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Original Article

Food- and Waterborne Disease Outbreaks in Australian Long-Term Care Facilities, 2001–2008

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Abstract

Food- or waterborne diseases in long-term care facilities (LTCF) can result in serious outcomes, including deaths, and they are potentially preventable. We analyzed data collected by OzFoodNet on food- and waterborne disease outbreaks occurring in LTCF in Australia from 2001 to 2008. We compared outbreaks by the number of persons affected, etiology, and implicated vehicle. During 8 years of surveillance, 5.9% (55/936) of all food- and waterborne outbreaks in Australia occurred in LTCF. These LTCF outbreaks affected a total of 909 people, with 66 hospitalized and 23 deaths. The annual incidence of food- or waterborne outbreaks was 1.9 (95% confidence intervals 1.0–3.7) per 1000 facilities. *Salmonella* caused 17 outbreaks, *Clostridium perfringens* 14 outbreaks, *Campylobacter* 8 outbreaks, and norovirus 1 outbreak. Residents were at higher risk of death during outbreaks of salmonellosis than for all other outbreaks combined (relative risk 7.8, 95% confidence intervals 1.8–33.8). Of 15 outbreaks of unknown etiology, 11 were suspected to be due to *C. perfringens* intoxication. Food vehicles were only identified in 27% (14/52) of outbreaks, with six outbreak investigations implicating pureed foods. Dishes containing raw eggs were implicated as the cause of four outbreaks. Three outbreaks of suspected waterborne disease were attributed to rainwater collected from facility roofs. To prevent disease outbreaks, facilities need to improve handling of pureed foods, avoid feeding residents raw or undercooked eggs, and ensure that rainwater tanks have a scheduled maintenance and disinfection program.

Introduction

Outbreaks of gastroenteritis in long-term care facilities (LTCF) transmitted by contaminated food or water are rare in comparison to those transmitted from person-to-person, but they may be severe and are potentially preventable (Kirk *et al.*, 2010b). Food- or waterborne outbreaks in LTCF are usually caused by bacteria or toxins (Levine *et al.*, 1991). Many different food vehicles have been implicated in outbreaks of gastroenteritis among LTCF residents, including eggs, chicken, spinach, and milk (Levine *et al.*, 1991). Investigation of outbreaks has highlighted that foods for the elderly that are centrally processed and prepared maybe vulnerable to contamination, particularly those that are pureed (Greig and Lee, 2009; Kirk *et al.*, 2010b).

In Australia, State and Territory governments have legislative responsibility for ensuring safety of the food supply. In 2008, Australia instituted a new national standard for foods served to those at risk of serious consequences of foodborne illness—the young, the elderly, and the immunocompromised (Kirk *et al.*, 2008b). Standard 3.3.1 requires Australian LTCF to have a documented food safety program, which States and Territories have incorporated into their legislation at different times (www.foodstandards.gov.au/foodstandards/foodsafetystandardsaustraliaonly/standard331foodsafet3808.cfm). In brief, a food safety program for an LTCF would document all food-handling operations and identify controls for any associated hazards, which would be audited regularly.

Health agencies use summary data arising from foodborne disease outbreak investigations to develop food safety policy and identify emerging risks (O'Brien *et al.*, 2006). The causes of foodborne disease outbreaks in Australian LTCF have not been previously examined. To identify the main causes of foodborne disease and make recommendations to reduce the risk, we analyzed data from outbreak investigations conducted between 2001 and 2008 in Australia.

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Methods

Outbreak surveillance

OzFoodNet is an Australian network that enhances surveillance and investigation of foodborne diseases in Australia (Kirk *et al.*, 2008a). Under the nationally coordinated OzFoodNet program, health departments in each of Australia's six States and two Territories employed one or more epidemiologists to enhance surveillance. In all Australian jurisdictions, clinicians are required by law to report food- and waterborne outbreaks or outbreaks in institutions to State and Territory health departments. In 2001, OzFoodNet established a register of all foodborne and gastroenteritis outbreaks to assist with development of policy to prevent foodborne diseases in Australia. OzFoodNet epidemiologists prospectively collected data on all gastroenteritis and foodborne outbreaks using a standard form that captured information about the number of people affected, characteristics and severity of illness, etiological agent, suspected vehicle of infection, and factors contributing to the outbreak. Data were entered into a Microsoft Access database.

Definitions

We defined an outbreak of food- or waterborne disease as $\geq$2 cases of gastroenteritis occurring in a single facility that was associated with a common meal or water source. OzFoodNet epidemiologists assessed whether the outbreak was potentially food- or waterborne based on

1. epidemiological association with a specific food or water source and/or
2. detection of the infecting agent in a specific food or water and/or
3. detection of an infecting agent usually transmitted by contaminated food or water and/or
4. descriptive epidemiology suggesting a point-source, such as food or water, as assessed by features, such as tightly clustered onset of illness among cases or characteristic clinical presentation.

To attribute an outbreak to a specific pathogen, we used definitions prepared by the Centers for Disease Control and Prevention (Lynch *et al.*, 2006), which usually relied on detection of a suspected pathogen or toxin in fecal specimens of two or more persons affected. In Australia, LTCF are defined under the Aged Care Act 1997 (ref: www.comlaw.gov.au/ComLaw/Legislation/ActCompilation1.nsf/0/72867C635D71AF8BCA2576380013ECBE/$file/AgedCare1997WD02.pdf) and provide personal and/or nursing care, along with accommodation, meals, and other services, to elderly residents. In 2007–2008, there were 2830 LTCF providing 172,657 places for elderly residents (Anon., 2009).

Investigators attributed illness to specific meals or foods using evidence from epidemiological, or laboratory studies, or compelling supporting information, such as feeding residents foods considered extremely high risk that fitted the incubation period for the pathogen or identification of identical strains of organisms in product trace-back. In support of their findings, investigators provided information on the epidemiological association, along with major factors leading to contamination of food, and survival and growth of microbial agents.

Data analysis

We extracted records of food- or waterborne outbreaks occurring in LTCF from the OzFoodNet outbreak register for the period 2001–2008 by year of notification, and summarized outbreaks by the number of LTCF residents who were affected, hospitalized, and died. To describe foods and contributing factors resulting in these foodborne outbreaks, we reviewed detailed State and Territory summary reports of the foodborne disease outbreak investigation. To calculate the annual mean reporting incidence by State and Territory, we divided the total number of outbreaks in LTCF during surveillance by the total number of facilities registered in each jurisdiction multiplied by 1000. The number of facilities by jurisdiction was obtained from the Australian Institute of Health & Welfare for 2001–2008 (Anon., 2009). To calculate 95% confidence intervals (CI) we assumed incidence followed a negative binomial distribution and incorporated robust variance estimation to account for potential correlation of data by jurisdiction. We analyzed data using Stata Version 10.1 (Stata Corp., College Station, TX).

Results

From January 1, 2001, to December 31, 2008, State and Territory investigators reported that 1.4% (52/3847) of outbreaks occurring in LTCF reported to the national register were foodborne and 0.1% (3/3847) were waterborne. These food- and waterborne outbreaks in LTCF affected a total of 909 people and resulted in hospitalization of 66 people and 23 deaths. The median size of foodborne outbreaks was 12 persons (range 3–47), compared with 7 persons (range 3–8) for waterborne outbreaks. In total, 5.9% (55/936) of all reported food- and waterborne outbreaks in Australia occurred in LTCF during the surveillance period.

Features of LTCF outbreaks

During the 8-year surveillance period, the annual mean incidence of food- or waterborne outbreaks was 1.9 (95% CI 1.0–3.7) per 1000 facilities. The median annual number of outbreaks was seven (range 4–11). During the 8 years, five out of eight Australian jurisdictions reported one or more food- or waterborne outbreaks. There were 32 outbreaks reported in the State of Victoria (4.9 per 1000 facilities annually), 10 outbreaks in Queensland (2.5 per 1000 facilities), 8 outbreaks in New South Wales (1.1 per 1000 facilities), 3 outbreaks in South Australia (1.3 per 1000 facilities), and 2 outbreaks in Western Australia (1.0 per 1000 facilities). Tasmania, the Northern Territory, and the Australian Capital Territory did not report any food- or waterborne outbreaks in LTCF during the surveillance period. For nine outbreaks, investigators reported one or more residents died during the course of the investigation, with a median of one death (range 1–7) for these outbreaks.

Agents causing outbreaks

The three main etiological agents causing food- or waterborne outbreaks were *Salmonella* serotypes (17 outbreaks), *Clostridium perfringens* (14 outbreaks), and *Campylobacter* spp. (8 outbreaks) (Table 1). *Salmonella* outbreaks were most common in summer and spring (September to February) compared with *Campylobacter* outbreaks, which were more

Table 1. Agents Responsible for Outbreaks of Food- and Waterborne Disease in Long-Term Care Facilities, Australia 2001–2008

Pathogen	Number outbreaks	Persons affected	Median persons ill per outbreak (range)	Median days duration of outbreak (range)	Case fatality ratio (%)	Mean proportion of affected reporting (%)	
						Vomiting	Diarrhea
Campylobacter sp.	8	110	6.5 (3–49)	3 (1–7)	0	13.8	89.9
Clostridium perfringens	14	354	22 (6–69)	3 (1–32)	2.2	6.4	100
Norovirus	1	42	42	10	0	66.7	66.7
Salmonella	17	244	12 (2–47)	7 (1–36)	6.1	28.7	95.4
Unknown	15	159	11 (5–19)	1 (0–2)	0	11.3	100
Total	55	909	12 (2–69)	3 (0–36)	2.5	20.2	96.4

common in winter and spring (June to November; Fig. 1). *C. perfringens* outbreaks occurred throughout the year. The proportion of LTCF residents who were hospitalized and died was highest for outbreaks caused by *Salmonella*. One or more residents died during 41% (7/17) of *Salmonella* outbreaks compared with 5% (2/38) of all other outbreaks (relative risk 7.8, 95% CI 1.8–33.8).

The main *Salmonella* serotype detected during outbreaks was Typhimurium, with phage types 135 and 44 causing three outbreaks each, phage type 9 two outbreaks, and phage types 102 and 126 single outbreaks. There were also single outbreaks due to *Salmonella* Enteritidis phage type 26, *Salmonella* Heidelberg phage type 1, *Salmonella* Potsdam, *Salmonella* Kiambu, *Salmonella* Muenchen, *Salmonella* Saintpaul, and *Salmonella* subspecies IIIb 61:i:z35. Five *Campylobacter* outbreaks were due to *C. jejuni*, whereas isolates were not speciated for the remaining three outbreaks. One foodborne outbreak was attributed to norovirus.

There were 15 outbreaks of unknown etiology affecting 159 people. Of these, 11 outbreaks were suspected to have been caused by *C. perfringens* due to consistent symptoms and incubation period among cases in each outbreak, along with moderate to heavy growth of the organism in fecal specimens of one or more affected persons for four outbreaks, one fecal specimen positive for *C. perfringens* enterotoxin in four outbreaks, and symptomatology alone for three outbreaks.

Contaminated foods and water resulting in outbreaks

Foods. For foodborne outbreaks, investigators conducted point-source cohort studies for 8 outbreaks, case control studies for 1, case series for 35 outbreaks, and no patient data were collected for 8 outbreaks. Investigators identified a suspected vehicle in only 27% (14/52) of foodborne disease outbreaks (Table 2). Statistical evidence for a food vehicle was obtained in 43% (6/14) of these outbreaks with the median relative risk being 7.3 (range 2.3–16.9). All six outbreaks implicated meals that were pureed using a blender, but a specific food was not identified. Three of these pureed-food-associated outbreaks were due to *Salmonella*, two to *C. perfringens* and one to an unidentified agent. Investigators suspected egg-based dishes as the cause of four outbreaks of

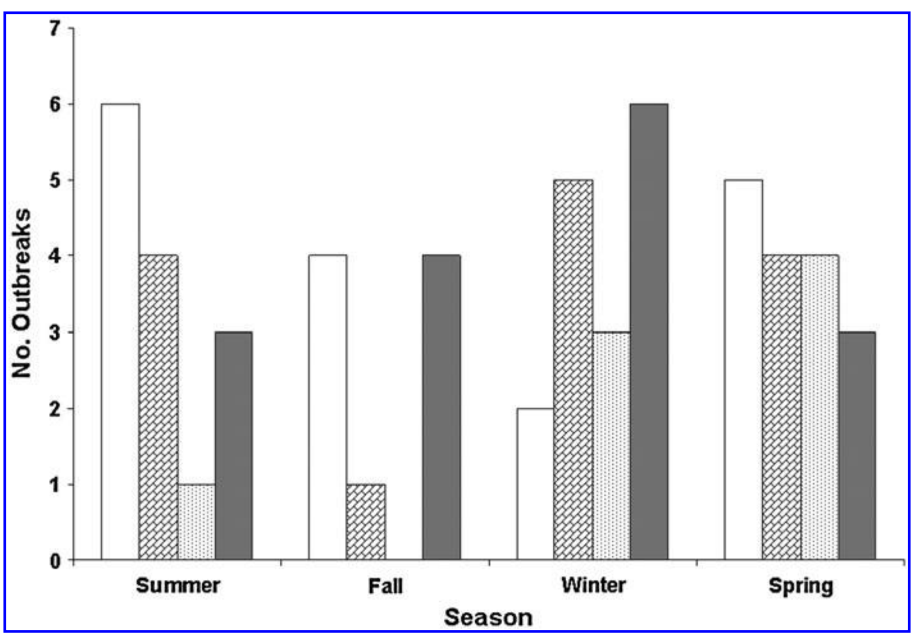

FIG. 1. Seasonality of food- and waterborne outbreaks in long-term care facilities, by etiological agent, Australia, 2001–2008. □, *Salmonella*; ▨, *Clostridium perfringens*; □, *Campylobacter*; ■, other/unknown.

Table 2. Vehicles Responsible for Outbreaks of Food- and Waterborne Disease in Long-Term Care Facilities, by State and Year, Australia 2001–2008

State	*Year*	*Vehicle*	*Persons affected*	*Agent*	*Evidence*
New South Wales	2005	Suspected chicken, mushroom & rice	10	*C. perfringens*	Compelling supporting evidence
	2006	Suspected chicken	3	*Campylobacter*	Compelling supporting evidence
	2008	Pureed meals	69	*C. perfringens*	Cohort study
	2008	Chocolate mousse containing eggs	10	*Salmonella*	Pathogen isolated from egg wash
Queensland	2001	Suspected tank water	3	*Salmonella*	Compelling supporting evidence
	2003	Suspected egg nog	47	*Salmonella*	Compelling supporting evidence
	2004	Tank water	8	*Salmonella*	Pathogen isolated from rainwater tank
	2005	Braised steak & gravy	36	*C. perfringens*	Pathogen isolated from food
South Australia	2001	Meat pie & rice pudding containing eggs	18	*Salmonella*	Pathogen isolated in food & egg-laying flock
	2008	Pureed & soft meals	38	*Salmonella*	Cohort study
Victoria	2002	Suspected meat stock in gravy & soup	23	*C. perfringens*	Compelling supporting evidence
	2004	Suspected tank water	7	*Campylobacter*	Compelling supporting evidence
	2005	Suspected eggs	7	*Salmonella*	Compelling supporting evidence
	2007	Pureed meals	22	*Salmonella*	Cohort study
	2007	Pureed meals	17	Unknown	Cohort study
	2008	Pureed meals	14	*Salmonella*	Cohort study
Western Australia	2003	Minced & pureed meals, gravy	42	*C. perfringens*	Cohort study

Salmonella, although in only two outbreaks were investigators able to isolate the same strain of *Salmonella* from eggs or the egg-laying environment (Tribe *et al.*, 2002; Roberts-Witteveen *et al.*, 2009).

Water. There were three outbreaks due to waterborne or suspected waterborne transmission in aged care facilities during the 8 years (Table 2). Two of these outbreaks were due to *Salmonella* and one to *C. jejuni*. All three outbreaks were suspected to be caused by residents consuming water that was captured and stored in rainwater tanks. The mode of transmission was assessed based on compelling evidence for two outbreaks where high levels of *Escherichia coli* were detected in water samples, and isolation of one of the infecting *Salmonella* serotypes from tank water in another.

Factors contributing to outbreaks

During surveillance, investigators reported potential contamination factors for 22% (12/55) of outbreaks, with the remainder being unknown or not applicable. The most common contamination factor was "ingestion of contaminated raw product" reported for 9% (5/55) of outbreaks, four of which were caused by *Salmonella* and one by *Campylobacter*. However, measured evidence for contamination was obtained in only two of these outbreaks. The reason for growth of pathogenic organisms was reported for 25% (14/55) of outbreaks, with "slow cooling of foods" the most commonly reported factor contributing to five *C. perfringens* outbreaks and one due to an unknown agent. In particular, investigators noted that preparation of large batches of foods, such as gravies and stews, from meat-based stocks that were allowed to cool over long periods were a potential cause of outbreaks. The use of left-over foods in subsequent meals was reported as a contributing factor in five outbreaks, particularly where foods were pureed. Factors for survival of organisms were reported for 20% (11/55) of outbreaks, with "insufficient time/temperature during reheating" the most common factor, four of which related to *C. perfringens* outbreaks and one of unknown etiology.

In several outbreaks, investigators reported probable secondary spread of infection after the initial peak of the foodborne outbreak. Six of these outbreaks were due to *Salmonella*, with staff becoming infected in three outbreaks. One of these was caused by a norovirus outbreak, where the chef prepared a meal while ill and secondary cases occurred after the initial peak of infections. In three *C. perfringens* outbreaks, cases persisted after the initial peak of infections, including one large outbreak where there were two distinctive peaks over a single month. Investigators reported that three individual facilities experienced more than one foodborne outbreak within a single year, including two that experienced multiple *C. perfringens* outbreaks.

Discussion

This is the first detailed review of the causes of food- and waterborne disease outbreaks in Australian LTCF. Foodborne disease outbreaks are relatively rare, with only four to eight outbreaks occurring in Australian facilities each year. This is in contrast to several hundred outbreaks of viral gastroenteritis spread from person to person in LTCF annually (Kirk *et al.*, 2010a). However, we found that food- and waterborne disease outbreaks, particularly those caused by *Salmonella*, resulted in higher case fatality ratios for residents. The case fatality ratio for norovirus—the most common viral agent of outbreaks spread from person to person in LTCF in Australia—is estimated to be 0.3% (Kirk *et al.*, 2010a) compared with 6.1% for salmonellosis in this review. Our review of food- and waterborne outbreaks highlighted that improper handling of pureed foods and feeding high-risk foods, such as raw eggs, to residents can cause serious outbreaks.

Similar reviews of 115 foodborne outbreaks occurring in U.S. LTCF and 58 outbreaks in the U.K. residential institutions also identified *Salmonella* as a common cause of serious foodborne outbreaks (Levine *et al.*, 1991; Ryan *et al.*, 1997). A recent review of foodborne outbreak surveillance data in the United States for 1998–2002 reported that 1% (68/6647) of foodborne outbreaks occurred in LTCF, which was a significantly lower than the 6% (52/878) we observed in this review ($p < 0.001$ for comparison) (Lynch *et al.*, 2006). Lynch *et al.* (2006) reported that 28% (19/68) of outbreaks were due to *Salmonella*, which was similar to our findings of 31% (17/55; $p = 0.8$), but reported that 31% (21/68) of foodborne outbreaks in LTCF were due to norovirus compared with 2% (1/55; $p < 0.001$) and there were no outbreaks of *C. perfringens* compared with our findings of 25% (14/55; $p < 0.001$).

The difficulty of diagnosing *C. perfringens* may explain the absence of reported outbreaks in reviews of LTCF outbreaks in the United States. In our study, there were almost as many outbreaks suspected to be due to *C. perfringens* as there were confirmed outbreaks. Identification of *C. perfringens* as the causative agent relies on rapid detection of outbreaks, as diarrhea in patients is short lived. In addition, diagnostic tests for confirmation are not routinely performed in most pathology laboratories and usually specimens must be sent to a public health reference laboratory. Elevated spore counts ($>10^6$ colony forming units/gram of feces) of *C. perfringens* among elderly people are not uncommon, and confirmation of the outbreaks may require direct detection of the enterotoxin in stools. We found that *C. perfringens* outbreaks were often of short duration and people predominantly experienced mild diarrhea that could be easily missed in LTCF. However, in one outbreak multiple deaths were reported, highlighting that *C. perfringens* intoxication may be fatal in vulnerable elderly people (Tallis *et al.*, 1999).

Victoria had a higher rate of reporting food- and waterborne outbreaks than any other State, which may have been due to more intense investigation (Kirk *et al.*, 2010a). Victoria has a very well-established outbreak reporting system, which functioned for several years before the introduction of national surveillance through OzFoodNet. It is difficult for health departments to determine whether an outbreak is food- or waterborne with such a large background of LTCF outbreaks that are presumed person-to-person spread. To improve detection of foodborne outbreaks, it is important that public health investigators critically review case series data for all LTCF outbreaks for characteristic features of bacterial or toxin-based illnesses and collect larger numbers of fecal specimens for appropriate testing where transmission from food or water is suspected (Kirk *et al.*, 2010a). The absence of reported outbreaks for three Australian jurisdictions reflects small numbers of LTCF in these States or Territories.

Despite the greater severity of food- or waterborne illness, the proportion of LTCF outbreaks that were identified as attributed to specific food vehicles is lower than for outbreaks in other settings where food is served and prepared (Fullerton and OzFoodNet Working Group, 2008). Information in our review regarding suspected vehicles should be interpreted with caution, as for many outbreaks investigators were only able to assess descriptive epidemiology and supporting information. Even where investigators reported a suspected source of food or water, the evidence implicating the specific vehicle was often weak and factors contributing to contamination, growth, and survival were poorly recorded. This reflects the difficulties in investigating outbreaks in these facilities, as residents are unable to recall eating specific foods and record-keeping is often poor (Kirk *et al.*, 2010b).

An important finding in our review was the frequency in which pureed or blended food was epidemiologically implicated as a cause of outbreaks. Dysphagia and chewing difficulties are common among elderly LTCF residents and 25%–60% of residents consume food that is pureed or minced to provide adequate nutritional intake (Hotaling, 1992; Germain *et al.*, 2006). Improperly cleaned blenders may seed meals with bacteria that can grow to high concentrations, as meals are often left for some time before being consumed by residents. It is vital that LTCF follow manufacturer's recommendations for sanitization of blenders, as the internal seals and blades can become colonized with *Salmonella* (Daly *et al.*, 2010). During outbreaks, investigators should swab blenders as a potential source of evidence about the cause (Daly *et al.*, 2010).

We identified that using left-over foods in pureed meals presents a higher risk for outbreaks of *C. perfringens* intoxication among LTCF residents. Similarly, poor temperature control during food preparation can allow *C. perfringens* to grow. Meat-based meals for LTCF residents, such as stews, roasts, soups, and gravies, are often prepared well in advance of consumption. These dishes are ideal vehicles for *C. perfringens* due to its ability to survive cooking through sporulation and short generation time. The cooling rate for large volumes of cooked food during refrigeration can be slow and allow bacteria to grow. It is preferable for facilities to cook smaller amounts or divide cooked meats into smaller batches before refrigerating.

In Australia, egg-laying chicken flocks are not colonized with *Salmonella* Enteritidis, which has been commonly associated with large outbreaks in Europe and North America, but egg-associated outbreaks of *Salmonella* Typhimurium are still a common cause of outbreaks in the community (Fullerton and OzFoodNet Working Group, 2008; Kirk *et al.*, 2008a). In this review, we found that dishes containing raw or undercooked eggs were a suspected cause of several outbreaks in LTCF residents. In one of the few Australian outbreaks of *Salmonella* Enteritidis phage type 26, eggs served to LTCF residents were the suspected cause and resulted in culling of an infected flock. We recommend that LTCF residents not eat raw or undercooked eggs, due to the risk of contamination with *Salmonella* and the increased vulnerability of elderly people (Mishu *et al.*, 1994; Frank *et al.*, 2007).

In Australia, waterborne disease outbreaks are rarely reported in association with drinking water (Dale *et al.*, 2010) and they are very rare in LTCF. While some studies did not find evidence that rainwater collected in tanks is associated with sporadic gastroenteritis (Heyworth *et al.*, 2006), others have shown that they can become contaminated and cause human disease (Ashbolt and Kirk, 2006; Franklin *et al.*, 2009). Rainwater tanks are an inappropriate source of drinking water for LTCF, unless there is a scheduled disinfection and maintenance program to control growth of pathogens and development of biofilms (Anon., 2004a, 2004b).

Our study was subject to some limitations. We summarized data collected by State and Territory investigators and did not validate their reports. In particular, reported deaths can be difficult to attribute to a particular cause, as elderly residents who die usually have many underlying illnesses (Frenzen, 2003). In most instances, what we report as deaths were those residents who died during the time of an investigation, but it is often unknown how much the death was directly attributable to the foodborne agent. The contribution of foodborne agents as the cause of deaths in LTCF residents needs further investigation with primary research.

We identified that some facilities experienced more than one foodborne outbreak during the surveillance period, but data were too sparse to assess reasons for this. It is also important to recognize that reported outbreak data represent only a proportion of actual cases of foodborne illness, as many outbreaks and single cases go unreported. In the LTCF setting this proportion may be smaller, as cases of gastroenteritis are more easily recognized than among community-dwelling elderly and they commonly manifest as part of outbreaks (Kirk *et al.*, 2010a). We identified several foodborne outbreaks that were followed by secondary transmission within the facility, which has been reported in the literature and highlights the importance of robust infection control for cases of gastroenteritis (Frank *et al.*, 2007).

Reported foodborne disease outbreaks were rare in LTCF, but were likely to be under-ascertained in some jurisdictions. They can have serious consequences with significant case fatality ratios. To prevent these outbreaks, facilities need to implement programs that consider the safety of foods and water sources for residents. In particular, facilities should avoid providing residents meals or drinks containing raw or inadequately cooked eggs unless they are pasteurized, take care with cooking, cooling, and reheating large volumes of food, and ensure that blenders are properly cleaned and sanitized between every use. Health authorities need to strengthen surveillance mechanisms for detecting foodborne disease outbreaks in these facilities, and investigators should consider swabbing blenders during outbreaks. To assist public health investigation of these outbreaks, it would help if facilities routinely recorded dietary histories for residents.

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Disclosure Statement

No competing financial interests exist.

References

Anon. *Guidance on the Use of Rainwater Tanks*. Canberra: EnHealth Council, 2004a.

Anon. *The Australian Drinking Water Guidelines*. Canberra: NH&MRC, 2004b.

Anon. *Residential Aged Care in Australia 2007–08: A Statistical Overview. Aged Care Statistics Series No. 28*. Canberra: Australian Institute of Health & Welfare, 2009, 151pp.

Ashbolt R and Kirk MD. *Salmonella* Mississippi infections in Tasmania: the role of native Australian animals and untreated drinking water. Epidemiol Infect 2006;134:1257–1265.

Dale K, Kirk MD, *et al.* Reported waterborne outbreaks in Australia are predominantly associated with recreational water. Aust NZ J Public Health 2010 (*in press*).

Daly ER, Smith CM, *et al*. *Salmonella* Enteritidis infections associated with a contaminated immersion blender, New Hampshire, 2009. Foodborne Pathog Dis 2010 [Epub ahead of print].

Frank C, Buchholz U, *et al.* Protracted outbreak of *S*. Enteritidis PT 21c in a large Hamburg nursing home. BMC Public Health 2007;7:243.

Franklin LJ, Fielding JE, *et al.* An outbreak of *Salmonella* Typhimurium 9 at a school camp linked to contamination of rainwater tanks. Epidemiol Infect 2009;137:434–440.

Frenzen PD. Mortality due to gastroenteritis of unknown etiology in the United States. J Infect Dis 2003;187:441–452.

Fullerton K and OzFoodNet Working Group. Monitoring the incidence and causes of diseases potentially transmitted by food in Australia: annual report of the OzFoodNet Network, 2007. Commun Dis Intell 2008;32:400–424.

Germain I, Dufresne T, *et al.* A novel dysphagia diet improves the nutrient intake of institutionalized elders. J Am Diet Assoc 2006;106:1614–1623.

Greig JD and Lee MB. Enteric outbreaks in long-term care facilities and recommendations for prevention: a review. Epidemiol Infect 2009;137:145–155.

Heyworth JS, Glonek G, *et al.* Consumption of untreated tank rainwater and gastroenteritis among young children in South Australia. Int J Epidemiol 2006;35:1051–1058.

Hotaling DL. Nutritional considerations for the pureed diet texture in dysphagic elderly. Dysphagia 1992;7:81–85.

Kirk MD, McKay I, *et al.* Food safety: foodborne disease in Australia: the OzFoodNet experience. Clin Infect Dis 2008a;47: 392–400.

Kirk M, Roberts L, *et al.* Understanding gastroenteritis in elderly Australians. Med J Aust 2008b;189:476–477.

Kirk MD, Fullerton K, *et al.* Surveillance for outbreaks of gastroenteritis in long-term care facilities, Australia, 2002–8. Clin Infect Dis 2010a (*in press*).

Kirk M, Veitch M, *et al.* Gastroenteritis and foodborne disease in elderly people living in long-term care. Clin Infect Dis 2010b;50:397–404.

Levine WC, Smart JF, *et al.* Foodborne disease outbreaks in nursing homes, 1975 through 1987. JAMA 1991;266:2105–2109.

Lynch M, Painter J, *et al.* Surveillance for foodborne-disease outbreaks—United States, 1998–2002. MMWR Surveill Summ 2006;55:1–42.

Mishu B, Koehler J, *et al.* Outbreaks of *Salmonella* enteritidis infections in the United States, 1985–1991. J Infect Dis 1994;169:547–552.

O'Brien SJ, Gillespie IA, *et al.* Publication bias in foodborne outbreaks of infectious intestinal disease and its implications for evidence-based food policy. England and Wales 1992–2003. Epidemiol Infect 2006;134:667–674.

Roberts-Witteveen AR, Campbell BA, *et al.* Egg-associated *Salmonella* outbreak in an aged care facility, New South Wales, 2008. Commun Dis Intell 2009;33:49–52.

Ryan MJ, Wall PG, *et al.* Outbreaks of infectious intestinal disease in residential institutions in England and Wales 1992–1994. J Infect 1997;34:49–54.

Tallis G, Ng S, *et al.* A nursing home outbreak of Clostridium perfringens associated with pureed food. Aust NZ J Public Health 1999;23:421–423.

Tribe IG, Cowell D, *et al.* An outbreak of *Salmonella* typhimurium phage type 135 infection linked to the consumption of raw shell eggs in an aged care facility. Commun Dis Intell 2002;26:38–39.

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