragamba treatment plants. The wide variations in these readings, which had by now been occurring for over a month, prompted the NSW Health Department, in consultation with the expert panel, to issue a new boil-water alert for most of Sydney. This was to be maintained for two weeks, until more information about the nature of the contamination and the health effects became available.

Finally, on 19 September, after clear water had been flowing for several days from all three treatment plants, the alert was lifted across the city.

EFFECTS ON HEALTH

Following the initial detection of cryptosporidium and giardia parasites in Sydney drinking water, at the end of July, the NSW Health Department initiated a series of measures to assess the effects of the contaminated water on the community. Enhanced surveillance was conducted using several approaches, including notifications, special surveys and analysis of the results of ongoing surveillance schemes.

ENHANCED SURVEILLANCE

Six public health units in Sydney regularly telephoned selected laboratories, general practitioners, emergency departments, pharmacies and nursing homes seeking information on any increase in cases of diarrhoeal illness. Under the *Public Health Act 1991* (NSW), laboratories are required to notify to Public Health Units (PHUs) cases of cryptosporidiosis but not of giardiasis. Microbiology laboratories were asked to report, each day, the total number of stool specimens received for microbiological examination and the number of giardiasis and cryptosporidiosis cases they had diagnosed. General practitioners, emergency departments and pharmacies were asked to report their impressions of whether there had been any change in the numbers of patients presenting with diarrhoea. Nursing homes were asked to report the number of residents who had diarrhoea that day. Daily surveillance continued from 3 August until 12 August and resumed on 27 August following the second boil-water alert.

Public Health Units were asked to report a summary of their findings to the NSW Health Department at the end of each day and to enter any cases of giardiasis and cryptosporidiosis (in Sydney residents) into the centrally collated NSW Health Notifiable Diseases Database.

Apart from expected day-to-day variations in reports of diarrhoea (which are most likely to represent background rates), there was a slight increase in reports of giardiasis in Sydney residents in early August (Table 1). However, there were very few reports of, and no increase in, cryptosporidiosis in Sydney residents.

There were no reports of significant increases in the number of attendances for the management of diarrhoea at the selected emergency departments, general practices and pharmacies. One nursing home in the Eastern Suburbs reported an outbreak of diarrhoea affecting about 20 of the 100 residents over the period 13 to 28 August. The illness was of short duration and all the patients recovered. The staff considered that the diarrhoea was probably due to a gastrointestinal virus, and no specimens were obtained. No other nursing homes reported outbreaks of diarrhoeal illness.

Data from the enhanced surveillance did not indicate that there was an increase in diarrhoeal illness in the Sydney area. The small increase in giardiasis is likely to be attributable to increased testing and identification of background cases unrelated to drinking Sydney water. This is supported by data available to the South Eastern Sydney Public Health Unit showing that laboratory isolation of other gastrointestinal pathogens (not related to drinking water), particularly campylobacter, increased in the same period as isolates of giardia increased. These cases would not have been caused by water-borne campylobacter, as chlorination would have inactivated these organisms.

TABLE 1

LABORATORY REPORTS OF CRYPTOSPORIDIOSIS AND GIARDIASIS, BY SPECIMEN DATE, SYDNEY, JULY TO SEPTEMBER 1998

Week beginning	Faecal specimens[a]	Cryptosporidiosis[b]	Giardiasis[c]
5 July	822	0	3
12 July	805	1	0
19 July	927	3	5
26 July	1637	2	13
2 Aug	2464	0	27
9 Aug	824[d]	0	14
16 Aug	NES[e]	0	16
23 Aug	873[f]	2	11
30 Aug	1752	3	18
6 Sep	1885	1	19

Notes:

(a) Number of faecal specimens submitted for micro-biological examination each week. Complete data for the entire period were available from three Area health services (Northern Sydney, South Eastern Sydney and Western Sydney).

(b) Notifications from Sydney Metropolitan Area health services.

(c) Data from selected laboratories.

(d) Data incomplete: samples available for 9–12 August only.

(e) NES = no enhanced surveillance 13–26 August.

(f) Data incomplete: samples available for 27–29 August only.

HOUSEHOLD SURVEY NO. 1

To help identify any large outbreak of water-borne diarrhoeal disease at an early stage and to determine the effect of the public health alert on the behaviour of Sydney residents, the NSW Health Department initiated a household survey in August after the first boil-water alert. Subjects were asked about the incidence of diarrhoeal illness and compliance with the boil-water alert.

The survey included 503 people in 163 households in areas of Sydney affected by the boil-water alert and 520 people in 173 households in areas unaffected by the alert. Participants were randomly selected from the electronic White Pages and stratified by health service area. The survey began on 5 August. This date was chosen to allow sufficient time for illness to have developed after an incubation period beginning on 29 July, but is unlikely to have allowed enough time for illness to have developed in people who continued to drink unboiled tap water after 29 July.

Diarrhoea lasting for more than three days was considered most likely to reflect infection with the parasites *Giardia* or *Cryptosporidium*, since these infections typically cause a longer-lasting illness than many other pathogens. Reported diarrhoea of shorter duration was considered more likely to have other causes, including viral infections, and is more prone to reporting bias.

Preliminary analysis shows that 2 to 3 per cent of individuals living in affected and unaffected households reported diarrhoea lasting more than three days in the previous month, and 2 per cent reported diarrhoea on the day of the survey (Table 2). Rates of diarrhoea of any duration in the previous month were also similar in affected and unaffected areas (10 and 11 per cent, respectively).

HOUSEHOLD SURVEY NO. 2

Following the second boil-water alert, issued on 25 August, the NSW Health Department began a second survey of households in affected and unaffected areas from 4 to 8 September.

This survey was expanded to include an additional 80 households in the Nepean and lower Blue Mountains areas, because of the possibility that these residents may have been exposed to contaminated water before the second boil-water alert was extended to those areas on 27 August. The survey covered 763 persons in 261 households affected by the boil-water alert, and 595 persons in 195 households in areas unaffected by the alert.

Preliminary analysis shows that, in both affected and unaffected households, in the previous month, 1 to 4 per

TABLE 2

HOUSEHOLD SURVEY NO. 1: CHARACTERISTICS AND RESPONSES OF PERSONS IN SYDNEY, THE BLUE MOUNTAINS, THE HUNTER AND ILLAWARRA AREAS, 5 TO 8 AUGUST 1998 (PRELIMINARY ANALYSIS)

Characteristic	Control		Exposed	
	n	%	*n*	%
Households	173		163	
Individuals	520		503	
Mean age (years)	33.7		37.3	
Females	264	51	258	51
Mean glasses water/day[a]	3.7		3.9	
Diarrhoea				
Diarrhoea since 1 July 98	56	11	50	10
Diarrhoea >3 days definitely	10	2	9	2
Diarrhoea >3 days possibly	18	3	16	3
Diarrhoea on interview day	11	2	8	2
Effect of boil-water order				
Boiled drinking water ≥1 min			382	74
Boiled drinking water <1 min			40	8
Drank unboiled tap water			35	7
Drank bottled water			207	40
Brushed teeth with boiled water			314	60
Lived in household where foods were washed in boiled water			289	55

Note:

(a) Of those who responded that they drank tap water.

TABLE 3

HOUSEHOLD SURVEY NO. 2: CHARACTERISTICS AND RESPONSES OF PERSONS IN SYDNEY, THE BLUE MOUNTAINS, THE HUNTER AND ILLAWARRA AREAS, 4 TO 8 SEPTEMBER 1998 (PRELIMINARY ANALYSIS)

Characteristic	Control		Exposed	
	n	**%**	***n***	**%**
Households	195		261	
Individuals	595		763	
Mean age	33.9		35.9	
Females	303	51	389	51
Mean glasses water/day[a]	4.1		5.7	
Diarrhoea				
Diarrhoea since 4 August 98	49	8	104	13
Diarrhoea >3 days definitely	13	2	10	1
Diarrhoea >3 days possibly	22	4	28	4
Diarrhoea on interview day	14	2	16	2
Seen doctor about diarrhoea since 4 August 98	15	3	25	3
Effect of boil-water order				
Boiled drinking water ≥1 min			655	86
Boiled drinking water <1 min			32	4
Drank unboiled tap water			96	13
Drank bottled water			368	48
Brushed teeth with boiled water			296	58
Lived in household where foods were washed in boiled water			461	60

Note:

(a) Of those who responded that they drank tap water.

cent of persons had diarrhoea lasting more than three days, and 2 per cent of persons had diarrhoea on the day of the survey (Table 3). Individuals in affected areas reported a higher rate of diarrhoea of any duration (13 per cent) than individuals in unaffected areas (8 per cent). However, the increased reporting of diarrhoea lasting three days or less in households in affected areas is not consistent with illness due to water-borne parasites and probably represents reporting bias.

CONCLUSION

Available data suggest that there was no measurable increase in disease attributable to drinking Sydney water, even though it apparently contained very high levels of cryptosporidium oocysts and giardia cysts. While this result would be unsurprising if all people in affected areas had been boiling their water, survey results indicate that compliance with the boil-water alert was well below 100 per cent. In addition, it is probable that exposures to contaminated water occurred before the contamination was identified and the boil-water alerts could be issued. Therefore, some people would have been exposed to contaminated water, and it would be expected that some of these would have become sick. The fact that rates of illness did not increase has not yet been explained.

Further work to examine the viability and infectivity of the parasites in animal models is under way. There is a need for development of tests to determine the viability and infectivity of these organisms to assist decision making in any future events. The Sydney water incident will doubtless stimulate further studies that will expand our understanding of these organisms, and better equip water suppliers, public health practitioners and the community to avoid potential water-borne outbreaks of the future.