Beyond Traditional Biosafety

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Biosafety professionals have ever-expanding roles at their institutions. In this Beyond Traditional Biosafety column, we focus on topics that may fall outside the scope of the traditional biosafety role, but where the expertise of the biosafety professional may be called upon to provide a valuable contribution to his or her institution. Please e-mail any comments or suggestions to Ted Myatt at tmyatt@partners.org, Co-Editor Barbara Johnson at barbara.johnson@verizon.net, or Co-Editor Karen B. Byers at karenbyers@dfci.harvard.edu.

Legionella

Many biosafety professionals are familiar with the 1970s outbreak at an American Legion conference that led to the discovery of Legionella (thus the names “Legionella” and “Legionnaires’ disease”). Many people wrongly conclude that this was a one-time historic event and that Legionnaires’ disease is no longer a concern. However, the U.S. Centers for Disease Control and Prevention (CDC) estimates that between 8,000 and 18,000 people are hospitalized each year with Legionnaires’ disease in the United States (Marston et al., 1997). Further, the CDC recently reported a 3-fold increase in Legionnaires’ disease cases in the United States in 2011 (CDC, 2011a). This represents a serious public health concern as the mortality rate of those infected is between 5% and 30% (and even higher for healthcare-acquired cases) (CDC, 2011b; CDC, 2011c). The majority of reported cases of Legionnaires’ disease are healthcare-associated; however, Legionnaires’ disease has been identified as a significant cause of community-acquired pneumonia, accounting for 2%-8% of cases in North America and Europe (Fang et al., 1990; Lim et al., 2001; Marston et al., 1997; Ruiz et al., 1999).

Disease transmission is dependent upon a number of factors, including intensity of exposure and the susceptibility of the person. Exposure occurs through the inhalation of aerosolized droplets of water containing the bacteria; no evidence exists that Legionnaires’ disease is transmitted person-to-person. The most susceptible populations include smokers, elderly, people with chronic obstructive pulmonary disease (COPD), immunocompromised individuals, and organ transplant patients. However, the CDC stresses that healthy individuals are also at risk. Exposure to Legionella is associated with two types of illnesses—Pontiac Fever and Legionnaires’ disease. Pontiac fever is a flu-like illness that is usually self-resolving, while Legionnaires’ disease is a severe, life-threatening pneumonia.

Legionella are found in the outdoor environment and are most often associated with building water systems, whirlpools, ornamental fountains, cooling towers, or evaporative condensers. Buildings with complex water systems and older buildings that have been modified over the years are of particular concern for Legionella contamination. Legionella appears to be capable of surviving routine water treatment (e.g., chlorine) and can multiply in conditions often found in building systems, such as water temperatures of 25°C to 42°C (77°F to 108°F), water stagnation, biofilms, scale, and sediment (ASHRAE, 2000). Surveys of U.S. hospitals have detected Legionella in 60% to 100% of water distribution systems (Kool et al., 1999; Vickers et al., 1987). Internationally, surveys have shown high rates of contamination in hospitals, hotels, offices, schools, and apartments (Goutziana et al., 2008; Mouhtouri et al., 2007; Napoli et al., 2010).

To address the risk of Legionella transmission due to contaminated building water systems, institutions frequently apply simplified approaches. One of these approaches involves water sampling in a limited number of locations to determine if a building is “safe” based on the number of locations testing positive for Legionella. However, a recent report showed that this simplistic approach does not adequately predict the true risk of contamination due to multiple factors. These include the inability to account for the location of positive samples, characteristics of the population in the building (e.g., immunocompromised patients), species detected (L. pneumophila, is the species responsible for most outbreaks), concentration of Legionella (number of colony forming units of bacterium per milliliter of water), use of disinfectant (determining the concentration of residual chlorine at point-of-use outlets), and performance of the building systems (e.g., knowing the locations of “dead-legs”) (Allen et al., 2012). Therefore, a multidisciplinary approach involving building engineers, exposure assessment experts, epidemiologists, and infection control and/or biosafety professionals is recommended.

Efforts are underway to standardize approaches to managing risks associated with Legionella in buildings. A new American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard (Standard 188, Prevention of Legionellosis Associated Building Water Systems) addresses the risk of Legionella in a proactive,
risk assessment-based approach (ASHRAE, 2012). This document is currently in draft form, but is expected to be released by the end of 2012. The ASHRAE 188 Standard is designed to reduce the risk of exposure to Legionella associated with building water systems by mandating written risk management plans. As a first step, institutions perform an initial building survey to determine the presence of risk factors related to legionellosis. These factors include that the building (or campus) has:

- Multiple housing units with centralized water heaters
- More than 10 stories
- An inpatient healthcare facility
- Occupants who are primarily older than 65
- Occupants who are receiving chemotherapy or bone marrow transplantation
- Whirlpools or spas present
- Water features that release aerosols
- Cooling towers or evaporative condensers that provide cooling or refrigeration for the heating, ventilating, air conditioning, and refrigeration (HVAC&R) system
- An incoming potable water supply with a residual halogen concentration of less than 0.5 mg/L (0.5 ppm)

According to the Standard, a building with one or more identified risk factors requires that a written risk management plan be created. Expectations are that colleges and universities, medical centers, and large biotechnology companies will have buildings within the institution with one or more risk factors. The plan, which is outlined in the Standard, is based on the principles of the Hazard Analysis and Critical Control Points (HACCP). HACCP is a preventative risk management approach primarily used in the food safety industry. ASHRAE has adopted the principles of HACCP as the methodology for managing risks associated with Legionella. The seven principles of HACCP are:

- Conduct a hazard analysis.
- Determine the critical control points (CCPs).
- Establish critical limits for each CCP.
- Establish a system to monitor control of the CCP.
- Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control.
- Establish procedures for verification to confirm that the HACCP system is working effectively.
- Establish documentation concerning all procedures and records appropriate to these principles and their application.

The team responsible for completing these steps includes at least one person who understands the principles of HACCP and one person who understands the building’s water systems. The team can also consist of institutional employees, suppliers, and consultants. The recommendation is that in addition to the two required team members, someone within the institution familiar with environmental health and safety (EH&S), who has a particular emphasis on microbiological safety, should be considered an integral part of the team.

As part of the HACCP plan, the team must verify that Legionella contamination is controlled, which may include water sampling for the presence of Legionella bacteria. Institutional biosafety professionals may be best suited to play the role of managing the testing which will include sample collection, coordination with the testing laboratory, and/or interfacing with the consultants brought on to collect the samples. This activity could be a challenging new role for biosafety professionals and another way to demonstrate value to the institution.

As a means to help protect the institution against a potential outbreak of legionellosis, it will be important for the institutional biosafety professional to become knowledgeable about this new Standard as it pertains to Legionella and building water systems.

References


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**Biosafety Tips**

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Biosafety Tips brings you practical approaches to biosafety or “news you can use.” If you are looking for a useful and sensible solution to a bioc containment problem or perhaps a reference to help convince a skeptical researcher of the need for caution, this is the place to look. In this column I will share some biosafety insights for managing a variety of workplace situations. I welcome feedback or suggestions for future topics. Please e-mail any comments or suggestions to karen_byers@dfci.harvard.edu or to Co-Editor Barbara Johnson at barbara_johnson@verizon.net.

**Lessons Learned from Laboratory-acquired *Salmonella* Infections**

The Centers for Disease Control and Prevention estimates that, in the United States, approximately 1.2 million *Salmonella* infections occur annually (CDC, 2012). Approximately 400 fatalities per year in the general U.S. population result from *Salmonella* infections; reactive arthritis also occurs in a small fraction of infections (CDC, 2012). Since there is no national reporting system for laboratory-acquired infections (LAI), the incidence of *Salmonella* (LAI) is not known. Reviewing the actual case reports described below and discussing the “lessons learned” from these events may be an effective training tool to illustrate the modes of transmission and the hazards of non-compliance.

**Outbreak in a Poultry Vaccine Plant**

When two staff members from the same poultry vaccine plant had confirmed cases of *Salmonella*, the Maine Department of Public Health (MDPH) conducted an investigation. The 74 staff who worked at the plant were interviewed; 21 staff members reported symptoms of *Salmonella* infection during the previous 1-month period. Seven stool cultures were available for analysis; five were positive for *Salmonella enteritidis*. The *S. enteritidis* isolated from the stool cultures submitted by workers at the vaccine plant had the same phage type as the poultry vaccine. During the same time period, there were eight cases of *Salmonella* infection from different locations in the state with no connection to the plant; the isolates from cases with no connection to the production plant had different phage types. Careful analysis of the work assignments of the staff with symptoms showed a strong association between infection and work in Room A. One month prior to the first case, on a routine walkthrough of the fermentation tank room, a production plant employee discovered a 1 to 1.5 liter spill of *S. enteritidis* culture on the floor (CDC, 2007). Wearing appropriate personal protective equipment (PPE), described as a “biohazard suit, hat, booties, mask, and gloves,” a plant worker cleaned up the spill using a mop with a 5% bleach solution and also a disinfectant. The mop was then transported 30 feet to Room A, where it was auto-