



## Review

## Assessing the incidence of gastroenteritis among elderly people living in long term care facilities

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## SUMMARY

We conducted a systematic review and meta-analysis of the literature in order to estimate the incidence of gastroenteritis in long term care facility (LTCF) residents from published accounts of infection surveillance. PubMed, Web of Science and Google Scholar were searched using keywords 'long-term care facility', 'nursing home', 'gastroenteritis', 'surveillance', and 'incidence'. We manually searched reference lists of all articles included. The number of cases of gastroenteritis and bed-days under surveillance was recorded so as to calculate incidence and assess the influence of the study country and case definition using random effects meta-analysis and regression. We included one trial and 14 surveillance studies in the analysis, with 47% (7/15) conducted after 1995. One study focused only on gastroenteritis in residents; the remainder considered a range of infections. There were 2 071 330 combined bed-days under surveillance and 717 cases of gastroenteritis. In all, 194 cases were associated with 10 outbreaks during these studies. We observed heterogeneity between studies, which may have been due to unreported clustering of gastroenteritis cases. The mean incidence of gastroenteritis in LTCF residents was 0.40 (95% confidence interval: 0.27–0.56) episodes per 1000 bed-days. Investigators conducting studies in the USA reported incidence three times lower than investigators in other countries. Use of a case definition developed specifically for LTCFs was not associated with a higher incidence of gastroenteritis. From our analysis, residents could expect to experience gastroenteritis once every 5–10 years, which is a lower rate than that estimated from point prevalence surveys. New studies are needed to better assess the incidence and causes of gastroenteritis in LTCF residents.

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## Introduction

Residents of long term care facilities (LTCFs) may be vulnerable to infections, including those affecting skin and respiratory, urinary and gastrointestinal tracts.<sup>1</sup> Gastroenteritis is usually mild and self-limiting, but may be more likely to result in hospitalisation and death among elderly people, particularly those in LTCFs, due to

frailty and chronic illnesses.<sup>2–4</sup> LTCF residents acquire gastroenteritis from a range of sources, including other infected persons or animals, or contaminated environments, foods or water.<sup>5</sup>

Many prospective surveillance studies in LTCF residents have attempted to estimate the burden and relative importance of different infectious conditions.<sup>6,7</sup> Facility practitioners conduct surveillance for infectious diseases to monitor facility performance and detect outbreaks.<sup>8</sup> Surveillance studies published in the literature commonly use definitions for infectious conditions developed at a Canadian consensus conference in 1991 developed specifically for the long term care setting, known as 'McGeer's definitions'. Studies conducted prior to this time used definitions that may have been less sensitive.<sup>9–11</sup> To meet McGeer's definition

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for gastroenteritis, a resident must have two or more episodes of diarrhoea or vomiting in 24 hours, or have a stool specimen positive for a pathogen or toxin with at least one symptom consistent with the agent. Participants at the Canadian consensus conference expressed reservations about this definition of gastroenteritis, as it was 'generally thought that because gastrointestinal symptoms are common, and viral gastroenteritis is often a mild disease, any definition that captured most viral gastroenteritis would also label many non-infectious episodes as infections'.<sup>10</sup> Despite widespread use of this definition since the conference, validation studies have not been published.

Gastroenteritis outbreaks affecting LTCF residents may have serious consequences and cause concern for governments and the public.<sup>4</sup> In recent years the high frequency of outbreaks in LTCFs has been widely recognised, but less is known about the occurrence of sporadic gastroenteritis.<sup>5</sup> In this paper, we systematically review the literature to summarise studies examining gastroenteritis in LTCF residents and conduct a meta-analysis to estimate the pooled mean incidence of this condition.

## Methods

We searched PubMed, Web of Science and Google Scholar for article titles published in any language. All searches were started with the terms 'long-term care' or 'nursing home' and then followed by combinations of 'diarrhoea', 'gastroenteritis', 'infection', 'surveillance', and 'incidence'. Relevant abstracts were reviewed for retrieval of a full article. We manually searched reference lists of all articles to identify further relevant studies on incidence. All articles considered for inclusion were assessed by two reviewers (M.D.K. and G.V.H.) and studies were included only where there was agreement.

For the purpose of this review, an LTCF was defined as an institution providing health care to elderly people unable to manage independently in the community and included nursing homes and chronic care facilities.<sup>8</sup> In the review, we included studies that represented prospective surveillance of gastroenteritis in LTCF residents, and the methods and case definitions used for surveillance were clearly stated. We excluded retrospective studies and cross-sectional surveys of infection prevalence from the review. We excluded studies where investigators did not report gastroenteritis separately in either the methods or results; the case definition was poorly described; or they combined in the numerator the number of episodes of gastroenteritis with other conditions, such as diverticulitis, cholecystitis and intra-abdominal infection.

Relevant data from articles were extracted, including the country and year of study, the case definition used, the number of facilities under surveillance, the number of resident bed-days, the number of episodes of gastroenteritis, and any clustering of cases that was observed. Where study investigators did not report the person-time under study, we divided the number of cases of gastroenteritis by the reported incidence per 1000 bed-days to estimate the number of bed-days for further analysis.

We used a Freeman–Tukey arcsine transformation of the incidence of gastroenteritis reported in each individual study to stabilise the variances and bring the characteristics of the transformed data close to those of the normal distribution.<sup>12</sup> The arcsine-transformed product ( $t$ ) was calculated by:

$$t = \arcsin(r/n + 1)^{1/2} + \arcsin((r + 1)/(n + 1))^{1/2},$$

where  $r$  represented the number of gastroenteritis events occurring during the study and  $n$  the number of bed-days under surveillance. Transformed gastroenteritis incidence was entered as a random

effect in meta-analysis and heterogeneity of study findings assessed using the  $I^2$  statistic.<sup>13</sup> Meta-regression was used to assess the importance of the country in which the study was conducted, the case definition used, whether investigators documented outbreaks, and the incidence of gastroenteritis if the study was conducted after 1995. Where predictors significantly affected transformed incidence rates, meta-analyses were stratified. We back-transformed results to calculate pooled estimates of the mean incidence of gastroenteritis in LTCF residents per 1000 bed-days.<sup>14</sup> Data were analysed in Stata version 10.1 (Statacorp., College Station, TX, USA).

## Results

As a result of the electronic search, we examined 559 article titles and 37 abstracts. Figure 1 summarises the selection process and shows the number of articles included in the review.<sup>6,9,11,15–26</sup> In our final analysis, we included one intervention trial and 14 studies where gastroenteritis was an outcome of healthcare-associated infection surveillance (Table 1).

Eight surveillance studies were conducted in the 1980s, two in the 1990s, four studies since 2000, and one published in 2007 did not record when it was conducted. The 15 studies were conducted in Brazil (one), Canada (two), Germany (two), Norway (one) and the USA (nine). All studies reported similar methods of surveillance and reporting cases of gastroenteritis. Most investigators used trained infection control practitioners to collect data. The median number of residents under surveillance was 403 (range: 55–1273), and 60% (9/15) of studies were conducted in one or two facilities. The median duration of study was 12 months (range: 6–36 months).

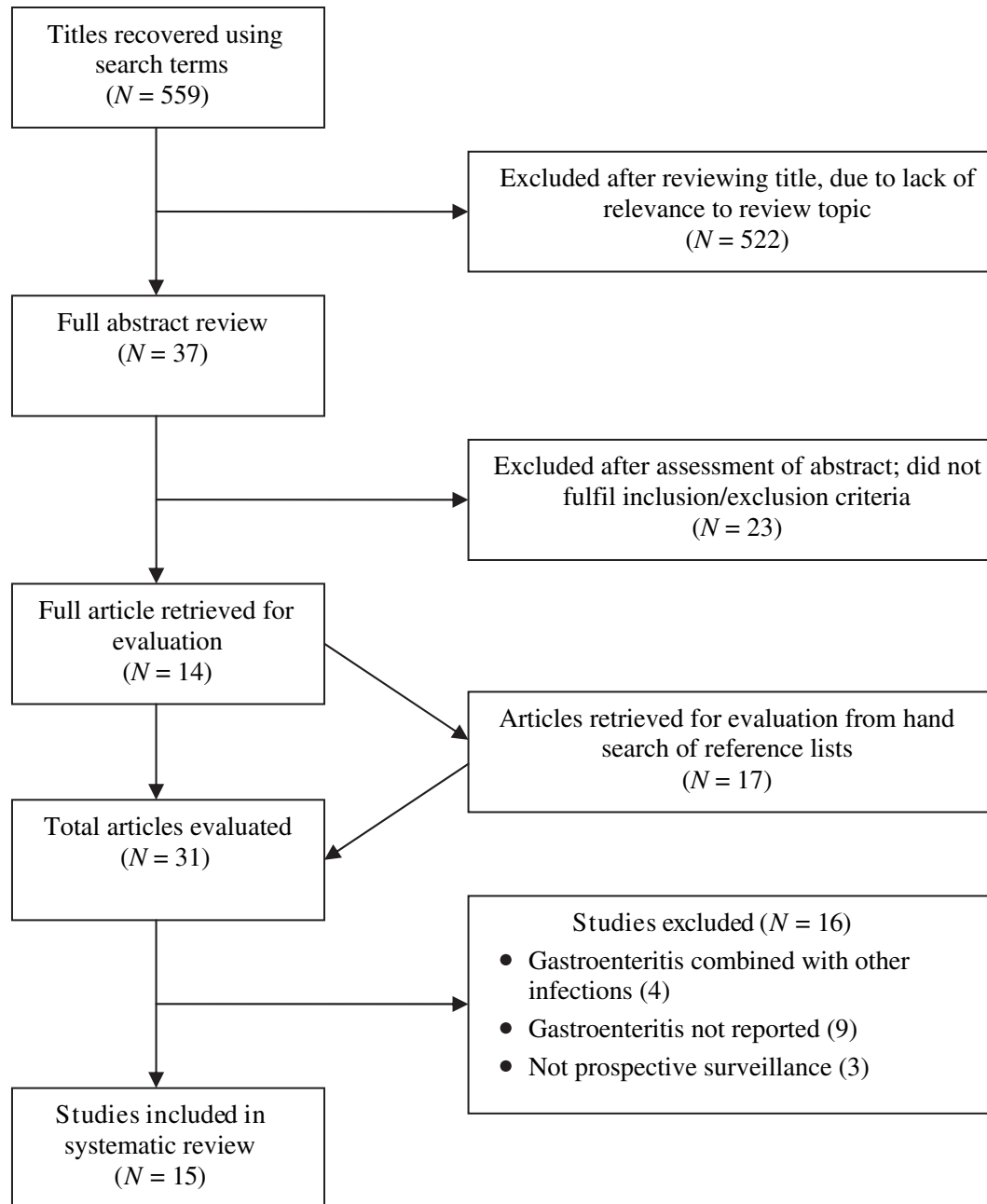
The median number of resident bed-days under surveillance for these 15 studies was 74 370 bed-days (range: 15 218–472 019) and the median incidence of gastroenteritis was 0.38 episodes per 1000 bed-days (range: 0.04–1.9 episodes per 1000 bed-days; Table 1). In studies comparing all infections acquired while living in long term care, gastroenteritis represented a median of 7% of all infections (range: 1–21%).

In total, there were 2 071 330 bed-days under surveillance in the 15 studies and investigators detected 717 cases of gastroenteritis. The pooled estimate of the mean gastroenteritis incidence from meta-analysis was 0.40 (95% CI: 0.27–0.56) events per 1000 bed-days. We observed considerable variation of reported incidence between studies, which reflected a high degree of heterogeneity ( $I^2 = 95.7\%$ ).

Investigators noted clustering of gastroenteritis cases in 40% (6/15) of studies, with four investigators reporting one outbreak, and two reporting three outbreaks. No investigator reported how an outbreak was defined. All investigators reported the number of cases involved in the outbreak, except for one study where we estimated the number of cases from the published epidemic curve.<sup>20</sup> We estimated that a total of 194 cases were associated with these 10 outbreaks.

Six studies used a case definition based on a Canadian consensus conference reported by McGeer *et al.*, with the remainder using self-constructed definitions or modified from Centers for Disease Control and Prevention (Table 1).<sup>10,27</sup> In regression analysis, the case definition used did not ( $P = 0.7$ ) significantly affect incidence rates. Similarly, whether investigators reported clustering of cases ( $P = 0.6$ ) or the study was conducted after 1995 ( $P = 0.7$ ) did not significantly affect incidence rates.

The mean rate of gastroenteritis for studies conducted in the USA was 0.23 (95% CI: 0.15–0.35) cases per 1000 bed-days, which was significantly lower than for studies conducted in other countries where the mean rate was 0.74 (95% CI: 0.39–1.2) cases per 1000 bed-days (Figure 2).



**Figure 1.** Flow diagram of studies identified and included in systematic review examining the incidence of gastroenteritis in residents of long term care facilities.

## Discussion

We were surprised to find how rarely gastroenteritis was reported among LTCF residents in these studies, given that these facilities are one of the most common settings of reported outbreaks of gastroenteritis in many countries.<sup>28,29</sup> We estimated that LTCF residents experience approximately one episode every 5–10 years. This reported rate was lower than that found in studies of gastroenteritis in persons aged >65 years living in the community.<sup>30</sup>

In our review, only two studies in Germany reported incidence rates (0.45 and 0.52 episodes per person per year) comparable to that found in community-based studies in developed countries.<sup>6,17,30</sup> It is unclear why studies conducted outside the USA reported higher incidence. It is possible that the higher incidence is

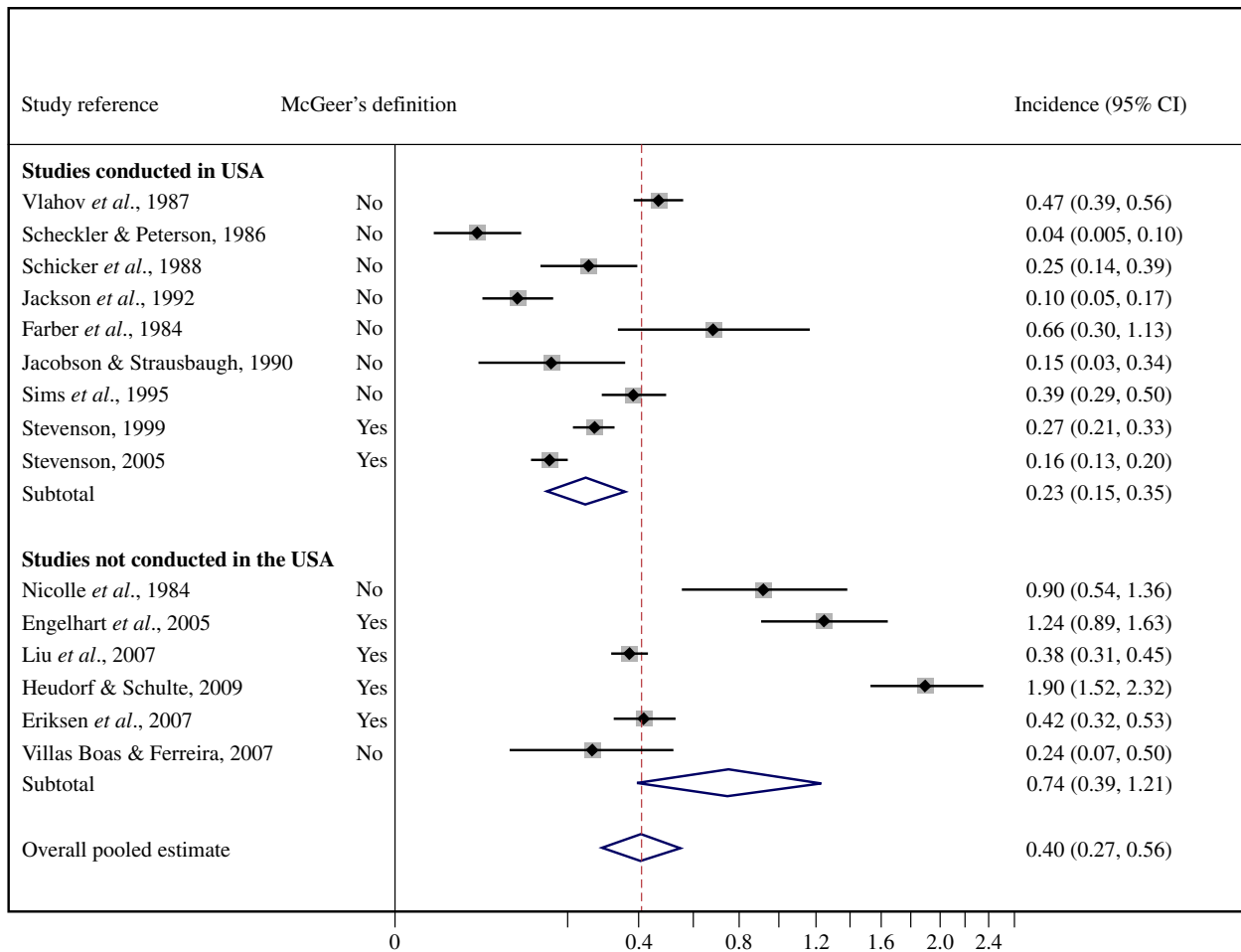
due to different pathogens causing disease in different countries, or greater recognition of gastroenteritis as a nosocomial syndrome in LTCF residents outside the USA. There is also the possibility of subtle differences in methods used by investigators that we were unable to observe from published accounts.

Our estimate of incidence was also lower than that observed in point prevalence surveys, which we excluded from our review. In our literature search, we identified five point prevalence surveys reporting cases of gastroenteritis, along with other infections.<sup>18,21,31–33</sup> The point prevalence of gastroenteritis in residents reported by these studies varied from 0.5% to 3%. If we assume that an episode of gastroenteritis lasts an average of three days in an elderly person, then estimates of incidence from these point prevalence studies would range from 1.4 to 8 episodes per 1000 bed-days. It is important to recognise that these point

**Table 1**  
Incidence of gastroenteritis among long term care facility residents from prospective surveillance reported in the literature

Study period and country	Surveillance methods	Data collection frequency	Case definition	No. of facilities	Residents under surveillance	No. of bed-days	Cases of gastroenteritis	Outbreak associated cases	Proportion of HCAI (%)	Reference
12 months 1983–1984, Maryland, USA	ICP	NS	Self-constructed	2	690	242 040	114	100	13	Vlahov <i>et al.</i> <sup>11</sup>
6 months, 1984–1985, Wisconsin, USA	TP	NS	CDC NNIS 1975	8	403	74 370	3	Unknown	1	Scheckler and Peterson <sup>21</sup>
12 months, 1985–1986, USA	TP, CR	Daily	Based on CDC definitions	1	166	60 672	15	Unknown	4.5	Schicker <i>et al.</i> <sup>22</sup>
3 years, 1984–1987, California USA	TP, CR	Weekly	Based on CDC definitions	1	666	110 746	11	Unknown	1	Jackson <i>et al.</i> <sup>18</sup>
12 months, 1982, Manitoba, Canada	TP, CR, Q, WR	2–5 times per week	Based on CDC definitions	1	68	21 000	19	12	17	Nicolle <i>et al.</i> <sup>20</sup>
12 months, 1982–1983, Pennsylvania, USA	TP, CR, WR	Weekly	Self-constructed	1	111	15 218	10	10	8	Farber <i>et al.</i> <sup>16</sup>
9 months, 1985–1986, Oregon, USA	TP, CR	NS	CDC NNIS 1975	1	231	26 600	4	4	4	Jacobson and Strausbaugh <sup>9</sup>
8 months, 1988–1989, Pennsylvania, USA	TP, CR, Q	Daily	Self-constructed	3	572	137 280	53	Unknown	Unknown	Sims <i>et al.</i> <sup>23</sup>
12 months, 1998–1989, Germany	TP, CR, WR	2–3 times weekly	Modified McGeer	1	125	34 793	43	Unknown	21	Engelhart <i>et al.</i> <sup>6</sup>
30 months, 1996–1998, Idaho, USA	TP, Q		McGeer	6	655	328 065	88	11	7	Stevenson <sup>24</sup>
18 months, Toronto, Canada	TP, Q	NS	McGeer	21	763	339 195	128	Unknown	10	Liu <i>et al.</i> <sup>19</sup>
12 months, 2001, Idaho, USA	ICP, TP, CR, WR, Q	NS	McGeer	17	1273	472 019	77	Unknown	4	Stevenson <i>et al.</i> <sup>25</sup>
6 months, 2006, Frankfurt, Germany	TP, Q	1–2 times weekly	Modified McGeer	2	278	45 710	87	Unknown	Unknown	Heudorf and Schulte <sup>17</sup>
6 months, 2004, Bergen, Norway	TP, Q	Weekly	McGeer	6	791	142 688	60	57	8	Eriksen <i>et al.</i> <sup>15</sup>
12 months, 2003, Botucatu, Brazil	TP, Q	NS	Society for Healthcare Epidemiology America	1	55	20 896	5	Unknown	7	Villas Boas and Ferreira <sup>26</sup>

HCAI, healthcare-associated infection; CDC, Centers for Disease Control and Prevention; NNIS, National Nosocomial Infection Surveillance; ICP, data compiled from existing infection control programme; TP, trained nurse or infection control practitioner collected data; CR, chart review to identify infections; Q, questionnaires or standard forms used to record infection data; NS, not stated.



**Figure 2.** Mean incidence of gastroenteritis in long term care facility residents stratified by country and showing studies using McGeer's case definition, with the position of each symbol representing each respective study and the horizontal line indicating the 95% confidence interval (CI) of each study.

prevalence surveys were underpowered to study gastroenteritis with only two of five studies recording more than 10 cases each, making comparisons with incidence studies unreliable.<sup>34</sup> Point prevalence studies also rarely take into account the likelihood of clustering for infections, which is high for gastroenteritis.

The occurrence of outbreaks influences the incidence of nosocomial infections and in the studies we examined investigators did not compare the incidence of epidemic and non-epidemic infections. It is important to consider outbreak-associated cases as a part of the burden of infection and to document their relative occurrence to sporadic cases. It is likely that some studies in our review included outbreak-associated cases that were not recognised as such or reported by authors. Unreported outbreak-associated cases could account for the significant heterogeneity we observed between studies of similar methods. The majority of outbreaks were small, although one study reported that two clusters accounted for all 96 cases in a single facility during a single year of surveillance.<sup>11</sup>

Approximately 53% of the studies were conducted before 1995. However, we did not observe changes in the incidence of gastroenteritis in these studies over time. There are several reasons why we might have expected incidence to have changed, including: introduction of mandatory infection control surveillance, changes to the LTCF population and management practices in LTCFs, increased contact between LTCF residents and healthcare services, new diagnostic tests, and global spread of pathogens, such as norovirus.<sup>8,35</sup>

Diagnostic tests have highlighted the important role of norovirus and *Clostridium difficile* in the epidemiology of gastroenteritis in LTCF residents.<sup>36–38</sup> A study in Ohio in 2006 reported that LTCF residents experienced 0.3 episodes of *C. difficile* infection per 1000 bed-days, although the proportion of cases experiencing symptoms was not reported.<sup>36</sup> Similarly, studies of norovirus infections in LTCF residents show that these infections are one of the most common gastrointestinal pathogens and commonly result in outbreaks.<sup>38,39</sup> There is a need for further work to clarify the role of different aetiological agents of gastroenteritis in facility residents, which may allow for specific interventions.

Many of the studies we included compared the incidence of different nosocomial infections, which means that they may not have been focused on recognition of gastroenteritis and were inadequately powered to study rarer conditions. In this meta-analysis, we pooled results across studies to assess the burden of gastroenteritis and were able to overcome the lack of larger studies.<sup>24</sup> Although we did not observe a statistically significant difference based on whether or not the McGeer definition was used, in community-based surveys of gastroenteritis the choice of case definition makes considerable differences to the estimated incidence of gastroenteritis.<sup>40</sup> In the 15 studies we reviewed, there were at least seven different case definitions used and only one study documented compliance with case definition by reporting symptoms.<sup>17</sup> One study that specifically studied gastroenteritis in three LTCFs noted that one-third of potential illness events were excluded because they did not meet the case definition.<sup>23</sup>



We observed differences in the intensity of surveillance and the way that data were collected between studies, but data were insufficient for formal comparison.<sup>6</sup> A limitation of our study was that we did not include unpublished datasets in our review. We were unable to locate unpublished and less accessible data despite extensive web-searching and evaluation of nursing and allied health databases, and so decided to rely solely on published data to maintain consistency within our review.<sup>4</sup> We do not believe that this would have introduced significant biases, as gastroenteritis was only one of many infections under surveillance in nearly all studies. Approximately half of the studies included were identified through hand-searching of reference lists, highlighting the difficulties of appropriate indexing and reviewing the literature systematically. Despite this, we believe that we successfully included a high proportion of relevant published data, as this study was part of a broader literature review into gastroenteritis in institutionalised elderly.<sup>5</sup>

The incidence of reported gastroenteritis in LTCF residents was relatively low, nevertheless it is important that we learn more about this condition due to its potential for serious clinical outcomes and propensity to cause outbreaks.<sup>8</sup> In this study, we were limited in the conclusions we could draw due to the small number of studies identified and the subtly different methods employed. We would encourage investigators to systematically collect and publish data on gastroenteritis in LTCF residents, and to consider the influence of the case definition, study design and outbreaks in calculations of incidence. In particular, it is important to learn more about the microbiological causes of gastroenteritis in LTCF residents.

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## Conflict of interest statement

None declared.

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