

# Environmental culturing for *Legionella*: Can we build a better mouse trap?

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**Key Word:** *Legionella*.

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The drinking water of hospitals has been directly linked to the occurrence of hospital-acquired legionellosis. In addition, the mode of transmission is now known to be primarily aspiration rather than aerosolization. Legionellosis is now recognized as a patient safety concern for nosocomial infection. In 2009, Centers for Medicaid and Medicare Services raised the issue that hospitals might no longer be reimbursed for charges incurred when caring for patients with health care-associated legionellosis based on the argument that this infection is largely preventable. Unfortunately, opposition from the US Centers for Disease Control and Prevention (CDC) and other organizations prevented the measure from passing, but the issue will be revisited next year.

Given the direct link between drinking water colonization by *Legionella* and hospital-acquired legionellosis, national public health agencies have mandated routine environmental surveillance as a preventive measure. On the other hand, some public health agencies, including the CDC, mandate culturing of the hospital drinking water in acute care hospitals only after 1 to 2 cases have been identified. The obvious flaw in this approach is the fact that legionellosis diagnosis requires some index of suspicion. Knowledge that *Legionella* is within the hospital drinking water raises that index of suspicion. Without this knowledge, hospital-acquired legionellosis has gone undetected to the extent that numerous hospitals have claimed that they have never seen a case of hospital-acquired

legionellosis. This commonplace belief has been refuted in numerous prospective studies<sup>1,2</sup> and most dramatically in Maryland, when hospital-acquired legionellosis abruptly appeared in 2 academic tertiary care health centers in Baltimore within weeks of adopting the Maryland guidelines for proactive surveillance.<sup>3</sup>

The table of International Guidelines for Legionella Prevention summarized in the Ditomasso article shows that the guidelines of Australia, France, United Kingdom, and Italy use quantitation (colony-forming units/liter) as a guide for remediation.<sup>4</sup> However, quantitative cultures have not proven to be predictive of the occurrence of hospital-acquired legionellosis. The reasons for this are intuitively obvious. Swabbing of the distal site can remove the biofilm and artifactually affect the quantitation numbers. The biofilm may also be affected by water usage and stagnation.

In contrast, the extent of *Legionella* colonization has proven to be surprisingly robust in predicting the occurrence of hospital-acquired Legionellosis.<sup>5-7</sup> Extent of colonization is calculated based on the percent distal site positivity (ie, the percent of water faucets that yield *Legionella* as compared with the total number of cultures taken). If more than 30% of the sampled outlets are positive (especially for *Legionella pneumophila*), actions should be taken to mitigate the risk to hospitalized patients.

Publicity in the newspapers and television complicates the process. In addition, lawsuits based on allegations of negligence have become commonplace for hospitals experiencing nosocomial *Legionella* infection. A study by the Association for Professionals in Infection Control and Epidemiology-Three Rivers Chapter (TRAPIC) and the Allegheny County (Pittsburgh) Health Department showed that, once proactive surveillance cultures for hospital drinking water were implemented in Pittsburgh, adverse publicity and the incidence of hospital-acquired legionellosis plummeted because preventive measures had been instituted.<sup>8</sup>

Ditomasso et al<sup>4</sup> present a sophisticated and comprehensive investigation of a topical issue: improvement of an approach and methodology for performing

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*Legionella* cultures for hospital drinking water. Although culturing is an inexpensive and straightforward approach, improvements can always be made. The authors showed that water sampling without swabbing of the distal faucets (referred to as biofilm sampling in the article) and that sampling of the circulation loop water was predictive of distal site positivity. The implication is that fewer sites could be cultured yet still give an accurate overview of the magnitude of *Legionella* risk in the hospital.

However, is this approach really the better “mouse trap” when it comes to detecting *Legionella*? Based on our experience, we address some frequent questions pertinent to efficient surveillance.

### SWAB VERSUS WATER?

Routine surveillance can be performed using either swab or water samples. The results will be affected by the type of sample collected and the method of sample collection. For example, swab samples should be collected first and after removal of the faucet aerator to achieve maximum recovery of *Legionella* from the biofilm within the fixture. If aerators are not removed, biofilm may not be adequately sampled, and the outcome can be a false negative result.<sup>9</sup>

In the context of a case investigation, maximal sensitivity is desirable. Therefore, water and swab samples should be collected from the water outlets in the immediate environment of a suspected case.

Rioux et al tested 200 samples and compared swab versus water samples (with filtration).<sup>10</sup> Specificity and sensitivity were 94% and 74%, respectively, and positive and negative predictive values were 76% and 94%, respectively. Given the high negative predictive value of swab samples, hospitals that are continuously disinfecting their drinking water may find that swab samples are adequate for routine environmental surveillance.

Ditomasso et al<sup>4</sup> allowed water to flow from the outlet for a minimum of 1 minute prior to sample collection. Although this is standard for testing potable water for fecal coliform bacteria, it is not advisable for *Legionella* testing. Like other bacteria, *Legionella* adhere to the biofilm that lines pipes and fixtures. Running the water prior to sample collection allows loosely adherent *Legionella* to be flushed down the drain, possibly leading to a false negative result.

### WHERE TO SAMPLE—DISTAL OUTLETS VERSUS CENTRALIZED HOT WATER OR RECIRCULATING HOT WATER LINE?

Ditomasso et al<sup>4</sup> correctly point out that “positivity of distal sites can stem from intrinsic problems at specific outlets.” However, this might be construed as an argument against monitoring only 1 location

(recirculation line) of the water system. Specific localized problems that can affect *Legionella* colonization of fixtures include moderate temperature, presence of mixing valves in electronic/sensor type fixtures, and lack of use.<sup>11-15</sup> Our experience indicates that increasing the recirculating hot water temperature to 140°F will restrict *Legionella* growth in the recirculating line; however, *Legionella* will be unaffected at the distal outlets, and these outlets will remain extensively colonized. Therefore, relying solely on the testing of the recirculating hot water line for assessing the status of *Legionella* colonization within a complex water distribution system may be misleading. Testing the recirculation line may not reflect the risk of exposure to a patient if *Legionella* has colonized the outlets.

When systemic disinfection methods are employed to control *Legionella* (copper-silver ionization, chlorine dioxide, chlorine), the water in the recirculation loop will be free of *Legionella*. However, *Legionella* can persist at the outlet if the disinfectant does not consistently reach the outlet. For example, the effectiveness of copper-silver ionization is dependent on the ions reaching the distal outlet. If water usage is low in a specific area, contact with the ions at the site may be insufficient. Human error and other factors can lead to disinfection system malfunction with return of *Legionella* within the drinking water. Therefore, regular environmental monitoring of previously positive locations is necessary to validate that the disinfection system is working properly. If the water is only sampled in the circulation loop, distal sites that are positive may go unidentified.

The approach described in the Allegheny County Health Department *Legionella* Guidelines and adopted by the US Veterans Healthcare System<sup>14</sup> requires annual testing of a minimum of 10 outlets—not an overly burdensome requirement. The 10 distal sites (faucets or showers) should be a rough representation of the drinking water system in a 500-bed hospital. Larger hospitals should select more sites. Sites on multiple floors and wings can be selected; high-risk areas such as hematology oncology, transplant units, medical surgical units, and intensive care units are given priority.

### HOW OFTEN SHOULD TESTING BE PERFORMED?

Like the authors, we also observed fluctuations in *Legionella* positivity in our study of 20 hospitals within the United States.<sup>15</sup> Given this fluctuation, there is a chance that high-level colonization (>30% outlets are positive) could be missed with only annual or semiannual testing. However, if given the choice, underestimating the problem is preferable to no opportunity to assess the risk of Legionnaires' disease to patients—which is the current position taken by the US CDC.

## ACTION PLAN

If greater than 30% of distal outlets yield *Legionella pneumophila*, specialized laboratory tests for *Legionella* should be applied to all patients with hospital-acquired pneumonia. Results from proactive culturing empowers the infection control professional by increasing the index of suspicion. Immediate use of diagnostic *Legionella* tests followed by early administration of effective antimicrobial agent therapy can be re-emphasized to the physicians. An immediate decision on disinfection can be deferred until after evaluation of the impact of these other measures. Systemic disinfection measures such as superheat and flush, copper-silver ionization, chlorine dioxide, and use of filters may be evaluated rationally with cost considerations in mind. We emphasize that continuous disinfection measures (copper-silver ionization and chlorine dioxide) may not be necessary in hospitals at low risk. Also, even in tertiary care hospitals with immunosuppressed patients, proactive culturing converts a high-risk hospital to a low-risk hospital. On the other hand, if an outbreak leading to a patient death is exposed by the media, tremendous pressure for the hospitals to demonstrate a commitment to patient safety usually means reflex installation of an expensive disinfection system. In these situations, which often border on panic, the long-term commitment of time and personnel to operate and maintain such disinfection systems is underestimated or overlooked.

Other pathogenic organisms that are found in the drinking water system include *Pseudomonas aeruginosa*, *Stenotrophomonas maltophilia*, and *Aspergillus*.<sup>16</sup> An unintended but salutary effect of suppression of other waterborne pathogens may occur with *Legionella* disinfection. It remains to be seen in controlled studies as to whether or not the incidence of hospital-acquired infections because of these other waterborne pathogens will decrease with systemic disinfection intended for *Legionella*.

In summary, the approach proposed by Ditomasso et al warrants consideration and verification in other hospitals. Focusing only on the recirculation loop may be more appropriate for facilities in which the residents are at low risk for opportunistic infections such as ambulatory medical clinics and nursing homes. Further explorations by other investigators for similar improvements should be encouraged because provision of safe water that is free of microbial pathogens will become a high priority for health care facilities in the very near future.

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