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Legionella - The Lurking Menace

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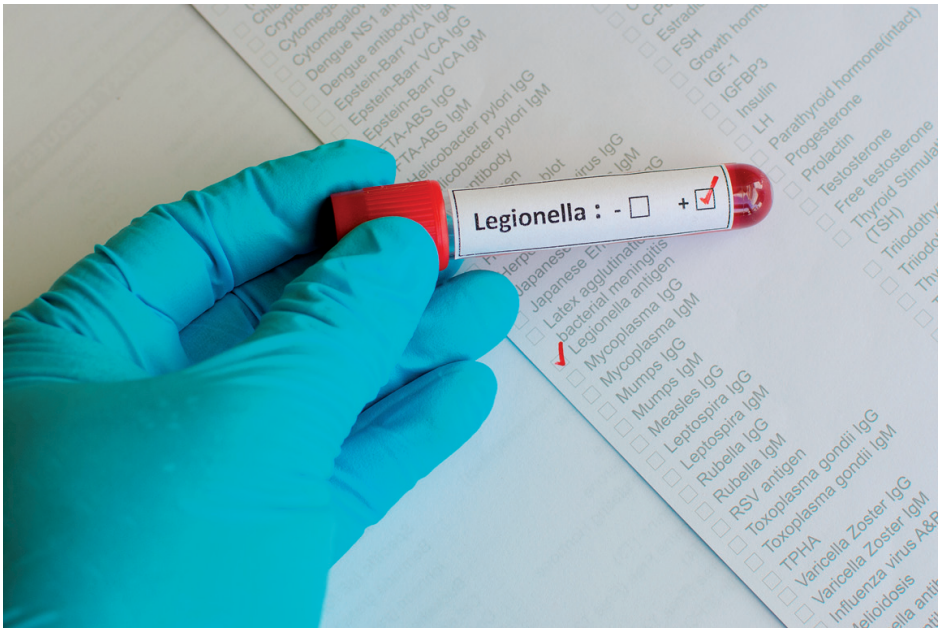
Legionella pneumophila is potentially dangerous bacteria and the causative agent for more than 10,000 cases of Legionnaires' disease reported each year. It is also responsible for the majority of drinking water-associated disease outbreaks in the United States.[1] The bacteria are most commonly found on surfaces exposed to warm water within building piping systems. This requires facility managers to remain vigilant as the presence of this pathogen can lead to a complete shutdown of operations until the entire water system can be cleaned and disinfected. The following is a comprehensive overview of Legionella pneumophila, the dangers it presents and the current industry best practices for detection and treatment of an infected water system.



Background

There are currently 58 known species of Legionella and more than 70 serogroups, half of which have been associated with human disease.[2] Legionella bacteria are found naturally in the environment worldwide, usually in aquatic environments. Some species including Legionella longbeachae, can be found in potting mixes.[3] Inhalation exposure of water aerosols to Legionella pneumophilia, a gram-negative bacterium, can result in severe pneumonia termed Legionnaires' disease or Legionellosis. Legionella amplification typically occurs in heated water sources found in indoor building water systems or recirculated water sources.

Legionella most often spreads by colonizing biofilms in plumbing systems. Examples of Legionella amplification in buildings often come from cooling towers, evaporative condensers, humidifiers, ice machines, potable water heaters, water pipes and distribution systems, shower heads, faucets, decorative fountains, nebulizers, hot tubs, and whirlpool baths.

Legionnaires' disease has an incubation period of 2 to 10 days (but up to 16 days has been recorded in some outbreaks).[2] Death occurs through progressive pneumonia with respiratory failure and/or shock and multi-organ failure. Transmission does not occur from person-to-person. Infection occurs primarily through inhalation or aspiration. Legionnaires' disease is primarily a building-related illness.

The main problem facing most institutions and facilities is that Legionella can be found at low concentrations in municipal water supplies because it is able to survive routine water disinfection treatment. Municipal water is often the colonizing source of Legionella bacteria in buildings. Legionella travels through a building water system where colonization often occurs in biofilms within water heaters and distribution systems. A biofilm, once developed, is difficult to eliminate. Biocides only act on the surface of the exposed surface of a biofilm.

Water temperature is a critical factor for the Legionella bacteria to thrive in natural and man-made locations. Ideal temperatures for growth are 80-120° F. Other environmental conditions that encourage bacteria growth include accumulated debris, scale and biofilm, stagnant water or low flow and "dead legs" in water distribution systems, residual chlorine levels below 0.5 ppm, and the presence of algae, amoebae, and protozoa. Legionella pneumophila is a natural parasite of environmental amoebae.[4]

Because cooling towers and other man-made water systems may become colonized from their make-up water source, and they typically contain warm water, it is important that such systems are well-maintained, periodically monitored, cleaned, and properly disinfected in order to prevent Legionella amplification.

Many reported Legionella outbreaks occur in healthcare facilities with water

treatment programs in place, thus highlighting the limited effectiveness of current control and monitoring practices for complex plumbing systems.

Prevention

There are several approaches to preventing and controlling Legionnaires' Disease. Leaders in the field follow an industrial hygiene methodology that focuses on proactive efforts to recognize and evaluate Legionella hazards instead of waiting for the first cases of disease to be reported. This approach begins with a thorough assessment of risk that requires a facility to:

- Inventory water systems.
- Observe and characterize water systems for Legionella amplification.
- Conduct environmental sampling.

o Do not rely on substitute tests such as dipstick tests, HPC, and ATP levels.

o Only reply on viable culturing methods.

- Conduct periodic water sampling.
- Never rely on surrogate indicators, such as disinfectant chemical levels (chlorine/bromine) and cleaning procedures for validation of bacterial control.
- Perform routine equipment inspections for rust, scale, sediment, and biofilm since they support the growth of Legionella.
- Monitor for protozoa and amoebae activity.
- Identify control measures if Legionella is present in the water system.
- Perform disease surveillance.
- Develop a detailed sampling strategy and plan (include make-up water or municipal water sampling).
- Model piping heat retention and loss.
- For focused microbial sampling evaluations for legionellosis, inspection and understanding of a building's heat rejection (e.g., cooling towers) and potable-water systems is essential in order to select sites for collection of samples possibly containing Legionella.

Showerheads can also amplify Legionella

Prevention and control measures work together. Successful treatment strategies require:

- Comprehensive building water or water system treatment program.
- Expert engineering controls to minimize aerosolization.
- Installation of drift eliminators in cooling towers.
- Removal of certain plumbing features (e.g., dead legs, rubber gaskets, cross contamination points) may eliminate potential reservoir locations for Legionella bacteria.

Cooling towers offer ideal environments for Legionella amplification

Should Legionella be detected, there are several treatment technologies available, all of which have various pros and cons. It is imperative that the limitations of each technology are well-understood before facility implementation. Failure to identify the most appropriate technology for a particular facility could result in significant and unnecessary cost expenditures.

The most common technologies include:

- Mechanical Cleaning
- Thermal Treatment
- Chemical Treatment & Biofilm Control
- Ultraviolet (UV) Light Disinfection
- Ozone

Chlorine is the only disinfectant specifically recommended in a Centers for Disease Control and Prevention (CDC) publication for infection control in healthcare facilities. However, it is very corrosive to piping systems. Chlorination has been criticized as the most unreliable and most expensive water treatment system and there are many documented cases of hospital conversions to alternate treatment technologies for failure of chlorination to control Legionella amplification.[5] The risks to facility plumbing should be evaluated before implementing any technology.

The industrial hygiene approach focuses on proactive efforts to recognize and evaluate Legionella hazards prior to disease onset.

F.W. Webb's Approach

If your facility is at risk for Legionella, organizations like F.W. Webb's Alliance Environmental Group (AEG) can help. They handle these challenges by selecting the most efficacious and cost-effective approach to Legionella assessment, evaluation, treatment, control, and mitigation. They develop comprehensive assessment plans, conduct thorough testing and analysis, plan preventive maintenance strategies, provide multiple treatment options, and deliver recommendations to the client. AEG specifically uses qualified scientists to develop comprehensive site-specific sampling plans with assistance from several national microbial analytical laboratories equipped for Legionella analysis and identification.

For more information on Legionella assessment, evaluation, treatment, and control in the Northeast, contact Alliance Environmental Group at (401) 732-7600.

1. van der Kooij D, Bakker GL, Italiaander R, Veenendaal HR, Wullings BA. 2017. Biofilm composition and threshold concentration for growth of Legionella pneumophila on surfaces exposed to flowing warm tap water

2. Sampling and Analysis of Indoor Microorganisms/Edited by Chin S. Yang, 2007, John Wiley & Sons, Inc.

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5. Recognition, Evaluation, and Control of Legionella in Building Water Systems; 2015; AIHA