

# Surveillance for outbreaks of respiratory tract infections in nursing homes

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## Abstract

**Background:** Outbreaks of respiratory tract infections are common in long-term care facilities for older people. The objective of our study was to determine both the frequency of such outbreaks and their clinical and epidemiological features.

**Methods:** Prospective surveillance for outbreaks of respiratory tract infections and a retrospective audit of surveillance records were conducted in 5 nursing homes in metropolitan Toronto over 3 years. The clinical manifestations of infected residents were identified and microbiological investigations for causal agents were conducted.

**Results:** Sixteen outbreaks, involving 480 of 1313 residents, were identified prospectively during 1 144 208 resident-days of surveillance, for an overall rate of 0.42 infections per 1000 resident-days. Another 30 outbreaks, involving 388 residents, were identified retrospectively. Outbreaks occurred year-round, with no seasonal pattern. Pathogens included influenza virus, parainfluenza virus, respiratory syncytial virus, *Legionella saintelensi* and *Chlamydia pneumoniae*. Multiple pathogens were detected in 38% (6/16) of the prospectively identified outbreaks. Of the 480 residents in the prospectively identified outbreaks 398 (83%) had a cough, 194 (40%) had fever and 215 (45%) had coryza. Clinical findings were nonspecific and could not be used to distinguish between causal agents. Pneumonia developed in 72 (15%) of the 480 residents, and 58 (12%) required transfer to hospital. The case-fatality rate was 8% (37/480).

**Interpretation:** Our findings emphasize the importance of adequate surveillance for outbreaks of respiratory tract infections in nursing homes and of early diagnosis so that appropriate interventions can be promptly instituted.

Outbreaks of respiratory tract infections are common in long-term care facilities for older people. Although frequently caused by respiratory viruses, they may also be caused by nonviral agents such as *Streptococcus pneumoniae*, *Chlamydia pneumoniae* and *Legionella* species.<sup>1-7</sup> The morbidity and mortality associated with outbreaks of respiratory tract infections due to any pathogen in long-term care facilities can be significant. Rates of pneumonia as high as 42% and case-fatality rates exceeding 70% have been reported in outbreaks due to influenza virus.<sup>8-10</sup>

Early identification of an outbreak and the pathogen allows the implementation of measures to interrupt transmission and optimize therapy. Thus, understanding the clinical and epidemiological features of outbreaks in long-term care facilities is important. Although many outbreaks have been described, and reports from several cohort studies of respiratory tract infections in long-term care facilities exist,<sup>1,2-11</sup> the cohort studies do not clearly distinguish between outbreak-associated and sporadic infections. As a result, the overall incidence of outbreaks and their clinical and epidemiological features remain poorly documented.

As part of a study to define risk factors for lower respiratory tract infection, we conducted active surveillance for outbreaks of such infection in 5 nursing homes over 3 years.<sup>12</sup> This allowed us to define the epidemiological features of such outbreaks in these facilities.

## Research

## Recherche

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## Methods

We conducted surveillance for respiratory tract infections in 5 nursing homes in metropolitan Toronto between July 1, 1993, and June 30, 1996. These nursing homes were residential long-term care facilities for elderly people who required 1.5–3 hours of nursing care daily. Nursing home A had 88 beds in 2 nursing units and an adjoining residential care unit housing 44 people. Home B had 254 beds in 6 units, home C 372 beds in 8 units and home D 162 beds in 4 units. Nursing home E housed 437 people in 6 units and had an adjoining geriatric day clinic. Annual influenza vaccination rates among the residents ranged from 70% to 90% during the study period. The mean age of the residents was 85 years; 75% were women, and 20% were totally dependent for activities of daily living. The residents' mean length of stay at the beginning of the study was 3.3 years.

Surveillance at nursing homes A, B and C continued over the entire study period; it began in June 1994 at nursing home D and in January 1995 at home E. Surveillance was conducted twice weekly by a study nurse trained in infection control. This included prospective monitoring for symptoms and signs of infection and chart reviews. In addition, nursing staff were asked to alert the study nurse about all residents with new respiratory symptoms, fever or suspected infection.

For surveillance and for retrospective identification of outbreaks, we used definitions of infection that had been reached by consensus.<sup>13</sup> Upper respiratory tract infection was defined by the presence of at least 2 of the following signs or symptoms: runny nose or sneezing; nasal congestion; sore throat, hoarseness or difficulty swallowing; dry cough; and cervical lymphadenopathy. Lower respiratory tract infection was defined by the presence of at least 3 of the following: new or increased cough; new or increased sputum production; fever (temperature > 38°C); pleuritic chest pain; new or increased findings on chest examination; and one of the following: new or increased shortness of breath, a respiratory rate of more than 25 breaths/min, or worsening mental or functional status. Pneumonia was defined by the presence of compatible radiological findings and at least 2 of the above symptoms or signs.

During surveillance an outbreak was defined as an increase in the number of respiratory tract infections above that which was expected to occur in any nursing unit. For each outbreak a case definition specific to the outbreak, based on the predominant symptoms and signs, was developed by the outbreak management team (nursing home and local public health unit staff). At the end of the study a modification of the definition by Gomolin and colleagues<sup>14</sup> of an outbreak of respiratory tract infection — 3 or more cases of infection occurring in a single nursing unit within 48 to 72 hours — was used in an audit of infection line listings (recorded symptoms or signs of respiratory infection) to assess the sensitivity of the prospective identification of outbreaks. For the purposes of our study, an outbreak resident-day was defined as 1 day per resident present for each day between the onset of the outbreak and the day that it was declared over.

Treatment and transfer decisions for individual cases were at the discretion of the resident's physician. Infection control measures were implemented during the outbreaks according to the policies and procedures of each institution and the local public health departments.

Nasopharyngeal swabs were obtained from a sample of symptomatic residents for the direct detection of respiratory viral antigens by means of immunofluorescence microscopy and for isola-

tion of respiratory viruses (influenza, parainfluenza, respiratory syncytial virus [RSV] and adenovirus).<sup>15,16</sup> Detection of *Legionella* antigens in urine was performed in one nursing home<sup>17</sup> after initial investigations failed to identify a pathogen. When possible, serum samples during acute infection and convalescence were obtained 3 to 5 weeks apart for testing by means of complement fixation for respiratory viruses and *Mycoplasma pneumoniae* and by means of indirect immunofluorescence for *Legionella* species. Serologic testing for *C. pneumoniae* was performed by means of microimmunofluorescence.<sup>3</sup> An attempt was made to obtain blood and sputum samples for culture from symptomatic residents.

Ethics approval for this study was obtained from the University of Toronto Research Ethics Committee and from each of the participating nursing homes.

## Results

During the 3 years of the study 2001 sporadic and outbreak-related respiratory tract infections (946 upper and 1055 lower) occurred in 1 144 208 resident-days of surveillance, for a mean infection rate of 1.75 episodes per 1000 resident-days. Sixteen outbreaks involving 480 cases of respiratory tract infection were identified prospectively among the 1313 nursing-home residents in the study, for an overall rate of 0.42 outbreak-related infections per 1000 resident-days (yearly range 0.23–0.72 outbreak-related infections per 1000 resident-days). The rate was higher in the winter than in the summer (0.55 v. 0.28 infections per 1000 resident-days) ( $p < 0.001$ ).

### Prospectively identified outbreaks

Of the 16 outbreaks identified prospectively, 3 occurred in the first year of the study, 9 in the second and 4 in the third year. There was a total of 104 899 outbreak resident-days, accounting for 9% of all resident-days during the surveillance period. Attack rates of outbreak-related infections ranged from 2% to 25% in the nursing homes (Table 1). Of the 480 residents with respiratory illness 72 (15%) had pneumonia (range 0%–34%), and 58 (12%) required transfer to hospital (range 0%–24%). The overall case-fatality rate was 8% (37/480) (range 0%–14%). Cough, fever and coryza were the most common symptoms: 398 (83%) of the infected residents had a cough (range 71%–100%), 194 (40%) had a fever (range 0%–68%) and 215 (45%) had coryza (range 11%–81%). Clinical findings were non-specific and could not be used to distinguish between causal agents.

Of the 480 residents with respiratory illness 75 (16%) had laboratory-confirmed evidence of infection. A total of 182 nasopharyngeal swabs were obtained. The pathogens identified included influenza virus (5 outbreaks of influenza A and 2 of influenza B), parainfluenza virus (13 outbreaks), RSV (2 outbreaks), and *C. pneumoniae* and *Legionella saintbelevsi* (1 outbreak) (Table 1). Influenza A virus was the only pathogen detected in one outbreak. Influenza virus was detected, either by immunofluorescence microscopy or

seroconversion, in 6 outbreaks. More than one causal agent was identified in 6 outbreaks.

Antibiotics were prescribed for 240 (50%) of the 480 residents. The proportion of residents in the 5 nursing homes who were treated with antibiotics ranged from 9% to 93%.

### Retrospectively identified outbreaks

In a retrospective review of recorded symptoms or signs of respiratory tract infection using the outbreak definition modified from Gomolin and colleagues,<sup>14</sup> we identified another 30 outbreaks involving 388 cases. Retrospectively identified outbreaks were smaller than those detected prospectively (median number of residents involved 9 v. 24.5) ( $p < 0.001$ ). Furthermore, the rate of outbreak-related infections identified retrospectively was higher in the summer than in the winter (0.44 v. 0.27 infections per 1000 resident-days) ( $p < 0.001$ ). There was, however, no overall seasonal pattern for outbreaks of infection.

Episodes during the retrospectively identified outbreaks were less likely than those during the prospectively detected outbreaks to include fever (32% v. 40%; relative

risk [RR] 0.80, 95% confidence interval [CI] 0.67–0.96) but were more likely to be treated with antibiotics (64% v. 50%; RR 1.3, 95% CI 1.15–1.45). A total of 48 nasopharyngeal swabs were obtained during the retrospectively identified outbreaks. A viral pathogen was identified in 13 of the 30 outbreaks: parainfluenza 3 in 11, RSV in 1, and both parainfluenza 3 and RSV in 1. In a fourteenth outbreak, 2 residents had a greater than fourfold increase in antibodies to *C. pneumoniae*.

Table 2 compares the rates of respiratory tract infections in the different nursing homes.

### Interpretation

Previous studies of the incidence of respiratory tract infections in nursing homes have reported overall rates among residents of 0.99 to 3.3 episodes per 1000 resident-days,<sup>11,18–24</sup> which is similar to the rate of 1.75 per 1000 resident-days (range in different nursing homes 1.4–2.8) found in our study. Outbreak-related infections accounted for a substantial proportion of the episodes: 24% of all respiratory tract infections occurred during the prospectively

**Table 1: Summary of prospectively identified outbreaks of respiratory tract infections in 5 nursing homes in metropolitan Toronto, 1993–1996**

Home (no. of beds)	Month of onset	Pathogen	No. of confirmed cases*	Attack rate, % (no.) of cases	Case-fatality rate, % (no.)	% (no.) of patients with pneumonia	% (no.) of cases treated with antibiotics	% (no.) of patients admitted to hospital	
A (88)	Feb 94	Influenza A	10	25 (22)	9 (2)	23 (5)	55 (12)	23 (5)	
	May 94	Parainfluenza 1	1	18 (16)	0	6 (1)	69 (11)	6 (1)	
	Feb 95	Influenza A Parainfluenza 3	3 2	17 (15)	0	13 (2)	93 (14)	0	
B (254)	Apr 94	Not identified	0	9 (24)	12 (3)	12 (3)	54 (13)	12 (3)	
	Jul 94	<i>Legionella</i> <i>Chlamydia pneumoniae</i> Parainfluenza 2	4 4 1	13 (33)	12 (4)	3 (1)	48 (16)	15 (5)	
	Nov 94	Parainfluenza 3	3	19 (47)	2 (1)	9 (4)	45 (21)	11 (5)	
	Jan 95	Parainfluenza 3	2	13 (34)	6 (2)	24 (8)	59 (20)	15 (5)	
	Mar 95	Not identified	0	10 (25)	4 (1)	24 (6)	36 (9)	16 (4)	
	Jul 95	Parainfluenza 3	3	11 (29)	10 (3)	34 (10)	59 (17)	24 (7)	
	Oct 95	Not identified	0	4 (11)	9 (1)	18 (2)	9 (1)	9 (1)	
	Apr 96	Influenza A Parainfluenza 3 Influenza B	7 4 1	25 (63)	14 (9)	11 (7)	60 (38)	8 (5)	
	C (372)	Aug 94	Parainfluenza 3	1	2 (9)	0 (0)	0	11 (1)	0
		May 95†	Influenza B Parainfluenza 3	1 1	8 (30)	3 (1)	23 (7)	67 (20)	3 (1)
D (162)	Feb 95	Parainfluenza 3 Influenza A RSV	6 2 1	13 (21)	10 (2)	14 (3)	76 (16)	10 (2)	
	E (437)	Feb 95†	Parainfluenza 3 Parainfluenza 2 RSV Influenza A	7 4 4 2	15 (65)	11 (7)	12 (8)	18 (12)	17 (11)
		May 96	Parainfluenza 3	1	8 (36)	3 (1)	14 (5)	28 (10)	8 (3)

\*All cases confirmed by means of direct immunofluorescence microscopy except *Legionella* and *C. pneumoniae* infections, which were confirmed by means of serologic testing.

†Two different organisms were detected from one resident on the same nasopharyngeal swab.

identified outbreaks and an additional 19% during outbreaks identified retrospectively. Outbreaks occurred during 9% of all resident-days during the study period. Thus, interventions that reduce transmission or otherwise protect residents against outbreak-associated infection (e.g., vaccination) could be expected to have a significant impact on the overall rate of respiratory tract infection.

The number of outbreaks identified prospectively in the individual nursing homes ranged from 1 to 8. This variation may be explained, at least in part, by variability in the identification and labelling of clusters of infection as outbreaks. Thus, home B, with the largest number of prospectively identified outbreaks, had the fewest retrospectively identified outbreaks, whereas home E, with the fewest prospectively identified outbreaks, had the largest number of retrospectively identified outbreaks. Despite surveillance, the majority of outbreaks (65% [30/46]) were not identified prospectively. Although it is somewhat reassuring that all influenza outbreaks were detected prospectively and that the retrospectively identified outbreaks were smaller than those detected prospectively, there is substantial room for improvement in surveillance to detect clusters of infection in these facilities. A high index of suspicion for outbreaks of respiratory tract infections needs to be maintained. We did not address the extent to which this problem may exist in other facilities or regions, but we believe that these data should encourage facilities to examine closely the sensitivity of their surveillance for outbreaks.

Only 7 of the 16 prospectively identified outbreaks occurred during the winter months, and retrospectively identified outbreaks were more likely to occur during the summer months. These data support the evidence that outbreaks of respiratory tract infection occur year-round in nursing homes and that continuous vigilance is needed.<sup>25</sup> The outbreak during which infections due to *C. pneumoniae* and *Legionella* occurred was in July; this suggests that testing for nonviral agents should be undertaken, particularly in summer outbreaks, if initial viral studies yield negative results.

The frequency of pneumonia varied from 0% to 34% in the nursing homes, with no obvious relation to any causal agent. The clinical presentations in our study were nonspe-

cific and could not be used to identify agents. These findings are in keeping with several previous reports comparing illness due to different pathogens in residents of long-term care facilities or day-care attendees.<sup>1,2,15,26,27</sup> The cause of most outbreaks of respiratory tract infections in nursing homes cannot be predicted by the constellation of signs or symptoms. The early and adequate use of laboratory testing is essential if the pathogen is to be identified. The value of obtaining nasopharyngeal swabs for the rapid detection of viral antigens has been previously documented.<sup>28</sup> This is particularly important in the detection of outbreaks due to influenza A, where the prompt institution of amantadine prophylaxis will usually end the outbreak.<sup>29,30</sup> Furthermore, given the frequent empirical use of antibiotics for outbreak-related illness observed in our study, establishing an early viral cause may limit the need to use antibiotics.

Although outbreaks of respiratory tract infection due to multiple pathogens have been described previously,<sup>26,27</sup> we found a relatively large number of outbreaks in which more than one pathogen was detected. This finding may have been the result of our relatively frequent use of nasopharyngeal swab sampling. Variation in the number of samples taken may also explain why pathogens were less frequently identified in the retrospectively identified outbreaks. These findings emphasize the need to obtain specimens from an adequate number of people before the cause of the outbreak can be determined. Failure to identify influenza A means that amantadine will not be used to protect residents, whereas the failure to identify other viruses cocirculating with influenza A will result in an underestimate of the effectiveness of both vaccine and amantadine prophylaxis. Our findings suggest that further systematic evaluation should be undertaken to determine the optimal number of nasopharyngeal specimens needed in the investigation of outbreaks of respiratory tract infections.

In summary, surveillance in 5 nursing homes over 3 years prospectively identified 16 outbreaks of respiratory illness. In addition, nearly twice as many outbreaks were identified retrospectively. Outbreaks occurred year-round and were often due to multiple pathogens. The clinical features were nonspecific and could not be used to identify causal agents. Our findings emphasize the importance of adequate surveillance for outbreaks of respiratory tract infection and of appropriate diagnostic testing in arriving at an early determination of the cause so that an intervention, such as the use of amantadine when influenza A is detected, can be promptly instituted. Improved detection and control of outbreaks of respiratory tract infection in these facilities would have significantly reduced the overall rate of infection.

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**Table 2: Rate of respiratory tract infections in the nursing homes**

Nursing home	Rate of infection per 1000 resident-days		
	Sporadic	Prospectively identified outbreak	Retrospectively identified outbreak*
A	0.81	0.55	0.84
B	0.97	0.94	0.11
C	1.05	0.10	0.28
D	1.64	0.22	0.92
E	0.69	0.39	0.39

\*Defined as 3 or more residents in one unit having had a respiratory tract infection within 72 hours of each other (modified definition of that used by Gomolin et al).<sup>14</sup>

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Competing interests: None declared.

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