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Preventing Disease from *Legionella* Is a Shared Responsibility

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Abstract

Legionellosis, manifesting as either Legionnaires' disease or Pontiac fever, is a serious concern in the United States. Water providers and property owners must do their part to control *Legionella*.

Few things are more important to providing safe drinking water than controlling disease-causing microorganisms. For decades, drinking water providers have focused on indicators of fecal contamination such as *E. coli*, *Giardia*, and *Cryptosporidium*. In recent years, however, drinking water professionals and building operators have begun to recognize the importance of so-called opportunistic premise pathogens like *Legionella*.

Legionella is a genus of bacteria found naturally in soil, surface water, and groundwater. There are more than 60 known species of *Legionella*. In the United States, the species *Legionella pneumophila* causes most of the reported cases of legionellosis, i.e., disease caused by *Legionella*.

Legionellosis takes two forms: Legionnaires' disease, a potentially deadly pneumonia, or Pontiac fever, a mild flu-like illness. There's no known health-based concentration of *Legionella* that causes disease. It's generally accepted that the concentration of *Legionella* found in the environment is too low to be a health concern to people. However, conditions can allow *Legionella* to grow in building plumbing systems, recreational water, and water features to the point where it can threaten human health.

Legionella is the No. 1 cause of waterborne disease outbreaks in the United States. In 2017, the last year for which data were finalized by the US Centers for Disease Control and Prevention (CDC), 7,458 cases of Legionnaires' disease were reported in the United States—more than six times the number of reported cases since 2000. Even more concerning is that many more cases are undiagnosed or unreported.

Microbiological Contaminants

EXPOSURE PATHWAYS

The first recorded outbreak of Legionnaires' disease was in Philadelphia in 1976 during the American Legion Convention, giving the disease its name. The outbreak was attributed to a hotel cooling tower and resulted in approximately 182 cases and 29 deaths. In more recent years, there have been notable deadly outbreaks in New York City and in Genesee County, Mich., which co-occurred with the lead crisis in Flint that resulted from a change in water source (see "Flint's Road to Recovery," *Opflow*, November 2018). Table 1 lists notable cases in 2018. Though not an exhaustive list, the table illustrates that *Legionella* is an ongoing issue across the United States.

As shown in the figure 2, three factors play a role in disease developing from *Legionella*: favorable conditions in building water systems for a pathogenic species of *Legionella* to proliferate, transmission of *Legionella* from the water to the lungs through aspiration or aerosolization, and susceptibility of the exposed individual.

Favorable Conditions for *Legionella* Proliferation.—Drinking water that complies with regulations isn't sterile. Even with the best available treatment, *Legionella* may travel from the source water through a treatment system and into a building water system.

Although free-floating *Legionella* bacteria can be found in bulk water, they're often associated with biofilms, which can provide nutrients and protection from disinfectants. *Legionella* are also intracellular parasites to some species of protozoa—at least 26. While living and reproducing inside protozoa, *Legionella* are provided an extra level of protection from disinfectants. Studies have found that *Legionella* are up to 50 times more resistant to chlorine while living inside protozoa. These mechanisms enhance the ability of *Legionella* to travel through the municipal water treatment and distribution process.

Legionella can survive in a wide range of water temperatures, with an optimal growth range between 77°F and 108°F (25°C–42°C). These optimal temperatures aren't often found in drinking water distribution systems but can be common in building water systems, specifically hot water and nonpotable water, where *Legionella* can grow and become a persistent problem.

Low disinfectant residuals, typically caused by high water age, sediment, corrosion products, and plumbing configuration (e.g., recirculation), can further contribute to favorable growth conditions. Plumbing materials, plumbing devices, and green design may also play important roles in the growth of *Legionella* and biofilms because they often reduce water flow, increase water age, increase surface areas for growth, and can provide nutrient sources. Because of these factors, some studies have estimated that *Legionella* may exist in as many as 50 percent of building water systems sampled.

Typically, *Legionella* wouldn't be detected in the cold water of a municipal distribution system. However, growth conditions such as sediments in water storage tanks, sections of

distribution systems with persistently low chlorine residuals, and warm water zones due to tank stratification or low-use mains can contribute to *Legionella* growth in a water system.

Main breaks, or other water main disturbances, can cause biofilm and nutrients to dislodge, which can increase the potential for growth within a building. Sediments will often be stirred up during a main break, lowering the disinfection residual of the water entering a building. The quality of the water entering a building could play an important role in *Legionella* growth.

A federal regulatory standard (i.e., a maximum contaminant level) hasn't been established in the United States for *Legionella*, but the US Environmental Protection Agency (USEPA) has set a maximum contaminant level goal of zero. In addition, the USEPA's Surface Water Treatment Rule requires treatment for disease-causing microorganisms like *Giardia* and viruses, and such treatment is believed to control *Legionella*.

Legionella may also be introduced to the water system through main breaks, cross connections, or backflow events. Also, although *Legionella* live in a water system's microbiome, the bacteria's presence or absence isn't directly related to any other microbiological measurement. *Legionella* control can't be assumed even when coliforms are absent, when heterotrophic plate counts are below 500 cfu/mL, or if another parasite has been removed.

Transmission.—If a pathogenic *Legionella* species colonizes a building water system, it must be transmitted to the lungs of a susceptible person for disease to occur. Transmission sources through aerosols or aspiration include shower heads, cooling towers, faucets, water-based humidifiers, hot tubs, decorative fountains, medical devices, misters, and ice machines. Somewhat unique sources have included reports of Legionnaires' disease associated with continuous positive airway pressure (CPAP) machines. The CDC recently reported that water aspiration by newborns during water tub birth also has been found to be a means of infection.

At-Risk Individuals.—Susceptible individuals are typically elderly, smokers, male, or immunocompromised, although studies have found that approximately 25 percent of cases may not have any of these typical risk factors. Controlling *Legionella* growth is especially important in hospitals and long-term care facilities because they house susceptible populations.

SHARED RESPONSIBILITY

Preventing disease caused by *Legionella* is a shared responsibility between water providers and building/property owners. With the exception of the Lead and Copper Rule, water quality deterioration beyond the water meter historically hasn't been the focus of drinking water providers. In recent years, understanding of the causes and risk factors associated with *Legionella* has increased.

Water providers have an opportunity to engage with property owners and educate them on the risks associated with this pathogen. Water providers also have a responsibility to

maintain a disinfectant residual for all customers and use best management practices for storage and distribution systems. Likewise, building owners are responsible for managing their building water systems to minimize *Legionella* risk.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has developed Standard 188, which is currently the only US standard for *Legionella*, and it requires that property owners evaluate their building water systems to determine whether they need to implement a water management program. Water management programs are essential for monitoring and controlling the conditions that lead to *Legionella* growth. A water management program consists of a plan to identify, monitor, control, validate, and document the actions taken to control *Legionella* in building water systems.

There's currently only a patchwork of regulations that require building owners to address *Legionella* risk. Buildings that are required to address *Legionella* include healthcare facilities accredited by the Centers for Medicare & Medicaid Services, healthcare facilities in the state of New York, cooling towers in New York state and New York City, and Veterans Administration facilities. Other organizations have provided guidelines and instructions to help building owners. A free toolkit by the CDC covers the process of setting up and implementing a water management program following ASHRAE 188 (<https://bit.ly/2tWhxR2>).

Managing *Legionella* in building water systems is a complicated issue. The responsibility largely lies in the hands of building owners, but water providers also are responsible for optimizing their distribution systems so all customers receive high-quality water. Ultimately, the responsibility for preventing disease from *Legionella* is a shared one.

Fig. 1.

Legionella bacteria are found naturally in the environment and can be conveyed through water distribution systems to the premise plumbing in buildings, where they may grow in warm water sources such as hot water heaters, storage tanks, pipes, cooling towers, decorative fountains, and hot tubs. Culture has been the method of choice for detecting *Legionella* from environmental samples but is sometimes difficult because of interference or overgrowth by other organisms (top). *Legionella* must be transmitted to the lungs of a susceptible person for disease to occur (bottom).

Fig. 2.

Exposure Pathways Three factors play a role in disease developing from *Legionella*.

Table 1:

Notable legionellosis cases in 2018^{*} Recent reports indicate *Legionella* is an ongoing issue across the United States.

Month	Location	Number of illness/ cases reported	Number of deaths	Source
February	Sarasota County, Fla.	13	0	Possibly pool, spa, or water heater
June–July	Honolulu	4	1	Hospital
June–July	McHenry County, Ill.	9	0	No common source
June–July	Cleveland	11	1	Not confirmed, possibly building cooling system
July	New York City	20	1	Cooling tower
July–August	Hampton Beach, N.H.	18	1	Not confirmed, possibly hot tub
July–August	El Paso County, Colo.	10	0	Not confirmed
September	Sioux Falls, S.D.	14	1	Not confirmed
September–October	New York City	8	0	Not confirmed

^{*} The information in this table was current at the time of article submission. Numbers may not reflect additional information between then and the time of publication.