Surveillance for Outbreaks of Gastroenteritis in Long-Term Care Facilities, Australia, 2002–2008

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(See the editorial commentary by Jones, on pages 915–916.)

Background. Each year in Australia, health departments investigate hundreds of gastroenteritis outbreaks. Long-term care facilities (LTCFs) for elderly persons are a common setting for these outbreaks and can result in potentially serious outcomes.

Methods. We established surveillance for gastroenteritis outbreaks in 2001, and analyzed data on outbreaks occurring from 1 July 2002 through 30 June 2008 to estimate the incidence in Australian LTCFs and residents. We summarized outbreaks by mode of transmission and etiological agent. We used negative binomial regression to examine variation in the number of fecal specimens collected in outbreaks—a marker of investigation intensity.

Results. During surveillance, 3257 (52%) of 6295 outbreaks of gastroenteritis and foodborne disease in Australia were reported in LTCFs. These outbreaks affected 84,769 people, with 1577 people hospitalized and 209 deaths. There were 0.19 (95% confidence interval, 0.14–0.26) residents affected per 1000 bed days and 16.8 (95% confidence interval, 12.4–22.7) outbreaks per 100 LTCFs annually. LTCF outbreaks were most commonly transmitted from person to person. Only 43 (1.3%) of 3257 outbreaks were foodborne, although 47 (6.4%) of 733 residents were hospitalized and 20 (2.7%) of 733 died. Norovirus was responsible for 1136 (35%) of all 3257 outbreaks. Higher numbers of fecal specimens per outbreak were collected in 4 Australian States, in later years of surveillance, and where the etiology was identified.

Conclusions. Norovirus outbreaks spread from person to person are common in LTCFs, although clinicians should be alert for foodborne outbreaks with more serious consequences. There is a need to identify effective infection control measures to assist facilities in managing outbreaks of gastroenteritis.

Infectious gastroenteritis is common, with an estimated 17.2 million episodes occurring annually in Australia [1]. The lowest incidence occurs in people aged ≥65 years [1, 2], who experience ~0.5 episodes per person per year in Australia. A study of elderly residents of 16 Australian long-term care facilities (LTCFs) estimated that the incidence of gastroenteritis was 0.2 episodes per person per year, 96% of which occurred as part of 17 outbreaks ranging in size from 2 to 72 persons [3].

LTCFs are common settings for outbreaks of gastroenteritis reported to health departments. Several people becoming ill at once may be easily recognized because people live in close quarters, may have access to centralized health care, and are dependent on others for their care [4]. In many countries, institutions are required by law to report outbreaks. Elderly residents of LTCFs may experience severe outcomes during these outbreaks because of comorbid conditions, frailty [1], declining immunity [5], and lowered body defense against enteric pathogens [6]. The most common etiological causes of gastroenteritis outbreaks in LTCF residents are norovirus [7], Clostridium difficile [8], Clostridium perfringens [9], rotaviruses [10], and Salmonella [11].

Agents causing gastroenteritis may be transmitted from an infected person or animal to another person, or from contaminated water or food, or through contact with contaminated environments [11]. Infectious characteristics of etiological agents result in outbreaks...
with differing features in terms of symptoms, severity, mode of transmission, and duration [12]. Examining the causes of outbreaks can provide information on the natural history of disease in vulnerable subpopulations and highlight areas for prevention. In this study, we analyze data on outbreaks occurring in Australian LTCFs for elderly people to (1) estimate the incidence, the number of people affected, and the size of outbreaks to quantify the burden of infection; (2) identify where and when outbreaks occur, the major modes of transmission and causative agents to highlight where disease might be prevented; and (3) identify differences in reporting across States and Territories to improve surveillance.

**METHODS**

**Outbreak surveillance.** In 2000, the Australian Government established OzFoodNet to enhance surveillance and estimate the burden and causes of foodborne disease [13]. In 2001, OzFoodNet established a register of foodborne disease outbreaks to improve knowledge about settings where these outbreaks occur and their causes. In 2002, the register was expanded to include gastroenteritis outbreaks spread by all modes of transmission.

The register was based on surveillance conducted in the United States and United Kingdom [14, 15]. State and Territory health department investigators filled in a form containing information about each outbreak and entered data onto a Microsoft Access database. Due to the sheer volume of outbreak reports, the 2 largest Australian States—Victoria and New South Wales—maintained separate registers of outbreaks of gastroenteritis not transmitted by food or water. Data were aggregated nationally into the OzFoodNet outbreak register every 3 months.

**Definitions.** We defined LTCFs as facilities providing care to older Australians in the form of accommodation, personal care services, and nursing care. In Australia, State and Territory health departments are responsible for infectious disease surveillance and investigation of outbreaks. Clinicians or LTCF managers report outbreaks of gastroenteritis to health departments. We defined an outbreak as ≥2 cases of gastroenteritis of suspected infectious etiology occurring in a single facility. We did not specify a time frame for cases to occur in these outbreaks, because this varied subtly from jurisdiction to jurisdiction and was based on more than what was expected in the facility. For each investigation, health department staff members assessed epidemiological, microbiological, and circumstantial evidence to attribute the outbreak to foodborne, suspected foodborne, waterborne, suspected waterborne, animal-to-person, person-to-person, or unknown mode of transmission. We coded non-foodborne or non-waterborne outbreaks reported in New South Wales as “Unknown (Institutional),” because they were not further categorized. We combined “suspected” and “confirmed” modes of transmission to form single categories for “foodborne” and “waterborne.” To attribute an outbreak to a specific pathogen, we used definitions prepared by the Centers for Disease Control and Prevention [15], unless a definition was unavailable when we required detection of the agent in ≥2 stool specimens and consistent symptoms. We defined outbreak duration as the days elapsing from symptom onset for the first case to symptom onset for the last case.

**Data management.** We examined data on all outbreaks that States and Territories reported from 1 July 2002 through 30 June 2008. We coded data as missing if they were implausible and appeared to be data entry errors, such as an improbable number of deaths or duration of outbreaks ≥100 days for certain pathogens, such as *C. perfringens*. We excluded outbreaks where the number of persons ill was not recorded or was <2.

**Descriptive analysis.** We calculated the number of persons in LTCFs who were affected by outbreaks, were hospitalized, or died and compared different modes of transmission and etiological agents. For measurements that were symmetrically distributed, we compared means and 95% confidence intervals (CIs) on the basis of a *t* distribution and medians with 25th and 75th percentiles for highly skewed data.

**Estimating incidence & multivariable analysis.** To estimate the incidence of outbreak-associated gastroenteritis in LTCF residents we (1) estimated the total number of residents affected by etiological agent, based on the fraction of residents affected in New South Wales “Institutional (Unknown)” outbreaks (New South Wales was the only jurisdiction to record the number of staff and residents affected, and we assumed the proportion of residents affected in outbreaks in this State was similar in other jurisdictions); and (2) summed the adjusted number of residents affected during the 6 years of surveillance to estimate the mean incidence rate per 1000 bed-days with use of denominator data for facility residents for the same time period.

We also estimated the mean number of gastroenteritis outbreaks occurring in LTCFs per 100 facilities each year. We calculated 95% CIs for the incidence in residents and facilities by assuming that data followed negative binomial distributions.

As the surveillance system counted events, such as the occurrence of outbreaks or numbers fecal specimens collected, we used negative binomial regression for all multivariable analysis. We used robust variance estimation suited to longitudinal or clustered data, because we considered that data within a State or Territory may have been more similar than between jurisdictions [16]. We assessed the rate of reporting of LTCF outbreaks by year, compared with the year that surveillance began in 2002–2003. We assessed the “intensity of microbiological investigation” by examining the number of fecal specimens collected in outbreak investigations, because this affects...
Table 1. Summary of Long-Term Care Facility (LTCF) Population, Outbreaks Reported, and Persons Affected, by State and Territory, Australia, 1 July 2002–30 June 2008

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>Mean no. of LTCFs</th>
<th>Mean LTCF population</th>
<th>No. of outbreaks in LTCFs</th>
<th>No. of outbreaks per 100 LTCFs per year</th>
<th>No. of people affected in LTCF outbreaksa</th>
<th>Estimated no. of residents affectedb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Capital Territory</td>
<td>23</td>
<td>1843</td>
<td>37</td>
<td>26.6</td>
<td>1232</td>
<td>937</td>
</tr>
<tr>
<td>New South Wales</td>
<td>924</td>
<td>52,632</td>
<td>1109</td>
<td>20.0</td>
<td>30,441</td>
<td>23,219</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>15</td>
<td>401</td>
<td>2</td>
<td>2.2</td>
<td>55</td>
<td>42</td>
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<tr>
<td>Queensland</td>
<td>494</td>
<td>27,486</td>
<td>351</td>
<td>11.8</td>
<td>10,965</td>
<td>8323</td>
</tr>
<tr>
<td>South Australia</td>
<td>294</td>
<td>14,935</td>
<td>201</td>
<td>11.4</td>
<td>4674</td>
<td>3553</td>
</tr>
<tr>
<td>Tasmania</td>
<td>90</td>
<td>4026</td>
<td>93</td>
<td>17.2</td>
<td>3244</td>
<td>2468</td>
</tr>
<tr>
<td>Victoria</td>
<td>809</td>
<td>38,636</td>
<td>1177</td>
<td>24.3</td>
<td>26,402</td>
<td>20,030</td>
</tr>
<tr>
<td>Western Australia</td>
<td>256</td>
<td>10,614</td>
<td>287</td>
<td>18.7</td>
<td>7756</td>
<td>5895</td>
</tr>
<tr>
<td>Australia total</td>
<td>2904c</td>
<td>150,272c</td>
<td>3257</td>
<td>16.8d</td>
<td>84,769</td>
<td>64,467</td>
</tr>
</tbody>
</table>

a Number of people affected includes both LTCF residents and staff members.
b Number of residents affected was estimated by applying proportion of residents affected in outbreaks of different etiological agent using data from New South Wales surveillance where residents and staff members were reported separately.
c Numbers may not add up because of rounding.
d 95% confidence interval, 12.4–22.7.

the probability of etiological confirmation and could possibly affect determination of the mode of transmission [17]. We estimated the incidence rate ratio of the number of fecal specimens collected during outbreaks against the following explanatory variables: State and Territory, year of surveillance, and whether the etiology was known.

We obtained annual data on the number of residents and facilities by State and Territory from the Australian Institute of Health and Welfare [18, 19]. Human ethics committee approval was not obtained for this study, because data were deidentified and collected for public health surveillance. We analyzed data using Stata, version 10.1 (StataCorp).

RESULTS

Incidence. From 1 July 2002 through 30 June 2008, 3257 (52%) of 6295 reported outbreaks of gastroenteritis and foodborne disease in Australia occurred in LTCFs. These 3257 outbreaks caused a total of 84,769 illnesses and 1577 hospitalizations. Two hundred nine deaths were recorded during the outbreak period. The median size of LTCF outbreaks was 21 persons (range, 2–203 persons), which included both facility residents and staff members. Of the outbreaks reported, only 220 (6.8%) of 3257 affected <5 persons, representing 725 (0.9%) of all 84,769 cases.

The annual mean number of outbreaks was 16.8 (95% CI, 12.4–22.7) per 100 LTCFs. In New South Wales LTCF outbreaks of institutional gastroenteritis where staff and residents were reported separately, 20,493 (74.1%) of 27,662 persons affected were residents and 7169 (25.9%) of 27,662 were staff members. A mean of 2904 Australian facilities provided services to a mean of 150,272 residents annually. During the 6 years of surveillance, there were a total of 3.25 × 10⁸ resident bed-days. The mean incidence of outbreak-associated gastroenteritis in residents was 0.19 (95% CI, 0.14–0.26) per 1000 bed-days.

Outbreak reporting by state, year, and season. The mean annual rate of reporting varied from a low of 2.2 outbreaks per 100 facilities in the Northern Territory to a high of 26.6 outbreaks per 100 facilities in the Australian Capital Territory (Table 1). Outbreaks were most common in Australia’s winter (June–August), when 1070 (33%) of all 3257 outbreaks were reported, and in spring (September–November), with 926 (28%) of 3257 reports (Figure 1). This was driven by outbreaks of norovirus and unknown etiological agents, although during 2 years (2003, 2005), the nadir occurred in June-July and no seasonal pattern was observed. When compared to the first year of surveillance (2002–2003), the rate of reported outbreaks was significantly higher in subsequent years (Figure 2). The highest number of reports occurred in 2007–2008 when there were 1050 outbreaks, equating to 37.1 outbreaks per 100 facilities.

We observed significant differences between States and Territories in the number of fecal specimens collected during outbreak investigations, with the mean number of specimens ranging from a low of 2.2 per investigation in Tasmanian outbreaks to a high of 6.5 in the Northern Territory (Table 2). Victoria had the highest incidence rate ratio for collection of fecal specimens during LCTF outbreaks. Significantly more fecal specimens were collected in outbreaks where the etiology was unknown, and 750 (37%) of 2042 outbreaks of unknown etiology had no specimen collected.

Mode of transmission. In outbreaks where transmission was characterized, person-to-person spread accounted for 1986 (90%) of all 2212 outbreaks and 52,952 (94%) of 56,273 per-
Figure 1. Outbreaks of gastroenteritis in long-term care facilities for norovirus (gray) and all other etiological agents combined (white), by month of surveillance, Australia, 1 July 2002–30 June 2008. All other etiological agents includes outbreaks due to all agents other than norovirus, including rotavirus, *Salmonella*, *Campylobacter*, *Clostridium perfringens*, and those of unknown etiology.

sons affected. New South Wales reported 1045 outbreaks affecting 28,496 people which were coded as “Unknown (Institutional)” and the mode of transmission was not further characterized. During the 6-year surveillance period, investigators suspected contaminated food resulted in 43 (1.3%) of 3257 outbreaks in LTCFs; of which, 28 (65%) of 43 were reported from Victoria. There were only 2 outbreaks of waterborne transmission during the period. The percentage of people hospitalized or who died was highest in foodborne outbreaks, where it was 6.4% (47 of 733) and 2.7% (20 of 733), respectively. Only 1 outbreak of norovirus was considered to be foodborne, with the remaining outbreaks spread from person to person. Outbreaks transmitted from person to person were associated with 141 (67.5%) of 209 reported deaths, whereas “Unknown (Institutional)” outbreaks in New South Wales were associated with 40 (19.1%) of 209 deaths.

**Agents causing outbreaks.** During the study period, norovirus was responsible for 1136 (35%) of 3257 outbreaks (Table 3). Outbreaks attributed to norovirus had a median size of 31 persons, making this pathogen responsible for the largest outbreaks. In New South Wales outbreaks, 1238 (24.9%) of 4734 people affected in norovirus outbreaks were LTCF staff members, compared with 222 (29.9%) of 658 for mixed infections, 27 (15.8%) of 114 for rotavirus, and 5682 (23.4%) of 22,156 for unknown agents.

Norovirus outbreaks were most common in winter and early spring when 359 (32%) and 365 (32%) of 1136 outbreaks were reported, respectively (Figure 1). Twelve (80%) of all 15 *Salmonella* outbreaks occurred in spring and summer, whereas 13 (62%) of 21 rotavirus outbreaks were reported in spring.

Bacterial outbreaks due to *Salmonella* and *Campylobacter* resulted in the highest proportion of people hospitalized, whereas *Salmonella* had the highest case fatality ratio (8.1%). Twenty-one outbreaks of rotavirus affected 344 people, with a case fatality ratio of 0.3%. There were 120 deaths reported during outbreaks attributed to norovirus (case fatality ratio, 0.3%), representing the largest number of deaths associated with any pathogen. People affected by *C. perfringens* intoxication had the shortest mean duration of illness at 42 h (95% CI, 27–57 h), compared with norovirus (mean duration, 58 h; 95% CI, 55–60 h; *P* = .12), rotavirus (mean duration, 95 h; 95% CI, 41–148 h; *P* = .02), and *Salmonella* (mean duration, 110 h; 95% CI, 76–144 h; *P* = .001).

Mixed pathogens were reported in 18 outbreaks, all of which involved detection of norovirus with other pathogens. In 9 (50%) of these 18 outbreaks, norovirus was detected in >1 fecal specimen, with the other organism detected in a single specimen. In the remaining outbreaks, norovirus was detected in only 1 specimen or the number of positive specimens was not stated.

Applying the Centers for Disease Control and Prevention criteria resulted in coding 536 (16%) of 3257 outbreaks as
Figure 2. Incidence rate ratio of gastroenteritis outbreaks in long-term care facilities by year of surveillance relative to the baseline year when surveillance began in 2002–2003, Australia, 1 July 2002–30 June 2008. Figures in brackets represent 95% confidence intervals around point estimates for incidence rate ratios.

“unknown” etiology despite an agent being detected in a single fecal specimen, including noroviruses in 495 outbreaks and rotaviruses in 26 outbreaks. There were 1506 (46.2%) of 3257 outbreaks where no fecal specimens were positive for any recognized pathogens.

**DISCUSSION**

We estimate that 17% of Australian LTCFs experience an outbreak of gastroenteritis each year, or that each facility has an outbreak once every 4-8 years. Our estimate of incidence was conservative, representing the mean of 6 years of data, including years when reports were lower and surveillance was newly established. A recent meta-analysis of LTCF infection surveillance estimated that residents experienced 0.4 episodes of gastroenteritis per 1000 bed-days [20], which is similar to our findings. As gastroenteritis in residents is often outbreak associated [3, 21], we believe that our estimate of incidence is credible and that ascertainment of LTCF outbreaks during surveillance was high.

Outbreaks cause considerable disruption to facility activities, illness in residents, staff members and visitors, and deaths in susceptible residents. Surveillance for outbreaks in other countries has highlighted a similarly high burden in LTCFs [22–24], although few studies have specifically examined outbreak-associated gastroenteritis in residents. One study in England and Wales found that 233 (83%) of 282 outbreaks had a microbiologically confirmed etiology, which was higher than what we report [25], although the overall rate of reporting was lower than for our study. To assist with managing outbreaks, Australian facilities develop plans to respond to outbreaks [26, 27].

Norovirus spread from person to person was the most common cause of LTCF outbreaks and was responsible for the largest number of deaths. Noroviruses are highly infectious [28], environmentally persistent, and difficult to disinfect [29]. During outbreaks, facilities implement control measures [30], such as hand washing and use of personal protective equipment, isolation of infected residents, exclusion of symptomatic staff and visitors, environmental disinfection, and management of contaminated waste and laundry [29]. Disinfection and contact precautions [29, 31] appear to be the most effective interventions, particularly when implemented within 3 days of an outbreak beginning [30]. Well-designed studies of infection control measures in LTCFs are urgently needed, because the effectiveness of interventions are not well established [30].

Foodborne disease outbreaks, although rarer and smaller, resulted in worse outcomes for residents. In particular, the high case fatality ratio for *Salmonella* reinforces the importance of rapid detection and investigation to prevent further illness. Victoria reported two-thirds of all foodborne and waterborne outbreaks, despite only one-quarter of LTCF residents living in...
Table 2. Multivariable Analysis of the Number of Fecal Specimens Collected during Outbreaks in Long-Term Care Facilities, by State and Territory, Year of Surveillance, and Whether the Etiology of the Outbreak Was Unknown, Australia, 1 July 2002–30 June 2008

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>No. of fecal specimens collected/total no. of persons ill (%)</th>
<th>No. of outbreaks with fecal specimens collected/total no. of outbreaks (%)</th>
<th>Mean no. of fecal specimens per outbreak</th>
<th>Incidence rate ratio (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australian Capital Territory</td>
<td>114/1232 (9)</td>
<td>33/37 (89)</td>
<td>3.5</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>New South Wales</td>
<td>261/30,44 (9)</td>
<td>875/1109 (79)</td>
<td>3.0</td>
<td>1.1 (0.7–1.6)</td>
<td>.71</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>13/55 (24)</td>
<td>2/2 (100)</td>
<td>6.5</td>
<td>1.8 (1.1–2.8)</td>
<td>.01</td>
</tr>
<tr>
<td>Queensland</td>
<td>1805/10,965 (16)</td>
<td>335/351 (95)</td>
<td>5.4</td>
<td>1.7 (1.1–2.7)</td>
<td>.02</td>
</tr>
<tr>
<td>South Australia</td>
<td>666/4674 (14)</td>
<td>193/201 (96)</td>
<td>3.5</td>
<td>1.6 (1.0–2.5)</td>
<td>.04</td>
</tr>
<tr>
<td>Tasmania</td>
<td>179/3244 (6)</td>
<td>83/93 (89)</td>
<td>2.2</td>
<td>0.6 (0.4–0.9)</td>
<td>.03</td>
</tr>
<tr>
<td>Victoria</td>
<td>5349/26,402 (20)</td>
<td>1072/1177 (91)</td>
<td>5.0</td>
<td>1.9 (1.2–2.9)</td>
<td>&lt;.003</td>
</tr>
<tr>
<td>Western Australia</td>
<td>961/7756 (12)</td>
<td>280/287 (98)</td>
<td>3.4</td>
<td>1.2 (0.8–1.9)</td>
<td>.36</td>
</tr>
<tr>
<td>Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002–2003</td>
<td>700/5352 (13)</td>
<td>184/199 (92)</td>
<td>3.8</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>2003–2004</td>
<td>1613/15,200 (11)</td>
<td>362/461 (79)</td>
<td>4.5</td>
<td>1.2 (0.9–1.4)</td>
<td>.21</td>
</tr>
<tr>
<td>2004–2005</td>
<td>1381/10,268 (13)</td>
<td>330/368 (90)</td>
<td>4.2</td>
<td>1.1 (0.9–1.4)</td>
<td>.28</td>
</tr>
<tr>
<td>2005–2006</td>
<td>1962/15,159 (13)</td>
<td>498/536 (93)</td>
<td>3.9</td>
<td>1.1 (0.9–1.4)</td>
<td>.28</td>
</tr>
<tr>
<td>2006–2007</td>
<td>2377/16,158 (15)</td>
<td>596/643 (93)</td>
<td>4.0</td>
<td>1.3 (1.1–1.6)</td>
<td>.01</td>
</tr>
<tr>
<td>2007–2008</td>
<td>3644/22,632 (16)</td>
<td>903/1050 (86)</td>
<td>4.1</td>
<td>1.5 (1.2–1.8)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Etiology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Known</td>
<td>7707/41,098 (19)</td>
<td>1175/1215 (97)</td>
<td>6.6</td>
<td>Reference</td>
<td></td>
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<tr>
<td>Unknown</td>
<td>3991/43,671 (9)</td>
<td>1698/2042 (83)</td>
<td>2.4</td>
<td>0.7 (0.6–0.7)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

NOTE. CI, confidence interval.

* Incidence rate ratios were estimated from negative binomial regression of the number of fecal specimens collected against the State, year, and whether the etiology of the outbreak was unknown. The natural log of the number of people ill was included as an offset in the model.

that State. Applying the Victorian reporting rate to Australia, we might have expected 2–3 times as many outbreaks of foodborne and waterborne disease than we report. The higher rate in Victoria may have been attributable to concerted investigation efforts, shown by the higher likelihood of fecal specimen collection. Victorian surveillance relies on early notification from LTCFs, faxing line lists of affected residents and staff, along with intensive efforts to confirm the etiology (http://www.health.vic.gov.au/ideas/diseases/gas_ill_index), an approach adopted by other jurisdictions. In general, clinicians can suspect a foodborne source for an outbreak where illnesses in case patients are severe and clustered in time; most people experience diarrhea; and few infections occur among staff.

We used Centers for Disease Control and Prevention criteria

Table 3. Features of Outbreaks of Gastroenteritis in Long-Term Care Facilities, by Etiological Agent, Australia, 1 July 2002–30 June 2008

<table>
<thead>
<tr>
<th>Etiological agent</th>
<th>No. of outbreaks</th>
<th>No. of persons affected</th>
<th>Median no. of persons ill per outbreak (IQR)</th>
<th>Duration of outbreak, median days (IQR)</th>
<th>Case fatality ratio, %</th>
<th>Mean proportion of patients reporting, %</th>
<th>Vomiting</th>
<th>Diarrhea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter species</td>
<td>8</td>
<td>65</td>
<td>6 (4–10)</td>
<td>3 (2–6)</td>
<td>0</td>
<td>18</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>14</td>
<td>354</td>
<td>22 (12–31)</td>
<td>3 (1–9)</td>
<td>2.2</td>
<td>6</td>
<td>100</td>
<td></td>
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<tr>
<td>Norovirus</td>
<td>1136</td>
<td>39,419</td>
<td>31 (19–45)</td>
<td>10 (7–14)</td>
<td>0.3</td>
<td>63</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>Rotavirus</td>
<td>21</td>
<td>344</td>
<td>13 (8–20)</td>
<td>10 (7–13)</td>
<td>0.3</td>
<td>57</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>Salmonella</td>
<td>15</td>
<td>172</td>
<td>5 (3–18)</td>
<td>10 (3–16)</td>
<td>8.1</td>
<td>47</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>Mixed infections</td>
<td>18</td>
<td>703</td>
<td>30.5 (17–57)</td>
<td>12 (8–12)</td>
<td>0.1</td>
<td>57</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous viruses</td>
<td>3</td>
<td>41</td>
<td>12 (9–20)</td>
<td>8 (5–9)</td>
<td>0</td>
<td>15</td>
<td>98</td>
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<tr>
<td>Unknown</td>
<td>2042</td>
<td>43,671</td>
<td>17 (8–29)</td>
<td>7 (3–11)</td>
<td>0.1</td>
<td>52</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3257</td>
<td>84,769</td>
<td>21 (11–35)</td>
<td>8 (5–13)</td>
<td>0.2</td>
<td>56</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>

NOTE. IQR, interquartile range.
to assess the etiology of outbreaks, which required ≥2 positive fecal specimens for most pathogens. For norovirus, a single positive specimen during an LTCF outbreak probably has high positive predictive value [32]. It is likely that norovirus caused 50% of LTCF outbreaks in our study, because in 495 outbreaks, a single specimen was positive for norovirus. No C. difficile outbreaks were reported, possibly because Australian pathology laboratories did not test for it during outbreaks [33] (T. Riley, personal communication). C. difficile is common in LTCF residents [34], and clinicians should consider toxin tests for fecal specimens collected during outbreaks [35].

Outbreak data are subject to limitations [15], including different State and Territory health department investigative approaches. This was supported by the variation of fecal specimen collection by jurisdiction and by time, although this may reflect LTCF willingness and awareness to collect specimens. We did not attempt to validate surveillance data reported by jurisdictions, such as the cause of deaths occurring during outbreaks. During surveillance, we observed an increase in the number of outbreaks over time, which may have reflected improved reporting. Alternatively, global spread of GI.4 strains of norovirus that occurs every couple of years could have resulted in a genuine increase [29, 36]. Despite variations in legal requirements for LTCFs to report outbreaks of gastroenteritis by jurisdiction, rates of outbreak reporting were reasonably consistent across the country. Our assessment of mode of transmission was problematic, because New South Wales only reported outbreaks categorized as foodborne, waterborne, or “Unknown (Institutional).” However, other jurisdictions consistently reported mode of transmission.

New South Wales data allowed us to adjust numbers in other jurisdictions and estimate the incidence of gastroenteritis in LTCF residents and staff members. For highly transmissible agents, one-quarter of all infections occurred in staff members, highlighting the burden that gastroenteritis outbreaks place on the LTCF workforce [29]. There is a need for greater focus on prevention of outbreak-associated gastroenteritis in staff members [30].

This study highlights the large number of gastrointestinal outbreaks that occur in Australian LTCFs annually. Given the potential burden, we encourage other countries to review data on outbreaks to identify how to prevent disease in vulnerable residents. To improve confirmation of etiology and reporting LTCF outbreaks, public health agencies need to standardize investigation methods and improve identification of foodborne outbreaks. From our study, the dominant role of norovirus in outbreaks is clear, although clinicians should be alert for serious foodborne outbreaks. It is essential that LTCFs and the public health community work together to identify effective infection control measures to reduce the impact of gastroenteritis outbreaks.

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Potential conflicts of interest. All authors: no conflicts.

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