Legionella… a Hidden Liability for Facilities Managers

by
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Introduction

Microbial contamination represents an extremely diverse and often confusing component of indoor air quality (IAQ). *Legionella pneumophila*, the bacterium that has been linked to Legionnaires Disease and Pontiac Fever, is one of those microbes that can represent a hidden liability for facility owners; however, the implementation of just a few minor pro-active steps can greatly reduce the potential of a *Legionella* outbreak at your facility. The following article provides the reader with some of the unique background and history of this organism and its impact on IAQ along with a review of the technical aspects of inspection and sampling. The article concludes with a review of treatment processes and a means by which the facility owner can evaluate the potential risk of a *Legionella* source at their facility.

Background and Introduction

Legionella is considered to be a "true bacteria" (Eubacteria). It is a common environmental "rod-shaped" gram-negative bacterium that is most typically associated with aquatic environments throughout the world. While *Legionella* may be ubiquitous in the natural environment, it is the presence of *Legionella pneumophila* and other similar species in the "built" environment that typically causes the greatest concern with regard to building liability.

Oddly enough, the scientific community was unaware that this bacterium existed prior to 1976. It was not until a mysterious disease resulting in the death of 34 individuals and the treatment of 100's of other individuals associated with a Legionnaires convention in Philadelphia that illuminated its presence. Its discovery as a result of its association with that convention was essentially why the bacterium was ultimately named *Legionella*; however, at the time the thought that an environmental bacterium was causing such a disease was largely considered improbable. Walter Dowdle, working with the Center for Disease Control in 1976 stated " at no time did any consultant suggest that the etiologic

agent .of Legionnaire's disease was a bacterium". It wasn't until later, when scientists McDade and Shepard associated the bacteria with Pontiac Fever, that the potential relationship with Legionnaire's disease started to unfold. Pontiac Fever is a less severe medical manifestation of an exposure to *Legionella* that is more akin to hypersensitivity pneumonitis and other "flu-like" disorders. Even then the media, public, scientists, and members of Congress were slow to accept a bacterium as the cause of Legionnaire's disease. *Legionella* as the causative agent of the Legionnaires outbreak in Philadelphia represented a shock to the scientific and medical communities. This discovery changed the way that humans evaluated the "built environment" with regard to microorganisms and ushered in a new concept of "indoor bioaerosol exposures" relative to common environmental microorganisms.

"The Legionnaire's episode of 1976 taught us the inadequacy of our understanding of the mechanisms of a host-parasite relationship and the role of the environment as a reservoir for infectious disease" says Dowdle in a keynote address at the 1976 Conference for the American Society for Microbiology. Mr. Dowdle continued by suggesting that the world of infectious diseases will have many more surprises as the world population continues to grow.

Meanwhile, the problems associated with Legionnaires disease continue to exist to this day. Paul Edelstein of the University of Pennsylvania School of Medicine states that "the disease is still difficult to diagnose, and it is likely that we will continue to mis-diagnose despite the use of optimal testing". Relatively few advances in the diagnosis of Legionnaires disease have occurred, and include the availability of commercial radioimmunoassay for urinary antigens, a DNA probe assay for *Legionella* isolates from the respiratory tract, and a monoclonal antibody for bacterial detection. However, Edelstein indicates that poorly validated commercially available immunological reagents may actually be hindering the advance of science in this area rather than offering any significant advancement.

However, despite these hindrances, the science in this area is evolving. Doctors and physicians are becoming more aware of the non-traditional "environmental-related" diseases that may impact their patients. A number of recent studies indicate that *Legionella* species cause 1 to 5% of community acquired pneumonias. Preliminary findings of a large, ongoing, population-based study of community-acquired pneumonia requiring hospitalization indicated an annual rate of Legionella infection on the order of 6.1 per 100,000 population. Clearly, this indicates a significant medical concern in the population in general; however, the significance can become even more personal if these infections can be linked to a cooling tower or hot water heater at your facility. The prevention and control of *Legionella* is obviously an area of risk management that warrants some attention at a public facility.

Where are Potential Reservoirs of *Legionella* at My Facility?

Water is the major environmental reservoir for *Legionella* bacteria and *Legionella* are frequent inhabitants of most water sources. Water sources in a building that do not maintain adequate chemical control can experience increases in *Legionella* concentrations and therefore "create" a substantial reservoir that could become problematic. These include fountains, decorative pools, and cooling towers and recirculated water-cooling systems, but could also include hot water, humidification, fogging, and other water systems.

Legionella has been shown to have a unique relationship with various protozoa. Science has shown that various protozoa will "ingest" these bacteria and that this action actually "protects" the bacteria from chemicals that may be present in the water system. Chemicals in the water will have a lethal impact on bacteria, protozoa, and other microbes; however, the concentrations of these chemicals diminish over time as a function of chemical activity and longevity. When the chemical concentrations in the water system become reduced, these bacteria can be "released" back into a water system that has an absence of any other microorganisms. The lack of "competition" allows these bacteria to increase in concentrations at a rather rapid rate, thus creating a potentially problematic reservoir. This is why the consistent maintenance of an appropriate chemical treatment program of water reservoirs at a facility is extremely important; however, this also suggests that some level of testing might be necessary to evaluate the overall impact of such a program.

How Do I Test for *Legionella*?

The primarily route of exposure for *Legionella*-related disease is the air; however, sampling for *Legionella* in the air is not recommended. The organism appears to be too fragile to be effectively recovered from airborne samples. The most appropriate means to evaluate the potential presence of *Legionella* bacteria in water reservoirs is through bulk water samples. The actual collection process is not that difficult. The facility manager should first contact an appropriate laboratory that can perform these analyses. The laboratory should have a standard collection protocol that the facility manager can utilize. The lab should also have sterilized water containers that can be utilized in the collection process; however, the collection could also use other common plastic vessels provided the vessels are clean and have been adequately rinsed with source water prior to the actual collection of the sample. A sample volume of approximately 500 – 1000 milliliters (½-1 quart) of water is typically adequate; however, let your laboratory dictate the specific amount of water they will need to complete the analytical process. This sample should be packed in a cooler with "blue-ice" or some other similar product that will keep the sample cool during shipment. The sample should be sent by overnight courier services with a label indicating to "open immediately" on receipt at the lab.

Obviously, an appropriate "chain of custody" should accompany the sample to provide the lab with appropriate details of who, where, and when the sample was collected, as well as to define "what" the sample is to be analyzed for. You will want to request that the results are reported in *Legionella* / milliliter (mL). Typically, a laboratory will perform bulk water analysis for *Legionella*-for around $100.00 per sample.

What do the Test Results Mean?

While most laboratories are eager to obtain your business with respect to analyzing *Legionella* samples, few will actually be willing to interpret the laboratory results. Fortunately, some beneficial research concerning *Legionella* has been published that will allow for a relatively easy interpretation of laboratory results. The title of the research is "Reducing Risks Associated with *Legionella* Bacteria in Building Water Systems" produced by B. Shelton, et.al and published in *Legionella;* Current Status and Emerging Perspectives. The research provides various remedial responses relative to concentrations of *Legionella* recovered from a standardized unit of water volume. Table 1 identifies various concentrations of *Legionella* observed in cooling towers and evaporative condensers, potable water, and humidifier/fogger water sources and provides a numerical reference coded to a specific remedial response that is identified in Table 2. It's really that simple. Get the data back from your lab and apply it to these criteria and you have a functioning *Legionella*-control program that is based on sound scientific principles and practice.

Developing a Prevention Program

The most appropriate program to prevent the development of a substantial *Legionella* reservoir at your facility and to prevent a potential outbreak of *Legionella*-related disorders is a balance between a well-documented water treatment program and periodic evaluation of *Legionella* populations. A myriad of chemical companies provide products that are designed to control microbiological populations in water reservoirs. Numerous suppliers provide these products and services to the industry; however, you must ultimately make certain that the specific chemicals that are selected for use at your facility also have a biocidal action against *Legionella* bacteria, as well as, the protozoa in which they may inhabit. You must also make certain that the chemicals are being applied in an appropriate concentration and rate to effect the desired biocidal action. Of course, the only way to really know if this is occurring is to undertake some sampling. You don't necessarily need to over-do it here, but having some actual documentation that the water treatment program that you are relying on is actually working is an important consideration relative to the establishment of an appropriate *Legionella* prevention program. The data obtained from the sampling can be correlated with research that will essentially direct you if further remedial actions are required. Full documentation of

these processes will provide verification to any interested parties that a sound *Legionella* prevention program is in effect at your facility.

About the Author

Larry D. Robertson has been assisting facility owners with indoor environmental problems for over 20 years. Robertson founded one of the very first laboratories in the world that specialized in indoor microbiological contamination, and was a founding member and President of the Indoor Air Quality Association (IAQA). Robertson has numerous publications and presentations that have served to educate the public on indoor air quality issues and is currently serving as the Technical Director of Indoor Environmental Consultants, Inc. located in Austin, Texas.

Table 1			
	Remedial Code if detected in		
Legionella/mL	Cooling Towers and Evaporative Condensers	Potable Water	Humidifier/Fogger
Detectable, but <1	1	2	3
1 to 9	2	3	4
10 to 99	3	4	5
100 to 999	4	5	5
≥ 1000	5	5	5

Reducing Risks Associated with Legionella Bacteria in Building Water Systems; B. Shelton, et. Al.;Legionella, Current Status and Emerging Perspectives; American Society for Microbiology, ISBN 1-55581-055-1;pg 279-281

Table 2	
Remedial Code	**Actions**
1	Review routine maintenance program recommended by the manufacturer of the equipment to ensure that the recommended program is being followed. The presence of barely detectable numbers of legionellae represents a low level of concern.
2	Implement Action 1 plus: Conduct a follow-up analysis after a few weeks for evidence of further *Legionella* amplification. This level of legionellae represent little concern, but the number of organisms detected indicates that the system is a potential amplifier of legionellae.
3	Imiplement Action 2 plus: Conduct a review of premises for direct and indirect bioaerosol contact with occupants and health risk status of people who may come in contact with the bioaerosols. Depending on the results of the review, action related to cleaning and/or biocide treatment of the equipment may be indicated. This level of legionellae represents a low but increase level of concern.
4	Implement Action 3 plus: Cleaning and/or biocide treatment of the equipment is indicated. This level of legionellae represents a moderately high level of concern, since it is approaching levels that may cause outbreaks. It is uncommon for samples to contain numbers of legionellae that fall in this category.
5	Immediate cleaning and/or biocide treatment of the equipment is definitely indicated. Conduct a posttreatment analysis to ensure effectiveness of the corrective action. The level of legionellae represents a high level of concern, since it poses the potential for causing an outbreak. It is very uncommon for samples to contain numbers of legionellae that fall in this category.
Reducing Risks Associated with Legionella Bacteria in Building Water Systems; B. Shelton, et. Al.;Legionella, Current Status and Emerging Perspectives; American Society for Microbiology, ISBN 1-55581-055-1;pg 279-281	