Types of infectious outbreaks and their impact in elderly care facilities

MOMOE UTSUMI1, KYO KO MAKIMOTO1, NA HID QUROSHI1, NOBUYUKI ASHI DA2

1Graduate School of Medicine, Division of Health Science, Osaka University, 1-7 Yamadaoka, Suita City, Osaka 565-0871, Japan
2Division of Contemporary Business Administration, Koshien University, 10-1 Momijigaoka Takarazuka City, Hyogo 665-0006, Japan

Address correspondence to: K. Makimoto. Tel: (+81) 6 6879 2541; Fax: (+81) 6 6879 2541. Email: kmakimoto@sahs.med.osaka-u.ac.jp

Abstract

Background: infectious outbreaks in long-term care facilities (LTCFs) tend to have a significant impact on infection rates and mortality rates of the residents.

Types of infectious outbreaks and their impact in elderly care facilities: a review of the literature

© The Author 2010. Published by Oxford University Press on behalf of the British Geriatrics Society. All rights reserved. For Permissions, please email: journals.permissions@oxfordjournals.org

Received 14 October 2009; accepted in revised form 13 January 2010


**Objectives:** this review aimed to update the information on pathogens identified in such outbreaks and to try to explore indicators that reflect the impact of outbreaks among residents and health care workers (HCWs).

**Methods:** MEDLINE (1966–2008) was used to identify outbreaks using the following thesaurus terms: ‘Cross-Infection’, ‘Disease Outbreaks’, ‘Urinary-Tract Infections’ and ‘Blood-Borne Pathogens’. Elderly care facilities were identified with the following thesaurus terms: ‘Long-Term Care’, ‘Assisted-Living Facilities’, ‘Homes for the Aged’ and ‘Nursing Homes’. Age category was limited using ‘Aged’.

**Results:** thirty-seven pathogens were associated with 206 outbreaks. The largest number of reported outbreaks by a single pathogen involved the influenza virus, followed by noroviruses. Among residents, the highest median attack rate for respiratory infection outbreaks was caused by *Chlamydia pneumoniae* (46%), followed by respiratory syncytial virus (40%). In gastrointestinal tract infection outbreaks, high median attack rates were caused by *Clostridium perfringens* (48%) and noroviruses (45%). Outbreaks with high median case fatality rates were caused by Group A *Streptococci* (50%) and *Staphylococcus pneumoniae* (44%). High median attack rates for HCWs were caused by *C. pneumoniae* (41%), noroviruses (42%) and scabies (36%).

**Conclusion:** a variety of infectious agents were identified as the cause of outbreaks in the elderly and HCWs in LTCFs. Attack rates and case fatality rates are useful indicators for setting priorities for education and prevention of the outbreaks.

**Keywords:** outbreak, elderly, long-term care facility

---

**Background**

Infectious outbreaks in long-term care facilities (LTCFs) or nursing homes are likely to have a significant impact on infection rates and mortality rates of the residents. It is estimated that several thousand outbreaks occur at LTCFs in the USA each year [1]. Respiratory and gastrointestinal (GI) tract infections are the most common causes of outbreaks in LTCFs [2–5].

The definition of LTCF and nursing home may vary in different countries. In the USA, LTCFs are defined as institutions that provide health care to people who are unable to manage independently in the community [1]. Nursing homes accommodate persons who require nursing care and related medical and psychosocial services, and the majority of nursing homes are LTCFs [6]. Elderly persons account for the overwhelming majority of LTCF residents, the mean age being 80 years old [1].

The acuity of illness in nursing home residents has increased in the past two decades as a result of the shortened length of hospital stays [1]. Thus, LTCF residents are more vulnerable to infections than previously thought [1]. Major risk factors for infections among LTCF residents are decreased immunity, functional impairment (e.g. incontinence, cough reflex), decreased cognitive function and the use of invasive devices (e.g. urinary catheters and enteral feeding tubes) [1]. In addition, the facility design and operational methods such as multiple resident rooms and group activities promote pathogen transmission [7].

A review of the literature on infectious outbreaks at LTCFs has not been conducted in the last two decades. This review aimed to update the information on pathogens identified in such outbreaks and to try to explore indicators that reflect the impact of outbreaks among residents and health care workers (HCWs). Outbreak indicators would be useful for generating a comprehensive prevention plan and for setting priorities for infection prevention programmes at elderly LTCFs.

**Methods**

The term LTCFs for the elderly included the following: long-term care facility, nursing home care, low-level elderly care facility, residential home for the elderly, long-term care home, aged-care facility, skilled nursing facility for the elderly and geriatric hospital.

**Search strategy**

MEDLINE (1966–2008) was used to identify outbreaks using the following thesaurus terms: ‘Cross-Infection’, ‘Disease Outbreaks’, ‘Urinary-Tract Infections’ and ‘Blood-Borne Pathogens’. Elderly care facilities were identified with the following thesaurus terms: ‘Long-Term Care’, ‘Assisted-Living Facilities’, ‘Homes for the Aged’ and ‘Nursing Homes’. Age category was limited using ‘Age’. Review articles of major pathogens were used to find additional articles that met the selection criteria.

**Inclusion criteria**

An outbreak was generally defined as a disease incidence exceeding the expected rate. In this paper, any article or report published in English reporting outbreaks involving elderly care facilities was included.

**Exclusion criteria**

Hospital outbreaks, community outbreaks, surveillance reports, and randomised controlled trials for influenza
Table 1. Aetiologic agents of outbreaks reported in long-term care facilities (LTCFs)

<table>
<thead>
<tr>
<th>Aetiologic agents</th>
<th>No. of reports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influenza viruses</td>
<td>49</td>
</tr>
<tr>
<td>Noroviruses</td>
<td>25</td>
</tr>
<tr>
<td>Salmonella sp.</td>
<td>16</td>
</tr>
<tr>
<td>Group A Streptococcus</td>
<td>16</td>
</tr>
<tr>
<td>Sarcina lutea</td>
<td>11</td>
</tr>
<tr>
<td>Clostridium difficile</td>
<td>8</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>8</td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
<td>8</td>
</tr>
<tr>
<td>Respiratory syncytial virus (RSV)</td>
<td>7</td>
</tr>
<tr>
<td>Legionella spp.</td>
<td>6</td>
</tr>
<tr>
<td>Parainfluenza viruses</td>
<td>4</td>
</tr>
<tr>
<td>Mycobacterium tuberculosis</td>
<td>4</td>
</tr>
<tr>
<td>Adenoviruses (epidemic keratoconjunctivitis)</td>
<td>4</td>
</tr>
<tr>
<td>Hepatitis B virus</td>
<td>4</td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>4</td>
</tr>
<tr>
<td>Rhinoviruses</td>
<td>3</td>
</tr>
<tr>
<td>Chlamydia pneumonia</td>
<td>3</td>
</tr>
<tr>
<td>Shigella sp.</td>
<td>3</td>
</tr>
<tr>
<td>Methicillin-resistant Staphylococcus aureus (MRSA)</td>
<td>2</td>
</tr>
<tr>
<td>Coronavirus</td>
<td>2</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>2</td>
</tr>
<tr>
<td>Campylobacter sp.</td>
<td>2</td>
</tr>
<tr>
<td>Trichophyton</td>
<td>2</td>
</tr>
<tr>
<td>Others</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>206</td>
</tr>
</tbody>
</table>

Note: The list excluded fatal outbreaks and an outbreak caused by niacin overconsumption. If more than one pathogen was reported in one outbreak, each was counted.

Outbreaks reporting only culture-positive cases were also excluded. Indicators reflecting the impact of infectious disease outbreaks were extracted. If there were more than two reports per pathogen, median, minimum and maximum values were tabulated.

Results

The search identified 601 articles or reports. Of these, 390 did not include outbreak investigations or reports and 29 met the exclusion criteria. Twenty-five articles were found by searching reference lists. In total, 207 articles were analysed.

The number of articles published per decade was two in the 1970s, 64 in the 1980s and 77 in the 1990s. Between 2000 and 2008, 64 articles were published.

Outbreaks by country

Outbreaks in 19 countries were reported in English. The largest number were reported in the USA (109), followed by Canada (30), UK (26), Australia (14), Japan (6), Germany (4) and France (3). Spain, Norway and Belgium reported two outbreaks each, and Czechoslovakia, Hong Kong, Israel, Italy, Singapore, Slovenia, Switzerland, Sweden and Taiwan reported one each.

Infectious disease outbreaks

Aetiologic agents identified as the source of the outbreaks are displayed in Table 1, and included bacteria (21 types), viruses (12 types) and four types of other agents. Ninety-one were caused by bacteria, 102 by viruses and 14 by other agents.

The largest number of reported outbreaks by a single pathogen was influenza viruses (49) [8–56], followed by noroviruses (25) [42, 57–80], Group A Streptococci (GAS) (16) [81–96] and Salmonella sp. (15) [97–112].

There were four reports of concurrent outbreaks caused by two types of pathogens [55, 56, 112, 113]. These were GI tract infections and respiratory infections. There was a report of two outbreaks caused by different pathogens occurring within 1 month of each other [41].

Non-bacterial or non-viral agents as a source of outbreaks were scabies [11] [114–124], Cryptosporidium parvum (1) [125], giardiasis (1) [126] and Pulex irritans (1) [127]. Unusual outbreaks reported included one caused by niacin overconsumption resulting from inadequate mixing of food [128] and two fatal outbreaks [129, 130], where 21 and 15 deaths were reported in two clusters. Respiratory infections were suspected [129, 130] but no specific pathogens were identified.

Pseudo-outbreaks

Two pseudo-outbreaks were reported. These were cherry haemangioma or senile haemangioma [131, 132]. In both outbreaks, it was difficult to convince staff that these were not infectious.

Affected sites

The respiratory tract accounted for 45% of the outbreaks (n = 93), the GI tract for 36% (n = 74), the skin for 7% (n = 15) and eyes for 2% (n = 4). Two pathogens were known to cause infections in various sites, namely GAS [80–95] and ceftazidime-resistant Klebsiella pneumoniae [133]. GAS was involved in infections of the blood, respiratory tract and skin. K. pneumoniae infected the lungs, urinary tract and surgical sites [133].

Indicators reflecting the impact of outbreaks in elderly care facilities

Outbreaks impacted both residents and HCWs. Indicators reflecting the impact of outbreaks were attack rates for the elderly and HCWs, the proportion of infected patients admitted to hospital, the case fatality rate and the duration of the outbreak.

An unusual impact of senile haemangioma pseudo-outbreaks was fear of exposure to an unknown pathogen. The estimated cost for pseudo-outbreak control including consultation and laboratory testing for differential diagnosis was $10,000 [131].
and *Vibrio cholera* cella-zoster virus was 4% [161].

(17%) [158], Astrovirus (14%) [159] 

Cryptosporidium parvum 

diasis (30%) [156],

breaks, and reported attack rates were as follows:

which occurred in small institutions in the 1980s.

rates were reported in the two norovirus outbreaks [77, 79],

adenovirus [145, 148] (Table 4). One hundred percent attack 

Haemophilus influenzae [150],

(36%) [149], human metapneumovirus (18%)

(3%) [152]. Attack rates for GI tract outbreaks with a 

were also observed in other infection sites. The highest me-

noroviruses (45%) [57–80, 42] (Table 3). High attack rates 

were reports of secondary infections among families of 

outbreaks because of the small number: giardiasis (40%) 

(36%) [118, 119]. Median attack 

rates could not be calculated for the following outbreaks because of the small number: giardiasis (40%) [126, rotavirus (29%) [153], B. cereus (24%) [155], C. parvum (10%) [157] and Varicella-zoster virus (1%) [161]. There 

were reports of secondary infections among families of 

HCWs [26, 62, 65, 68, 71, 76, 78], which are mostly caused by 

noroviruses [62, 65, 68, 71, 76, 78]. The number of re-

ports was insufficient to examine the pattern.

**Median hospital admission rate**

Outbreaks with high median hospital admission rates were 

classified by *Legionella spp.* (100%) [162–164] and GAS 

(63%) [84, 85, 89–91]. The median admission rate was 

14% for *influenza* [8, 9, 12–19, 22, 25, 26, 29, 31, 32, 34, 

35, 37, 40, 42–45, 48, 53], 18% for *Salmonellosis* [100, 

102, 104, 105, 108, 110, 111] and 6% for *noroviruses* [58– 

60, 63–65, 68, 69, 72, 73, 78]. The hospital admission rates 

could not be calculated because of the inadequate information 

provided.

**Table 2. Attack rate, case fatality rate and duration of outbreaks in respiratory infection outbreaks in LTCFs**

<table>
<thead>
<tr>
<th>Agent</th>
<th>Attack rate</th>
<th>Fatality rate</th>
<th>Median duration of outbreak in days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Resident</td>
<td>Staff</td>
<td>Resident</td>
</tr>
<tr>
<td></td>
<td>Median attack rate (%)</td>
<td>No. of reports</td>
<td>Median attack rate (%)</td>
</tr>
<tr>
<td>Chlamydia pneumoniae</td>
<td>46 (34–68)</td>
<td>3</td>
<td>22–60</td>
</tr>
<tr>
<td>Respiratory syncytival virus (RSV)</td>
<td>40 (29–75)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Rhinoviruses</td>
<td>35 (5–62)</td>
<td>3</td>
<td>23 (3–58)</td>
</tr>
<tr>
<td>Influenza viruses</td>
<td>33 (4–94)</td>
<td>40</td>
<td>23 (3–58)</td>
</tr>
<tr>
<td>Parainfluenza viruses</td>
<td>41 (14–51)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
<td>13 (7–15)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Legionella spp.</td>
<td>(5–13)</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

*Median (lowest–highest). If the number of reports is 2, only the range is displayed.

**Median attack rates for residents**

The attack rate refers to the proportion of persons who de-

veloped infection among those exposed. The highest median attack rate for respiratory infection outbreaks were caused by *Chlamydia pneumoniae* (46%) [134–136], followed by respira-

tory syncytival virus (RSV; 40%) [137–141] (Table 2). As for GI tract infection outbreaks, high median attack rates were caused by *Clostridium perfringens* (48%) [142–144] and noroviruses (45%) [57–80, 42] (Table 3). High attack rates 

were also observed in other infection sites. The highest me-

median attack rate was 70% (range: 15–93%) for scabies [114, 

115, 118, 119, 122], followed by 42% (range: 31–49%) for adeno-

virus [145, 148] (Table 4). One hundred percent attack 

rates were reported in the two norovirus outbreaks [77, 79],

which occurred in small institutions in the 1980s.

Only one report was found for each of the following out-

breaks, and reported attack rates were as follows: *Bordetella pertussis* (36%) [149], human metapneumovirus (18%) [150], *Haemophilus influenzae* (11%) [151] and *Neisseria meningitidis* (3%) [152]. Attack rates for GI tract outbreaks with a small number of reports were *Bacillus cereus* (31%) [155], giardiasis (30%) [156], *Cryptosporidium parvum* (25%) [157], *Aeromonas hydrophila* (17%) [158], Astroivirus (14%) [159] and *Vibrio cholerae* (14%) [160]. The attack rate for Varicella-zoster virus was 4% [161].

**Median attack rates for HCWs**

In total, 16 pathogens were reported to have affected 

HCWs. High attack rates in HCWs were caused by *C. pneumoniae* (41%) [134, 136], noroviruses (42%) [57, 58, 60–65, 

68–71, 74, 76–79] and scabies (36%) [118, 119]. Median attack 

rates could not be calculated for the following outbreaks because of the small number: giardiasis (40%) [126, rotavirus (29%) [153], B. cereus (24%) [155], C. parvum (10%) [157] and Varicella-zoster virus (1%) [161]. There 

were reports of secondary infections among families of 

HCWs [26, 62, 65, 68, 71, 76, 78], which are mostly caused by 

noroviruses [62, 65, 68, 71, 76, 78]. The number of re-

ports was insufficient to examine the pattern.

**Median hospital admission rate**

Outbreaks with high median hospital admission rates were 

classified by *Legionella spp.* (100%) [162–164] and GAS 

(63%) [84, 85, 89–91]. The median admission rate was 

14% for *influenza* [8, 9, 12–19, 22, 25, 26, 29, 31, 32, 34, 

35, 37, 40, 42–45, 48, 53], 18% for *Salmonellosis* [100, 

102, 104, 105, 108, 110, 111] and 6% for *noroviruses* [58– 

60, 63–65, 68, 69, 72, 73, 78]. The hospital admission rates 

could not be calculated because of the inadequate information 

provided.

**Table 3. Attack rate, case fatality rate and duration of outbreaks in gastrointestinal (GI) infection outbreaks in LTCFs**

<table>
<thead>
<tr>
<th>Agent</th>
<th>Attack rate</th>
<th>Fatality rate</th>
<th>Median duration of outbreak in days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Resident</td>
<td>Staff</td>
<td>Resident</td>
</tr>
<tr>
<td></td>
<td>Median attack rate (%)</td>
<td>No. of reports</td>
<td>Median attack rate (%)</td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>48 (31–49)</td>
<td>3</td>
<td>42 (9–100)</td>
</tr>
<tr>
<td>Noroviruses</td>
<td>45 (13–100)</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Rotaviruses</td>
<td>(36–68)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>31 (9–53)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Staphylococcus sp.</td>
<td>(17–40)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Salmonella sp.</td>
<td>17 (6–29)</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

*Median (lowest–highest). If the number of reports is 2, only the range is displayed.
The case fatality rate refers to the proportion of deaths among those infected. Outbreaks with high median case fatality rates were caused by GAS (50%) [81–85, 87, 89, 91, 92, 94, 95], S. pneumoniae (44%) [165–169], Escherichia coli O157:H7 (31%) [169–171] and Legionella spp. (32%) [162, 164, 172, 173].

Case fatality rates not listed in the table because of the limited number of reports were respiratory infections caused by Neisseria meningitidis (33%) [152], methicillin-resistant Staphylococcus aureus (MRSA)-related pneumonia (25%) [174] and H. influenzae (20%) [151]. Lower case fatality rates were found in GI tract infection outbreaks caused by rotavirus (9%) [153, 154].

Among HCWs, there was one death in an inpatient outbreak occurring in a 50-bed aged-care facility in 2002, and the case fatality rate was 11% [14]. The attack rate was 35% for residents and 21% for HCWs. In the pre-outbreak period, 90% of the residents received influenza vaccine, while only 28% of the HCWs received the vaccine. The vaccination status of the deceased employee was not described [19].

Table 4. Attack rate, case fatality rate and duration of outbreaks other than respiratory and GI tract infections in LTCFs

<table>
<thead>
<tr>
<th>Agent</th>
<th>Attack rate</th>
<th>Case fatality rate</th>
<th>Median duration of outbreak in days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Resident</td>
<td>Staff</td>
<td></td>
</tr>
<tr>
<td>aMedian attack rate (%)a</td>
<td>No. of reports</td>
<td>Median attack rate (%)a</td>
<td>No. of reports</td>
</tr>
<tr>
<td>Sarcoptes scabiei</td>
<td>70 (15–93)</td>
<td>5</td>
<td>36 (17–83)</td>
</tr>
<tr>
<td>Adenovirus (epidemic keratoconjunctivitis)</td>
<td>42 (31–49)</td>
<td>4</td>
<td>13 (8–44)</td>
</tr>
<tr>
<td>Hepatitis B virus</td>
<td>8 (4–10)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Group A Streptococcus</td>
<td>8 (3–30)</td>
<td>7</td>
<td>2 (2–7)</td>
</tr>
</tbody>
</table>

Median case fatality rate

The case fatality rate refers to the proportion of deaths among those infected. Outbreaks with high median case fatality rates were caused by GAS (50%) [81–85, 87, 89, 91, 92, 94, 95], S. pneumoniae (44%) [165–169], Escherichia coli O157:H7 (31%) [169–171] and Legionella spp. (32%) [162, 164, 172, 173].

Case fatality rates not listed in the table because of the limited number of reports were respiratory infections caused by Neisseria meningitidis (33%) [152], methicillin-resistant Staphylococcus aureus (MRSA)-related pneumonia (25%) [174] and H. influenzae (20%) [151]. Lower case fatality rates were found in GI tract infection outbreaks caused by rotavirus (9%) [153, 154].

Among HCWs, there was one death in an inpatient outbreak occurring in a 50-bed aged-care facility in 2002, and the case fatality rate was 11% [14]. The attack rate was 35% for residents and 21% for HCWs. In the pre-outbreak period, 90% of the residents received influenza vaccine, while only 28% of the HCWs received the vaccine. The vaccination status of the deceased employee was not described [19].

Secular trends of attack rate and case fatality rates for influenza outbreaks by decade

The secular trend of attack rates and case fatality rates for influenza outbreaks were examined over three time periods (1980–89, 1990–99 and 2000–08). The median attack rate and ranges for residents for each time period were 28.0% (0–94%), 28.0% (5–77%) and 48.8% (10–96%), respectively. The median case fatality rate and ranges for residents were 7.0% (0–30%), 5.8% (0–55%) and 5.0% (0–15%), respectively. The median attack rate and ranges for HCWs were 35.0% (3–58%), 20.0% (7.1–25%) and 31.4% (15–50%), respectively. Vaccination rates were not consistently reported. In summary, no decreasing trend was observed for these indicators.

Median duration of the outbreak

The longest median duration of an outbreak was 150 days involving the hepatitis virus [175–178]. Scabies also had a long median outbreak duration of 120 days (range: 57–365 days) [42, 58–65, 67–70, 72–76, 78, 79]. The shortest median duration of outbreak was 1 day involving C. perfringens [142–144].

Outbreaks involving multiple facilities

Outbreaks spreading from one facility to another were caused by noroviruses, Mycobacterium tuberculosis and Clostridium difficile. The cause of spread of the norovirus outbreak was patient transfer [63] or the HCW’s family working in a different facility [73]. In a multi-facility tuberculosis outbreak, patient transfer and HCWs working in multiple facilities were a likely cause of spread of the outbreak [179]. Patient transfer also accounted for a multi-facility C. difficile outbreak [180].

Occurrences of concurrent multi-facility outbreaks were also common in influenza outbreaks. However, the mode of spread to other facilities was not clear in many cases [18, 21, 26, 31, 36].

Discussion

In reviewing the literature, 37 aetiologic agents were identified as sources of outbreaks in LTCFs. Three outbreak impact indicators were extracted and summarised. The attack rate is the most useful indicator to compare the contagiousness of the pathogens and to evaluate an outbreak containment programme. The case fatality rate reflects virulence and the degree of medical attention necessary as it requires prompt identification of the pathogen and initiation of appropriate treatment.

Previous research identified common pathogens in LTCFs without specific indicators of contagiousness and virulence. Attack and case fatality rates, surrogate measures for contagiousness and virulence, can be used to categorise aetiological agents. These are (i) high attack rate and high case fatality rate (e.g. RSV and E. coli 0157:H7), (ii) high attack rate and low case fatality rate (e.g. C. pneumoniae and noroviruses), and (iii) low attack rate and high case fatality rate (e.g. S. pneumoniae and GAS). This objective classification scheme is useful for setting priorities for prevention plans, resource allocation and education.
Increased resources are being allocated for influenza vaccination of the elderly population in many countries [181]. Nevertheless, influenza outbreaks do occur in highly immunised LTCF residents because of increasing acuity [11]. Enhanced training of HCWs to conduct respiratory illness surveillance in both residents and fellow HCWs has been proposed [11].

This review found that HCWs were at an increased risk of infection in an outbreak, which a previous review did not examine in detail [2]. Thirteen different aetiological agents were identified in HCWs, and a majority had an attack rate exceeding 20%. Three factors may be responsible for these high attack rates. First, HCWs at LTCFs are working with highly vulnerable elderly residents, and they tend to have more exposure to the outbreak pathogens than HCWs in acute care settings. Second, infection control programmes at LTCFs are generally inadequate and infection control personnel tend to be undereducated [1]. Third, HCWs providing direct care to the residents also tend to be undereducated about infection prevention. Educating and reinforcing transmission-based precautions and hand hygiene would reduce respiratory and GI tract infections among HCWs.

A few articles reported the spread of outbreaks to other facilities [63]. HCWs working in multiple facilities would increase the risk of spreading an outbreak to another facility. HCWs' families are also at increased risk of secondary infection [26, 62, 65, 68, 71, 76, 78], mostly in norovirus outbreaks. The infection control manual requires inclusion of prevention strategies to minimise secondary infections, and education programmes are necessary for HCWs on the risk of secondary infections and specific prevention plans.

The duration of outbreaks varied for each pathogen. Exploring the reasons for prolonged outbreaks is beyond the scope of this review. It may depend on the size of the facility, the proportion of private rooms, and the physical and mental function of the residents.

Reports of pseudo-outbreaks were rare. Nevertheless, pseudo-outbreaks of senile haemangioma illustrated the importance of educating staff about common skin conditions [131, 132] as well as common infectious diseases in the elderly. Once staff were convinced of its infectivity, denying it meant questioning their assessment [131]. Given the cost of managing a pseudo-outbreak, staff education is a very worthwhile investment.

This review has several limitations. First, we only searched for papers written in English. Non-English-speaking countries with a high proportion of elderly may have different outbreak patterns because the facility sizes and care system differ among countries. Second, only Medline was used for the literature search, while a search of reference lists of relevant articles was used to find additional articles. Embase was not used because of limited access, which may have resulted in fewer European outbreak reports.

Third, publication bias may exist, and the attack and case fatality rates summarised here may be biased toward higher rates. If the median attack rates were closer to the minimum, then it is possible that the outbreaks with higher attack rates were more likely to be reported than those with lower attack rates. Overall, the results do not support this type of bias for residents. Authors are encouraged to report essential information for the indicators. The variety of rare pathogens reported indicates publication bias toward rare pathogens. A relatively high frequency of GAS outbreaks suggests a publication bias toward outbreaks with high case fatality. In spite of these biases, the common pathogens in our results were the same as the previous review with few exceptions such as vancomycin-resistant Enterococci (VRE) [1]; the findings reflect common outbreak problems in LTCFs.

Culture-positive outbreaks were excluded in the review as they require a separate review. Multi-drug resistance pathogens (MDRPs) such as MRSA and VRE are endemic in LTCFs [182, 183]. The high frequency of antibiotic usage to treat infections in residents contributes to the emergence of resistant organisms in LTCF residents and is also considered to be a major factor in increased incidence of C. difficile-associated disease [184]. Frequent transfer between acute care and LTCFs provides ample opportunities to spread MDRP in both settings [1], which suggests that an infection control programme in one facility is not adequate to contain the problem and appears to require a wider strategy for infection control.

In summary, this review identified 37 pathogens associated with 206 outbreaks at LTCFs. HCWs were infected by 16 of the 37 pathogens. Indicators reflecting the impact of an outbreak in the articles were attack rate, case fatality rate and duration of the outbreak. Infectious outbreaks can be classified into the following three categories: (i) high attack rate and high case fatality rate, (ii) high attack rate and low case fatality rate, and (iii) low attack rate and high case fatality rate. The objective classification scheme applied here is useful for setting priorities for prevention plans, resource allocation and education.

Key points

- Infectious outbreaks in long-term care facilities (LTCFs) or nursing homes tend to have a significant impact on infection rates and mortality rates of the residents.
- Attack and case fatality rates, surrogate measures for contagiousness and virulence, can be used to categorise aetiologic agents. These are (i) high attack rate and high case fatality rate, (ii) high attack rate and low case fatality rate, and (iii) low attack rate and high case fatality rate.
- This objective classification scheme is useful for setting priorities for prevention plans, resource allocation and education.

Acknowledgements

This work was supported by the Univers Foundation (grant number 07.02.080).
Types of infectious outbreaks and their impact in elderly care facilities

We would like to thank the reference librarian Mr Toshiyuki Swa at the Osaka University Life Science Library for assisting us in conducting the literature search.

Supplementary data

Supplementary data are available at Age and Ageing online.

References

The long list of references supporting this review has meant that only the most important are listed here and are represented by bold type throughout the text. The full list of references is available at Age and Ageing online as Appendix 1.


Received 13 February 2009; accepted in revised form 20 January 2010.