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Legionella

in residential water systems

By Janet E. Stout, Ph.D., and Robert R. Muder, M.D.

Recent studies^{1,2} indicate that sporadic cases of Legionnaires' disease are acquired from a previously underappreciated source—residential water systems. This article gives an overview of research findings and what can be done to eradicate *Legionella* in home systems.

Legionnaires' in Hospitals

Shortly after the discovery of Legionnaires' disease in the community setting, outbreaks of Legionnaires' disease were reported in hospitals. Although cooling towers were first implicated as the source of exposure in early investigations, it soon became clear that potable water distribution systems (warm water systems) represented the primary source of exposure for hospital-acquired Legionnaires' disease.³

Subsequent investigations showed that 12% to 70% of hospital water systems were colonized with *Legionella*.⁴ Prospective clinical studies have demonstrated a direct link between the presence

of the bacterium in the water supply and the occurrence of disease.⁵

If hospital water distribution systems were colonized with *Legionella pneumophila* and were the source of infection for hospitalized patients, investigators hypothesized that the same must be true for residential water systems. In 1987, we published the first report of community-acquired Legionnaires' disease acquired from exposure within the home.⁶ Subsequent reports showed that 6% to 32% of homes could be colonized with *Legionella* (Table 1).¹ Investigation of cases of community-acquired legionellosis has led to the emerging rec-

ognition that the disease can be contracted from the water in a patients' home.

We are involved in a large-scale study of community-acquired Legionnaires' disease sponsored by the U.S. Environmental Protection Agency. The study's objective is to determine, in a systematic fashion, how often residential water systems are the source of exposure for community-acquired Legionnaires' disease.

Legionella in Home Systems

The preliminary results of this study were reported in October 2003.² Our study is ongoing. However, the results are consistent with the message that the overall risk of acquiring this disease from exposure within the home is likely to be low. However, certain individuals are at greater risk of acquiring Legionnaires' disease from exposure to the bacterium in residential water systems.

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‘Recent studies^{1,2} indicate that sporadic cases of Legionnaires’ disease are acquired from a previously underappreciated source—residential water systems.’

We followed 35 cases of Legionnaires’ disease caused by *L. pneumophila*, serogroup 1 (15 from Ohio and 20 from Pennsylvania). For 24 cases the diagnosis was made by culture, for 10 by urinary antigen testing, and one by direct fluorescent antibody (DFA).

Environmental testing of the residential water system was performed for 60% (21/35) of eligible cases. A link to home exposure was made if the identical strain that infected the patient was also found in the home water system. *L. pneumophila*, serogroup 1 was the disease-causing species in all patients and was isolated from the home water systems of 24% (5/21) of these patients. Molecular typing of patient and environmental isolates was performed by pulsed-field gel electrophoresis (PFGE) for 2/5 cases. The diagnosis of Legionnaires’ disease was made by the urinary antigen test for the remaining three cases, thus no isolate was available for typing. This analysis supports the conclusion that the source of exposure was the residential water supply.

Home water systems of patients infected with *L. pneumophila*, serogroup 1 were extensively colonized with *L. pneumophila*, serogroup 1. In these homes, 92% (22/24) of water outlets were positive for *L. pneumophila*, serogroup 1. Similarly in a Quebec survey, positive cultures were found in the hot water tank in 52.2% (36/69), at a distal site (faucet or showerhead) in 43.5% (30/69), and in both hot water tank and distal sites 4.3% (3/69).⁷

Thus, it is important that multiple sites in a patient home must be cultured for maximal sensitivity.

Two of our patients had a previous hospital admission within the incubation period for the disease. Interestingly, for one patient both the hospital and home water systems were positive for *L. pneumophila*, serogroup 1. PFGE typing supported the conclusion that the disease-causing strain came from the home water system and not the hospital water system.

Who Is at Risk?

Legionellosis typically occurs in individuals with underlying illnesses that increase their risk of disease. These conditions include chronic lung disease, immunosuppression, organ transplant recipients, HIV infection, diabetes, advance age, and cancer. Treatment with high doses of corticosteroids also significantly increases the risk of infection.

In our current study, those individuals that acquired Legionnaires’ disease from exposure to the organism in the home water system were >70 years of age, or had an underlying disease such as cancer, leukemia or HIV.

Demographic data also is available for 13 Legionnaires’ disease cases from other studies where the home water system was the source of infection.¹ In these studies, the median age was 56 years (range 20 to 76 years), 23% (3/13) were cigarette smokers, one patient had chronic lung disease, and 54% (7/13) were considered immunosuppressed. The mortality was 23% (3/13).

In health care today, most hospitalized patients have a short hospital stay and are sent home with serious medical conditions. An unfortunate consequence of this practice is an ever-



Location	Number of Homes	Percent Colonization	Legionella Serogroups	Risk Factors for Colonization		
				Temp. Hot Water Tank	Electric Heater	Other
Pittsburgh	55	10.9% (6/55)	Lp1	Low	Yes	City Area
Quebec, Canada	211	32.7% (69/21)	Lp4 (24.8%) Lp2 (21%)	Low	Yes	Low Temp., Faucet, Old Heater, Old District
Pittsburgh	218	6.4% (14/218)	Lp1 (85%)	Low	No*	City Area, Iron Level, Low Temp. Faucet
Germany, Netherlands and Austria	65	8% (5/65)	Lp	N/A	N/A	Copper Plumbing, Low Water Use

* Only 5% of homes had electric heaters; Lp = *L. pneumophila*; N/A = not available. Reprinted with permission from *European Journal of Clinical Microbiology and Infectious Diseases*.

Table 1: Risk factors for Legionella environmental colonization in homes.

expanding pool of individuals that may be susceptible to *Legionella* infection from exposure within the home.

Mode of Transmission

Aspiration (from contaminated water or transient oropharyngeal colonization) or intense aerosolization via a humidifier or whirlpool spa may be the mode of transmission in sporadic cases of community-acquired Legionnaires' disease—rather than by aerosolization. Although aerosolization via showering is intuitively attractive, showering has not been shown to be a major disseminator of *Legionella*.⁸ We have shown that multiple outlets within the home may be colonized with the bacterium. Exposure to *Legionella* could occur from any one of these outlets. Therefore, it is virtually impossible to pinpoint the precise mode of transmission within the home environment.

What Can be Done?

When we found a home water system heavily colonized with *L. pneumophila*, a thermal eradication (heat and flush) procedure was performed. Thermal eradication has been used in hospitals for *Legionella* disinfection for many years. This procedure is labor intensive in the hospital setting, but it is relatively easy to perform in the residential setting. The procedure involves raising the hot water temperature to the maximum setting on the hot water tank (140°F [60°C]) and flushing each outlet for 20 to 30 minutes with the super-heated water. After the procedure the temperature was returned to the previous setting.

A thermal eradication procedure was performed in four homes. The reduction in *Legionella* percent positivity of outlets for each home was 75% to 25%, 100% to 0%, 100% to 0%, and 100% to 0%, respectively. This procedure appeared to be as effective in home water systems as it has been in hospital water systems. Likewise, we would expect that the reduction in *Legionella* colonization may be short-term (months) and may have to be repeated if recolonization occurs.

Conclusions and Recommendations

A recent publication provides an extensive review of the subject of Legionnaires' disease acquired from residential wa-

ter systems.¹ This publication can be viewed at www.legionella.org. Our results, and the results from other studies, provide growing evidence that sporadic cases of Legionnaires' disease are acquired from a previously unappreciated source—exposure to potable water sources within the home.

Based on these results we conclude the following:

1. Community-acquired Legionnaires' disease is acquired from exposure to residential water systems more often than previously appreciated.
2. Residential water systems should be investigated as possible sources for sporadic cases of Legionnaires' disease before implicating cooling towers and aerosol-producing devices.
3. Patients with underlying conditions that increase their risk of contracting Legionnaires' disease (cancer, immunosuppressive therapy, advanced age) may benefit from preventive measures to reduce exposure to *Legionella* within the home. This may include periodic thermal disinfection, point-of-use filtration, or use of boiled water for drinking.

References

1. Pedro-Botet, M.L., J.E. Stout, V.L. Yu. 2002. "Legionnaires' disease contracted from patient homes: the coming of the third plague?" *Eur J Clin Microbiol Infect Dis*, 21:699–705.
2. Stout, J.E., R.R. Muder, A.P. Dufour, et al. 2003. "Community-acquired Legionnaires' disease: residential water systems are an underappreciated source of exposure." *43rd Interscience Conference for Antimicrobial Agents and Chemotherapy*, p. 341.
3. Muder, R.R., V.L. Yu, A. Woo. 1986. "Mode of transmission of *Legionella pneumophila*: a critical review." *Arch Intern Med*, 146:1607–1612.
4. Lin, Y.E., R.D. Vidic, J.E. Stout, et al. 1998. "*Legionella* in water distribution systems." *J Amer Water Works Assoc*, 90:112–121.
5. Yu, V.L. 1998. "Resolving the controversy on environmental cultures for *Legionella*." *Infect Cont Hosp Epid*, 19: 893–897.
6. Stout, J.E., V.L. Yu, and P. Muraca. 1987. "Legionnaires' disease acquired within the homes of two patients. Link to the home water supply." *JAMA*, 257(9):1215–1217.
7. Alary, M., J.R. Joly. 1991. "Risk factors for contamination of domestic hot water systems by *Legionella*." *Appl Environ Microbiol*, 57:2360–2367.
8. Sabria, M., V.L. Yu. 2002. "Hospital-acquired legionellosis: solutions for a preventable disease." *Lancet Infect Dis*, 2:368–373. ●