PathCon® Laboratories

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Legionella Bacteria in Environmental Samples: Hazard Analysis and Suggested Remedial Actions

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THE DISEASE

The diseases caused by *Legionella* bacteria, or legionellosis, are currently recognized to occur in two distinct clinical forms: Legionnaires' disease and Pontiac Fever.

Of the two, Legionnaires' disease is the more serious condition, causing a multi-system disease including pneumonia with fatality rates of about 15%. When outbreaks occur, usually less than 5% of exposed individuals develop disease, commonly within 3 to 9 days after exposure.

Pontiac fever is a non-fatal flu-like disease of short duration which does not cause pneumonia. Approximately 95% of exposed individuals develop disease, usually within 2 to 3 days. The number of cases of Legionnaires' disease occuring in the United States each year has been estimated by the Centers for Disease Control and Prevention (CDC) at 10,000 to more than 100,000 per year.

THE BACTERIUM

Legionellosis is caused by *Legionella* bacteria which occur natually in surface waters including lakes, streams, and mud. There are more than 34 known species and more than 50 serogroups of *Legionella*. Many of them have not yet been implicated in human disease. *Legionella pneumophila* serogroup 1 is most frequently implicated in disease and is most frequently found in the environment. It is possible that some species have not yet been associated with human disease beause they occur so rarely in nature; therefore, all strains should be considered potentially pathogenic.

RISK OF INFECTION

To cause disease several factors must occur: the organism must be virulent, it must be in sufficient number to cause disease, the water source must be aerosolized and distributed to the human host, the legionellae must be inhaled by the potential host deeply into the lungs, and the human host's defenses must be unable to stop the infection.

The infectious dose has not been determined, but the larger the dose, the more likely an infection will occur. The risk of infection will be greater if the dose of *Legionella*-containing water is in direct, close contact with the target person (as is the case with humidifiers and foggers) than if the water is distant from the target person {as with cooling towers, (CT), and evaporative condensers, (EC)}. Portable water systems may represent an intermediate category.

The risk of infection is greater and a lower dose is required in those individuals who are older, smokers, heavy drinkers, immunocompromised with other diseases or on immunosuppressive therapy.

BUILDING AND INDUSTRIAL SOURCES

Water in many natural or man-made systems serves as an amplifier of *Legionella* bacteria by providing suitable conditions for growth. Potential sources include cooling towers, evaporative condensers, humidifiers, potable water heaters and holding tanks, pipes containing stagnant warm water, shower heads, faucet aerators, decorative fountains, nebulizers, mister reservoirs, and whirlpool baths. *Legionella* apparently survives in low numbers in routine water treatment used to treat potable water and can be carried in the treated drinking water into buildings, where the bacteria can colonize in the plumbing fixtures, especially in hot water systems.

Therefore, cooling towers and other systems may become contaminated through the make-up water. Well-maintained systems are less likely to be colonized with legionellae than systems that are poorly maintained. Continued vigilance in terms of excellent preventive maintenance and an excellent water treatment program are required to minimize the risk of *Legionella*.

HEALTH HAZARD ANALYSIS

The mere presence of legionellae either in heat rejection systems or water services will not by itself cause disease. High numbers of legionellae have been noted in cooling towers and other sources with no associated disease. However, an epidemiologic link has been established between the legionellae in the environment and the occurrence of legionellosis. Best and co-workers (1983) found that the reduction of legionellae in the environment was linked to a reduction in the incidence of clinical Legionnaires' disease.

Most outbreaks from cooling towers and evaporative condensers have been associated with high numbers of legionellae, at least 1,000 colony-forming units per milliliter (CFU/ml) or more in the implicated source (Shelton and co-workers, 1994). At PathCon Laboratories, we have found numbers of *Legionella* averaging 160 CFU/ ml (range <1 to 1,500) in a potable water system associated with an outbreak; and as few as 10 CFU/ ml of fogger reservoir water that may have caused disease in people in immediate direct contact with the mist. Of utmost importance, most cases of legionellosis occur as sporadic cases, not epidemics, and it is not known how many organisms in a water source may represent an infectous risk for sporadic cases to occur.

Many people with responsibility for maintaining air quality in buildings and industrial settings require programs designed to detect potential problems with legionellae. For this reason, we have developed quantitative legionellae criteria and

corresponding remedial actions. These quantitative *Legionella* data are based on numbers of viable legionellae because health risk from nonviable *Legionella* has not been documented. Although there is honest disagreement among informed scientists on the risks associated with legionellae in the environment, the degree of remedial action suggested in Table 1 is expected to err on the side of safety. Many health authorities discourage the notion of completely eliminating *Legionella* bacteria from environmental waters. Other workers have recommended that immunocompromised patients be completely protected from waters containing *Legionella* (Helms, et al., 1983). It is our opinion that these data in Table 1 are not applicable in areas with immunocompromised individuals or for waters used for therapeutic purposes. In these situations, no level of *Legionella* organisms is acceptable.

Table 1: *Suggested Legionella Remedial Action Criteria*

		Remedial Action if Detected in:	
***Legionella* (CFU/ml)**	**CT/EC ***	**Potable Water**	**Humidifier/Fogger**
Detectable But<1	1	2	3
1 to 9	2	3	4
10-99	3	4	5
100-999	4	5	5
≥ 1,000	5	5	5

* Cooling Tower / Evaporative Condenser

REMEDIAL ACTIONS

Action 1. Review routine maintenance program recommended by the manufacturer of the equipment to ensure that the manufacturer's recommended program is being followed. The presence of barely detectable numbers of legionellae represents a low level of concern.

Action 2. Implement Action 1 (see above). Conduct follow-up legionellae analysis after a few weeks for evidence of further amplification. This level of legionellae represent little concern, but the number of organisms detected indicates that the system is a potential amplifier for legionellae.

Action 3. Implement Action 2. Conduct review of premises for direct and indirect bioaerosol contact with occupants and health risk status of people that may come in contact with the bioaerosols. Depending on the results of the review of the premises, action related to cleaning and/or biocide treatment of the equipment may be indicated. This level of legionellae represents a low but increased level of concern.

Action 4. Implement Action 3. Cleaning and/or biocide treatment of the equipment is indicated. This level of legionellae represents a moderately high level of concern. The level is approaching levels that may cause outbreaks. It is uncommon for samples to contain numbers of legionellae which fall into this category.

Action 5. Immediate cleaning and/or biocide treatment of the equipment is definitely indicated. Conduct post-treatment legionellae analysis to ensure effectiveness of the corrective action. The level of legionellae represent a high level of concern. These numbers are at a level that has the potential for causing an outbreak. It is very uncommon for samples to contain numbers of legionellae which fall in this category.

ANALYTICAL LIMITATIONS

The microbiological analysis may be influenced by many factors including the possibility that *Legionella* bacteria may be harbored and amplified inside the cells of aquatic protozoa or in slime or biofilm. Therefore, a negative test result does not necessarily indicate that the environmental source of a sample is free of *Legionella*. The only way to ensure that legionellosis does not occur is to eliminate *Legionella* bacteria from the environment, but research has shown that, because of the ubiquitous nature of the bacteria, it is unlikely that a water source will always remain free of legionellae. A negative result indicates only that if present, the number of *Legionella* in the sample, at the time the sample was taken, was less than the detection limits of the test. The finding of low numbers of *Legionella*, or even negative findings, does not ensure that an environment will not be the source of legionellosis.

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