

# Deadly Legionella: Commonly Found in US Water Systems

By Kelly A. Reynolds, MSPH, PhD

While advances in water treatment practices and regulatory treatment guidelines have led to a dramatic reduction in waterborne outbreaks, additional public health challenges relative to drinking water continue to be identified. *Legionella* is the most commonly reported pathogen in US waterborne outbreaks and responsible for nearly all waterborne deaths in the US from 2009-2010. Controlling this widespread environmental pathogen is not easy; however, POU solutions are available and effective if properly applied.

## A definitive hazard

*Legionella* is a genus of bacteria that can cause illness known as legionellosis. Symptoms are manifested in two distinct categories: the more severe pneumonia known as Legionnaire's

disease and the milder, flu-like illness known as Pontiac fever. While Pontiac fever typically resolves on its own, Legionnaire's disease often results in hospitalization and sometimes death. Although Legionnaire's disease can be treated with antibiotics, five to 15 percent of cases still result in fatal outcomes. *Legionellae* are free-living, ubiquitous freshwater inhabitants and are commonly recovered from drinking water sources and tap water systems. The bacteria are spread via aerosolized water and have been traced to misters, cooling towers, humidifiers, fountains and showers. Originally linked to an epidemic of fatal pneumonia in a population of war veterans attending an American Legion convention in Philadelphia, PA, in 1976, *Legionella* now causes an estimated 8,000 to 18,000 hospitalization events per year in the US. Exposure is usually via inhalation of contaminated water droplets and is not transmitted from person to person. Pneumonia is still a primary cause of infection-related deaths in the US. About half of all community-acquired pneumonia worldwide in adults and up to 75 percent of hospital-acquired pneumonia are due to unknown etiological agents. *Legionella* and other emerging waterborne respiratory pathogens are thought to cause a significant portion of these infections, as they are commonly present in water supplies but difficult to grow from clinical samples. The true public health impact of free-living amoebae in drinking water are not known, but on average they are detected at the tap water point of use at a rate of 45 percent.

**Table 1. Characteristics of *Legionella* waterborne disease outbreaks associated with drinking water\* (n=19) in the US from 2009-2010**

State	Date	Cases	Hospitalizations	Deaths	Water source	Setting
Florida	Jul 2009	2	2	0	Well	Membership club
Maryland	Sep 2009	10	9	1	Well	Private residence
Nevada	Dec 2009	10	1	0	Lake/reservoir	Hotel/motel
New York	Apr 2009	3	3	2	Lake/reservoir	Hospital/health care
New York	Dec 2009	3	3	1	Lake/reservoir	Hospital/health care
So. Carolina	Jul 2009	3	3	0	Groundwater	Hotel/motel
Utah	Jun 2009	5	5	0	Well/spring	Hotel/motel
Georgia	Apr 2010	4	4	0	Well/spring	Hotel/motel
Maryland	Aug 2010	2	2	0	Surface water	Personal care home
Nevada	Dec 2010	4	2	1	Well, river/stream	Hotel/motel
New York	Apr 2010	3	3	1	Lake/reservoir	Hospital/health care
New York	Jun 2010	3	3	0	Lake/reservoir	Prison/jail
New York	Jul 2010	2	2	0	Lake/reservoir	Hospital/health care
New York	Jul 2010	5	3	0	Lake/reservoir	Hospital/health care
Ohio	Feb 2010	3	3	0	Unknown	Long term care facility
Pennsylvania	May 2010	3	3	1	Well	Personal care home
Pennsylvania	Jun 2010	2	2	0	River/stream	Apartment/condo
Utah	Aug 2010	2	2	1	Spring, creek	Hotel/motel
Utah	Dec 2010	3	3	0	Well, surface water	Assisted living/rehab

\*All water systems involved were community water supplies. Modified from CDC, 2013.

## Helper amoebae

*Legionella* in tap water systems are able to proliferate and may resist disinfectant treatments due to association with protective biofilms or natural hosts. Disinfectant levels capable of killing bacteria in water are not effective for elimination of many protozoa. *Legionella* can actually grow within free-living amoeba, where they are protected

from disinfectants and escape detection and effective treatment. Studies have shown that bacteria proliferation and virulence is enhanced in the presence of amoebae and that biofilms form rapidly in mixtures of amoebae and bacteria together. Essentially, bacteria such as *Legionella* use amoeba as not only a protective environment but also as a food source, further enhancing their growth and persistence in drinking water systems. One survey of free-living amoebae in environmental source waters found that 62 percent of surface water samples and 71 percent of groundwater samples tested positive. These amoebae are also commonly isolated from treated water supplies and distribution systems. Organic matter content, temperature, sediment and biofilms are environmental variables likely to affect free-living amoebae and subsequently, bacterial pathogen populations.

### Waterborne outbreaks

In terms of waterborne disease outbreaks associated with drinking water, *Legionella* is now the primary etiological agent, accounting for 58 percent (19/33) of the outbreaks during the most recent published survey period (2009-2010). In most of these reported events, *Legionella* was detected in the localized plumbing systems. Ultimately, these *Legionella* outbreaks resulted in 72 illnesses, 58 hospitalizations and eight deaths (see Table 1). Further, *Legionella* caused an additional seven outbreaks, resulting in 99 illnesses and six deaths from other non-recreational waterborne exposures, including cooling towers, a mist/steam device, an ornamental fountain and other unknown water sources from chronic care facilities.

*Legionella* again made headlines in February 2013 following the death of five, and possibly six, patients in the Veterans Affairs Hospital in Pittsburgh, PA. Genetically, the bacteria from the more recent outbreak were nearly identical to isolates from a 1982 outbreak in the same facility. The 1982 outbreak resulted in 100 cases of Legionnaire's disease over a three-year period, resulting in approximately 30 deaths. The fact that the strains from the 1982 and 2013 outbreaks were so similar indicates that the harmful bacteria persisted in the hospital's water pipes for decades, despite efforts to purge the organism with hot water flushes, chemical disinfectants and installation of antibacterial pipes.

### Treatment options

Control of *Legionella* in water is particularly difficult given its ability to grow in distribution systems and premise plumbing of hospitals, commercial buildings and residences. Areas requiring control are often outside US EPA's jurisdiction for water quality monitoring and treatment. Preventing *Legionella* exposures requires a comprehensive water safety plan. The World Health Organization published a white paper in 2007 on how to monitor and control for *Legionella* in a variety of systems. Specific miti-

gation strategies include: excluding the microbe from entering water systems; preventing growth by controlling nutrient levels, temperature and stagnation; controlling amoeba and using a biocide. Common *Legionella* control strategies are to hyperchlorinate (>two ppm residual concentration) distribution and premise plumbing systems and to superheat (>160°F) and flush the system. POU treatment techniques such as UV disinfection and filters rated for removal of bacteria are effective barriers and recommended to minimize at-risk population exposures to *Legionella* from faucets and showerheads. Such prevention measures are essential for reducing the number of *Legionella* outbreaks in the US and worldwide.

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