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Legionella in the Grocery Store: Assessment of Risk

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Abstract

An outbreak of Legionnaires' disease associated with a grocery store mister/fogger machine occurred in Louisiana in 1989. Since mister machines are used in many industrial settings, there is a need for the food industry to become better acquainted with this problem. *Legionella*, the causative bacterium of Legionnaires' disease and Pontiac fever, was first discovered in a 1976 outbreak in Philadelphia, but is known to have caused disease as early as 1943. Once considered exclusively an American disease associated only with air conditioning, outbreaks of Legionnaires' disease have occurred worldwide, and most recent outbreaks have been traced to breathing bioaerosols from potable water sources. There are 30 known species of legionellae bacteria and 48 serogroups. The bacteria are widespread in natural water environments and may be amplified in plumbing and cooling systems in buildings and industrial settings. The presence of legionellae bacteria does not always represent a health risk but systems which amplify the bacterium in water and disseminate the bacteria in the form of bioaerosols should be controlled.

Background

An outbreak of pneumonia occurred following an American Legion convention in Philadelphia, Pennsylvania in July, 1976, which led to the discovery of a previously unidentified bacterium (McDade, et al., 1977). The bacterium was given the name *Legionella pneumophila*, and the disease was called Legionnaires' disease.

Legionellosis

The diseases caused by *Legionella pneumophila*, or legionellosis, is currently recognized to occur in two distinct clinical forms, Legionnaires' disease and Pontiac fever. Of the two, Legionnaires' disease causes the more serious illness consisting of a pneumonic disease. Usually less than 5% of individuals exposed to contaminated aerosols during outbreaks develop disease, and the incubation period - the time from exposure to the pathogen to onset of disease - is usually 3 to 9 days. The most common symptoms of the disease are a dry non-productive cough, high fever (usually 101°F or higher), chest pain, shortness of breath, and mental confusion. Often there is accompanying abdominal pain and mild diarrhea. Hospitalization with appropriate antibiotic therapy is required. The usual therapy is Erythromycin with or without Rifampin (Blackmon, 1981). Fatality rates may be 15% or higher. The second illness, Pontiac fever, is a non-fatal flu-like disease of short duration which does not cause pneumonia. In contrast to Legionnaires' disease, 95% of the individuals exposed become ill within 48 to 72 hours. Fortunately, recovery is rapid and doesn't require antibiotic therapy or hospitalization.

Epidemiology

Although the epidemiology of the disease is not fully understood, cases may occur as outbreak clusters or as sporadic cases. The number of sporadic cases is probably under-reported. Less than a thousand cases of legionellosis were reported in 1985 (Centers for Disease Control, 1985), but it is estimated that 25,000 - 50,000 sporadic cases occur each year in the United States (Centers for Disease Control, 1985a). Serologic surveys have shown that many people have serum antibodies to legionellae, which may be attributed to cases of Pontiac fever or very mild cases of Legionnaires' disease. Most of the earlier outbreaks were traced to contaminated aerosols from either cooling towers or evaporative condensers, but the majority of recent outbreaks have been traced to potable water services and components such as hot water heaters, showers, whirlpool baths (Best, et al., 1983, States, et al., 1987), and most recently an outbreak was associated with mister machines (Centers for Disease Control, 1990). Distribution of epidemics is usually seasonal, most occurring in the summer. The occurrence of sporadic cases is not seasonal and occur throughout the year.

The Bacterium

Legionellosis is caused by a group of small rod shaped bacteria that are usually 1 by 3 micrometers, are Gram negative, and do not produce endospores. To grow *Legionella* organisms in the laboratory requires special media containing L-cysteine, soluble iron, and a pH of 6.9 (Brenner, 1984). These organisms proliferate in a wide variety of fresh waters. Currently there are thirty known species and 48 serogroups of legionellae, i.e., 14 serogroups of *L. pneumophila*, 2 serogroups of *L. bozemanii*, 2 serogroups of *L. feeleii*, 2 serogroups of *L. hackeliae*, 2

serogroups of *L. longbeachae*, 2 serogroups of *L. sainthelensi*, and 1 serogroup of each of the other 24 species. Of the 30 known species, 16 have been associated with human disease (Table 1). It is possible that some species have not yet been associated with human disease because they occur so rarely in nature; therefore, all species should be considered as potential pathogens.

Environmental Sources

The first isolation of the bacteria from environmental samples was during an outbreak investigation at a midwestern university, at which time the bacteria were isolated from a cooling tower, a nearby stream, and mud near the stream (Morris, et al., 1979). Since that time, many lakes and streams, especially those that are thermally polluted, have been found to harbor the organism. Although excavation of soil was thought to be a risk factor, *Legionella* has been found to be a water organism rather than a soil organism.

Many natural or man-made aquatic systems serve as amplifiers for *Legionella* by providing suitable conditions for multiplication. Cooling towers, evaporative condensers, humidifiers, potable water heaters and holding tanks, pipes containing stagnant warm water, shower heads, faucet aerators, mister reservoirs, and whirlpool baths are examples. *Legionella* sometimes survive in the routine water treatment used to produce potable water, and may be carried in the treated drinking water into buildings where they colonize the plumbing fixtures, especially in hot water systems (Wadowski, et al., 1982). The most probable mechanism by which cooling towers and other wet type heat rejection systems become contaminated is from the make-up water.

The best approach to effective control is an effective equipment maintenance program, in that well maintained cooling towers are less likely to be implicated in an outbreak than poorly maintained ones. Conditions that promote the collection of warm stagnant water and growth of microorganisms such as algae and protozoa have been documented to be excellent amplifiers of *Legionella* (Fields, et al., 1989; and Tison, et al., 1980). Protozoa specifically appear to selectively amplify *Legionella* in some water systems (Barbaree, et al., 1986). Association of *Legionella* with protozoa in the environment, and the ability of the legionellae to survive within protozoan cells, may provide mechanisms for legionellae to survive harsh environmental conditions.

Risk of Infection

The infectious dose for humans has not been definitively determined. It is thought by some scientists that the number of *Legionella* must exceed 1,000 per milliliter of cooling tower water for an outbreak to occur. However, in one outbreak associated with mister/foggers, as few as 10 colony forming units of *L. pneumophila* serogroup 1 per milliliter of mister reservoir water may have caused Legionnaires' disease in people exposed directly to the aerosol from the mister. More importantly, most cases of legionellosis occur as sporadic cases, not outbreaks, and it is not known how few organisms in water sources may be responsible for sporadic cases.

The mere presence of legionellae either in aerosol producing systems or potable water services will not in itself cause disease. In order for this to occur, several conditions must exist simultaneously:

1. The legionellae must be sufficiently virulent or capable of causing disease -- many species have not been associated with human disease.
2. The legionellae must be present in sufficiently high numbers to cause an infection.
3. The legionellae must reach the human host via air without extensive damage to the bacterial cell.
4. The legionellae must be inhaled by the potential host as particles less than 5 μm in size and subsequently impact deeply in the alveolar sacs of the lung.
5. The host's defense system must be unable to stop the infection.

Since legionellosis is caused by airborne legionellae, harsh conditions relative to ambient temperature, moisture, and solar radiation may reduce the likelihood of infections. Also, the source of legionellae is usually less than 300 meters in distance from the site of human exposure.

Certain risk factors are associated with a greater likelihood of infection. Also, these same risk factors are probably associated with a person being susceptible to a lower number bacteria than health individuals having no risk factors. Legionnaires' disease is likely to occur more frequently in males, in middle-aged or older individuals, in people who smoke and ex-smokers, those who drink alcohol excessively, those who have chronic illness, cancer patients, AIDS patients, transplant patients, and those receiving immunosuppressive therapy.

Some people have expressed concern that legionellosis could result by drinking contaminated water especially if it should be aspirated into the lungs. Even though over 50 percent of individuals with legionellosis suffer diarrhea and abdominal pain, there is no evidence to suggest that Legionnaires' disease is acquired through the intestinal route. The intestinal symptoms are probably produced by toxic substances released from legionellae in the lungs or other organs. Therefore, the concerns of legionellae in grocery stores should be directed toward breathing contaminated bioaerosols, not from consumption of food and water.

Associated with Human Disease	Not Associated with Human Disease
L. anisa	*L. bruensis*
L. birminghamensis	*L. cherrii*
L. bozemanii	*L. erythra*
L. cincinnatiensis	*L. gratiana*
L. dumoffii	*L. israelensis*
L. feeleii	*L. jamestowniensis*
L. gormanii	*L. moravica*
L. hackeliae	*L. oakridgensis*
L. jordanis	*L. parisiensis*
L. longbeachae	*L. quinlivanii*
L. maceachernii	*L. rubrilucens*
L. micdadei	*L. santicrucis*
L. pneumophila	*L. spiritensis*
L. sainthelensi	*L. steigerwaltii*
L. wadsworthii	
L. tucsonensis	

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