

## Legionnaires' Disease in Long-Term Care Facilities: Overview and Proposed Solutions

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Pneumonia is a leading cause of morbidity and mortality in nursing home patients. In acute care hospitals, there is considerable evidence to indicate that Legionnaires' disease is a significant cause of nosocomial pneumonia, the source of which is the potable water system. A relatively limited amount of data exists as to the role of Legionnaires' disease as a cause of pneumonia acquired in long-term care residents. Several lines of evidence suggest that Legionnaires' disease may be an important but underrecognized cause of pneumonia in long-term care residents. These include reports of outbreaks, prospective studies of community-acquired pneumonia that include nursing home patients, and prospective studies of individual long-term care facilities linking Legionnaires' disease to colonization of the potable water system with *Legionella*. Multiinstitutional studies combining environmental and clinical surveillance for *Legionella* are needed to further confirm the relationship between colonization of potable water and the occurrence of disease in the long-term care facilities. Until these studies are completed, it is recommended that individual facilities undertake annual sampling of the potable water system for *Legionella*, coupled with introduction of the rapid *Legionella* urinary antigen test should *L. pneumophila* serogroup 1 be found. *J Am Geriatr Soc* 53:875-880, 2005.

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**L**egionnaires' disease is a notable problem in acute care settings. Legionnaires' disease has been shown to be an important cause of community- and hospital-acquired pneumonia. In hospitals with *Legionella* colonization of the water systems, hospital-acquired legionellosis is frequently endemic, accounting for 10% to 40% of hospital-acquired pneumonias.<sup>1-3</sup> Legionnaires' disease also

accounts for 2% to 15% of community-acquired pneumonia.<sup>4-8</sup> In contrast, the incidence of Legionnaires' disease in long-term care residents is not clearly delineated. This article is a review of the current literature on Legionnaires' disease in long-term care facilities. It suggests management approaches for Legionnaires' disease and strategies for prevention.

Pneumonia is the leading cause of death and an important cause of transfer to acute care facilities in long-term care residents.<sup>9</sup> There are a number of epidemiological factors that suggest that long-term care residents might be at particular risk for legionellosis should it be present in the environment. These include the modes of transmission of *Legionella* infection as well as host factors predisposing to *Legionella* infection in residents. Microaspiration of water contaminated with *Legionella* appears to be the primary mode of transmission of *Legionella* in hospital settings.<sup>10,11</sup> Hospital-acquired legionellosis has resulted from aspiration of nasogastric tube feedings diluted with tap water.<sup>12</sup> Long-term care residents often have swallowing difficulties, and many receive nasogastric tube feedings, predisposing factors to aspiration.

It is conceivable that cases of Legionnaires' disease go unrecognized in long-term care facilities. The clinical features of legionellosis are not distinctive, although diarrhea, confusion, and high fever have been prominent in some studies.<sup>13</sup> It is generally not possible to make a presumptive diagnosis of Legionnaires' disease based on clinical presentation alone. The recognition of disease may be even more problematic in elderly nursing home residents, in whom episodes of pneumonia often present without fever or cough.<sup>9</sup>

Diagnosis of Legionnaires' disease requires the application of specific diagnostic tests that are not usually available in long-term care facilities. The organism cannot be seen on Gram stain and will not grow on standard microbiological media typically used to process sputum specimens. Selective media (buffered charcoal yeast extract agar with added antibiotics to inhibit respiratory flora) are required. When a laboratory with expertise in *Legionella* processes specimens, sputum culture yields a diagnosis in approximately 80% of cases.<sup>14</sup> Sputum culture may not be particularly helpful in diagnosing pneumonia in long-term care residents. Adequate sputum samples are difficult to

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obtain in this patient population, and few facilities have the appropriate laboratory support.

A rapid test that detects *Legionella* antigens in the urine has a sensitivity of 80% and specificity in excess of 95%.<sup>14</sup> It detects infection due to *L. pneumophila* serogroup 1, which accounts for 80% of *Legionella* infection.<sup>15</sup> The urinary antigen test does not reliably detect infection due to other serogroups or species.

### LEGIONELLA OUTBREAKS IN LONG-TERM CARE FACILITIES

For the purposes of this review, an outbreak of Legionnaires' disease is defined as two or more cases that have been identified over a limited time period. The long-term care facilities reviewed herein include three nursing homes and one rehabilitation facility (Table 1). *L. sainthelensi* serogroup 1 was implicated as the cause in 29 patients in two facilities, and *L. pneumophila* was the cause in 24 patients in the other two facilities. *Legionella* was found to have colonized the potable water in two of the four long-term care facilities (Table 1).<sup>16,17</sup> In the two remaining facilities, *Legionella* cultures of the potable water system were negative, but the extent of sampling was limited.<sup>16,18</sup>

An additional outbreak has been reported in abstract form.<sup>19</sup> Eleven cases with two fatalities occurred over a 17-day period in a newly constructed facility. *L. pneumophila* isolates obtained from a case patient were identical to those isolated from the facility's potable water system using monoclonal antibody subtyping and amplified fragment-length polymorphism, confirming the potable water system as the source of infection.

Additional cases and clusters of up to five cases have been reported in nine additional nursing homes to public health agencies in Pennsylvania,<sup>20–22</sup> Maryland,<sup>23,24</sup> Massachusetts,<sup>25,26</sup> Oregon,<sup>27</sup> and Ontario<sup>28</sup> during 1999 to 2003. In at least two of these facilities, the local public health agency isolated *L. pneumophila* from the facility's water system.

Community-acquired and hospital-acquired legionellosis were initially recognized in the context of outbreaks. As more hospital outbreaks were discovered over time, it became apparent that hospital-acquired Legionnaires' disease could be endemic within a hospital and escape recognition.<sup>3,12,29</sup> It was hypothesized that identification of outbreaks of legionellosis occurring in long-term care facilities indicates that *Legionella* infection is endemic in many long-term care facilities but is unrecognized and underreported.

### PROSPECTIVE STUDIES OF LEGIONNAIRES' DISEASE IN INDIVIDUAL LONG-TERM CARE FACILITIES

Prospective studies of *Legionella* in hospitals have shown a clear association between hospital-acquired Legionnaires' disease and colonization of the hospital water supply with *Legionella*.<sup>30–33</sup> There have been only three such prospective studies in long-term care facilities, and all were performed in western Pennsylvania.

During a 10-month study in a long-term care facility, *L. pneumophila* was consistently isolated from the water distribution system, with a rate of 50% from hot water tanks

Table 1. Predisposing Factors in 42 Patients with Legionnaires' Disease in Outbreaks in Long-Term Care Facilities

Author	Type of Long-Term Care Facility	Patients with Legionnaires' Disease, n	Legionella Species	Duration of Study	Diagnostic Tests	Underlying Diseases, %			Isolation of <i>Legionella</i> from Potable Water
						Stroke	Chronic Lung Disease		
Loeb, Canada 1999	2 nursing homes—A and B	29	<i>Legionella sainthelensi</i> Serogroup-1		Serology, urinary antigen	41	14	A—Yes	
Wiedl, Germany, 1993	Rehabilitation facility	11	<i>Legionella pneumophila</i> Serogroup-1	10 weeks	Serology, direct fluorescent antibody, urinary antigen, cultures	45	27	B—No* Yes	
Maesaki, Japan, 1992	Nursing home	2	<i>Legionella pneumophila</i> Serogroup-1	1 week	Cultures	0	0	No*	

\* Limited sampling performed.

and 45% from distal sites.<sup>34</sup> Of the 185 cases of pneumonia, a fourfold rise in antibody titer confirmed that *Legionella* caused 7% (13/185).

*Legionella* was also shown to colonize a newly constructed long-term care facility.<sup>35</sup> *L. pneumophila* serogroup 1 was isolated from the first plumbing outlet that was operational on first sampling and was cultured from 50% of the distal water outlets in 1 year. *Legionella* culture, direct fluorescent antibody (DFA) staining of sputum, *Legionella* urinary antigen for *L. pneumophila* serogroup 1 and serology were used for diagnosis of Legionnaire's disease. Six cases of Legionnaires' disease were identified over a period of 2 years. The diagnoses were made using positive urinary antigen (n = 1), culture (n = 2), and serology (n = 3). *L. pneumophila* serogroup 1 caused five of six cases; deoxyribonucleic acid (DNA) subtyping established that clinical isolates were identical to the environmental isolates.

A prospective study in another long-term care facility<sup>36</sup> found widespread colonization of the water system with *L. pneumophila* serogroup 1. Subsequent testing using *Legionella* urinary antigen of 14 patients with pneumonia acquired within the facility uncovered three (21%) with Legionnaires' disease. *Legionella* was isolated from the sputum of one of these patients. The clinical strain was identical to the environmental strains according to pulsed-field gel electrophoresis analysis of bacterial DNA.

In a long-term care facility previously studied,<sup>37</sup> no cases of legionellosis were found in 56 episodes of pneumonia. Environmental cultures were not performed at the time of the study, but environmental cultures for *Legionella* were negative when performed more than 7 years later (Stout JE, personal communication). Because *Legionella* colonization of a facility's water system is highly stable over time in the absence of eradication measures,<sup>29,38,39</sup> it is likely that *Legionella* was not present in the facility's water system at the time that this study was performed.

**LEGIONNAIRES' DISEASE IN RESIDENTS OF LONG-TERM CARE FACILITIES TRANSFERRED TO HOSPITALS**

Although most studies of the etiology of community-acquired pneumonia have not specifically reported on pneumonias acquired in long-term care facilities, a few have done so (Table 2). Of five such studies, three used serology as the sole means of diagnosis, a modality that may have low sensitivity. Two used multiple diagnostic methods, including serology, culture, and urinary antigen testing.

In a 5-year prospective study of community-acquired pneumonia involving 719 patients, *Legionella* serology was the sole modality used for diagnosis of legionellosis; a fourfold rise in antibody titer was required for diagnosis of *L. pneumophila*. The overall incidence of *Legionella* was only 1.9% in this study population. In the subgroup of 131 patients admitted from nursing homes, no cases of Legionnaires' disease were identified.<sup>40</sup> Whether the nursing homes from which the patients were transferred were colonized with *Legionella* was not reported.

In a study of etiology of pneumonia requiring mechanical ventilation in older people involving 104 patients, DFA staining of sputum, *Legionella* urinary antigen for *L. pneumophila* serogroup 1, and serological tests for *Legionella* antibody

**Table 2. Legionnaires' Disease in Prospective Studies of Community-Acquired Pneumonia that Included Patients from Long-Term Care Facilities with Pneumonia Requiring Hospitalizations**

Author	Long-Term Care			Diagnostic Test Used to Detect <i>Legionella</i>				Type of Study	
	Patients with Pneumonia, n	Proportion of <i>Legionella</i> Pneumonia, %	Patients with Pneumonia, n	Proportion of <i>Legionella</i> Pneumonia, %	Culture	Fluorescent Antibody	Serology		Urinary Antigen
El Solh, United States, 2001	104	9	47	0	No	Yes	Yes	Yes	
Fang, United States, 1990	359	6.7	46	6.5	Yes	Yes	Yes	Yes	
Marrie, Canada, 1989	719	1.9	131	0	No	No	Yes	No	
Marrie, Canada, 1986	99	0	74	1.35	No	No	Yes	No	
Janssens, United States, 1996	99	0	20	0	No	No	Yes	No	

were used for diagnosis. Nine percent of community-acquired pneumonias were due to *Legionella*. In a subgroup of 47 cases admitted from nursing homes, no cases of Legionnaires' disease were identified.<sup>8</sup>

In a prospective multicenter study of community-acquired pneumonia involving 359 patients,<sup>41</sup> four specialized *Legionella* tests were used: *Legionella* culture, DFA of sputum, *Legionella* urinary antigen for *L. pneumophila* serogroup 1, and *Legionella* serological tests for antibody. *Legionella* was the etiology in 6.7% of all patients. Of the subgroup of 46 patients admitted from nursing homes, *Legionella* was the etiology in 6.5%. Although *Legionella* was the third-most-common cause of community-acquired pneumonia after *Streptococcus pneumoniae* and *Hemophilus influenzae*, it was the fifth-most-important cause in nursing home patients in this study.

In a case-control study of nursing home pneumonia, *Legionella* serology was used as the only diagnostic test for Legionnaires' disease. One case of *Legionella* pneumonia was discovered among 74 cases of nursing home pneumonias, as opposed to two cases in the community-acquired pneumonia group.<sup>42</sup> Another study employing serology as the only diagnostic test for *Legionella* also failed to demonstrate any case of *Legionella* pneumonia in nursing homes.<sup>43</sup> In one of these five studies, one of the nursing homes from which patients were transferred was known to have been colonized with *Legionella*.<sup>41</sup> In the remaining four studies, *Legionella* cultures of the environment of the long-term care facilities were not performed.

## DISCUSSION

A number of factors limit an accurate estimate of the true incidence of legionellosis in long-term care facilities. The etiological diagnosis of pneumonia in long-term care facilities is difficult, because sputum samples are difficult to obtain because of poor cough reflex and abnormal mental status.<sup>9</sup> Most facilities do not have the level of microbiology laboratory support that is available to acute care hospitals.

Legionellosis almost certainly has been underdiagnosed in studies of pneumonia in long-term care residents. In three of the five studies in which patients required transfer to acute care facilities, serology was the only diagnostic modality employed (Table 2). Depending on the experience of the laboratory and the quality of the antigen, serology may have a sensitivity of only 40% to 60% in detecting *Legionella* infection.<sup>14</sup> Demonstration of rise in antibody titer may also require multiple convalescent sera 1 to 3 months after the initial illness. Only two studies used urinary antigen testing or culture, which have superior sensitivity. In the one study in which a significant number of nursing home-acquired cases of legionellosis was documented, the investigators implemented intensive laboratory testing with multiple diagnostic modalities for *Legionella*.<sup>41</sup>

The occurrence of legionellosis within a facility requires an environmental source of *Legionella*. In acute care hospitals, *L. pneumophila* has been shown to colonize 12% to 70% of hospital water distribution systems; colonization has been consistently linked to hospital-acquired legionellosis.<sup>14,33</sup> It is therefore plausible that such colonization may also occur in the water distribution systems of long-term care facilities. In studies of pneumonia patients trans-

ferred to hospitals from long-term care facilities, the *Legionella* colonization status of the facilities was generally unknown.

Investigators have demonstrated a link between colonization of the water system by *Legionella* and the occurrence of Legionnaires' disease in long-term care facilities.<sup>34-36</sup> Because these studies were performed in a circumscribed geographic area, whether the findings apply to long-term care facilities in general remains to be confirmed.

The factors predisposing to Legionnaires' disease are similar to those predisposing to other bacterial pneumonias acquired in long-term care facilities. On review of underlying diseases of 42 patients with Legionnaires' disease in published outbreaks involving long-term care facilities (Table 1), 52% of patients had predisposing risk factors for aspiration. In the Canadian outbreak, eating pureed food was a significant risk factor for the acquisition of infection in a multivariate analysis, suggesting that a swallowing disorder predisposing to aspiration was the mode of transmission (Table 1).<sup>16</sup> Other risk factors for legionellosis such as chronic lung disease, corticosteroid use, and chronic renal insufficiency are also frequent in long-term care residents.

The key question to be addressed is whether there is any benefit to residents of long-term care facilities in identifying *Legionella* infections. Long-term care patients with respiratory tract infections are often treated with empirical antimicrobial therapy in the absence of a specific diagnosis. Broad-spectrum beta lactam agents are frequently used;<sup>9</sup> these agents have no activity against *Legionella*. The knowledge that legionellosis is endemic within the facility would provide a rationale to include a quinolone or a newer macrolide in the initial therapeutic regimen. Alternatively, there may be no need to include an agent with activity against *Legionella* if the water supply of the facility is free of *Legionella*. Finally, if necessary, legionellosis can be prevented by eradicating the organism from the facility's water system with newer high-technology water-disinfection methods.<sup>44</sup>

Future studies of *Legionella* infection in long-term care facilities are needed to determine the relationship between colonization of the water system and the occurrence of legionellosis in this setting. The most appropriate study would be a multiinstitutional study that includes facilities in different geographic areas. Participating facilities would submit samples from multiple sites in the potable water system for *Legionella* culture. Those with colonized water systems would then undertake surveillance for *Legionella* infections. At a minimum, this study could establish whether the presence of *Legionella* in the potable water system of a long-term care facility predicts the occurrence of infection in residents.

If a sufficient number of facilities are studied, it would be possible to identify a degree of risk based on level of colonization and patient characteristics. If infection is largely confined to immunosuppressed patients, or those with other identifiable risk factors, knowledge of the risk profile of the residents would permit a facility to make a rational decision as to the appropriate course of action. Possible approaches might include installation of a disinfection system or institution of a medical policy of administering antimicrobials effective against *Legionella* to all patients with nursing home-acquired pneumonia. Neither

approach is without its drawbacks. Installation of a disinfection system entails at least moderate expense and a requirement for on-going maintenance; increased use of empirical quinolone therapy may contribute to increasing antimicrobial resistance.

### RECOMMENDATIONS

Given that negative publicity and the possibility of litigation have sometimes accompanied identification of cases of Legionnaires' disease within a healthcare facility, some medical directors and administrations may be reluctant to undertake active surveillance for environmental *Legionella* or for cases of Legionnaires' disease. Nevertheless, concern for patient safety should be the primary driver of the development and adoption of effective guidelines for prevention of infection in long-term care facilities.

Although more than 20 years have passed since the publication of the first prospective study demonstrating that *Legionella* colonization of a hospital water system predicts the occurrence of nosocomial disease<sup>3</sup> and despite several confirmatory studies in the interim,<sup>31–33–45</sup> public health authorities remain divided over the necessity of testing of hospital water systems for *Legionella*. The Centers for Disease Control and Prevention, for example, recommends culturing hospital water supplies for *Legionella* only in response to the identification of nosocomial infection,<sup>46</sup> although it has recently expanded this recommendation to include hospitals performing organ transplantation. Certain state and local health departments, alternatively, recommend a more proactive approach, with culture of the water system and active surveillance for cases of *Legionella* should be isolated from the environment.<sup>47,48</sup> Several other nations, including the Netherlands, Germany, France, Denmark, and Taiwan, now mandate routine environmental surveillance for *Legionella* in hospitals, regardless of the occurrence of cases. In the interim, nosocomial legionellosis, highly preventable by elimination of *Legionella* from the hospital water supply, continues to occur in acute care hospitals in the United States.

A proactive stance by leaders and investigators in both geriatrics and infectious diseases is encouraged to address this emerging issue so that a rational, cost-effective approach will be available for the identification and control of *Legionella* infection in long-term care facilities.

Based on this review, the following approach for prevention and management of Legionnaires' disease in long-term care facilities is offered.

Environmental surveillance<sup>49</sup> of *Legionella* in long-term care facilities should be performed yearly.

If environmental surveillance shows the presence of *L. pneumophila* serogroup 1, then the urinary *Legionella* antigen test, a simple yet sensitive test for diagnosis of pneumonia due to *L. pneumophila* serogroup 1, should be available in house for use by long-term care facilities.

Positive surveillance cultures for *Legionella* in the potable water should lead physicians caring for long-term care residents to entertain a high degree of suspicion for legionellosis. In pneumonias of undiagnosed etiology, a quinolone or macrolide should be added for anti-*Legionella* activity, and sputum when available should be sent for culture and DFA.

Disinfection of the water supply should not be instituted automatically upon discovery of *Legionella* in environmental cultures. It may be cost-effective to focus on early diagnosis and specific antimicrobial therapy in facilities colonized with *Legionella*. If clinical and laboratory surveillance for legionellosis demonstrate multiple cases and high levels of colonization of the water system, one would have the option of installing a disinfection system to eradicate the organism.

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