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Preventing Legionellosis

By Janet Stout, Ph.D., Associate Member ASHRAE

Hospital engineers often go to guidance documents for help in preventing Legionnaires' disease. While advisory documents from health authorities and professional societies provide guidelines for approaches to prevention (*Table 1*),[1] a consensus opinion for prevention of this disease does not exist.[2] The lack of consensus stems from several unresolved issues:

- Many of the recommendations are not evidence-based and, if followed, may not result in control and prevention of hospital-acquired Legionnaires' disease;
- The role of environmental monitoring for *Legionella* in determining the risk for hospital-acquired Legionnaires' disease continues to be debated; and
- The guidance is variable as to when and how to perform active disinfection of a water system.

ASHRAE Standards Project Committee 188P is converting ASHRAE Guideline 12-2000, *Minimizing the Risk of Legionellosis Associated with Building Water Systems*, into a standard. The engineering community should be aware that many of the current recommendations in the guideline would be considered "weak" if measured by an objective evidence-based grading system. Several of these recommended practices place an undue burden on building engineers to perform costly, labor-intensive tasks with uncertain benefit.

Evidence-Based Approach To *Legionella* Guidelines

An evidence-based approach has been suggested as a way to resolve many of these issues.[3,4] If applied to a guideline, evidence-based criteria would require that:

- Recommendations be prospectively validated through controlled studies;
- Studies should include a prolonged observational period (greater than one year) to evaluate the efficacy of recommended actions; and
- Recommended approaches/actions achieve the expected result, prevention of the disease through environmental control.

If such an approach is instituted, guidance can be assessed objectively. Strong evidence to support a recommendation can be defined as evidence-based and supported by a peer-reviewed controlled study. Such evidence generates recommendations that provide a clear benefit for the majority of institutions and their patients. A recommendation with only anecdotal, published abstracts or reports that are not peer-reviewed without evi-

About the Author

Janet E. Stout, Ph.D., is a research associate professor in the Department of Civil and Environmental Engineering at the University of Pittsburgh and Director of the Special Pathogens Laboratory in Pittsburgh. She is a voting member of the ASHRAE Standards Project Committee 188P, Prevention Practices for Legionellosis Associated with Building Water Systems.

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State/ Organization	Diagnostic Testing	Clinical Surveillance	Routine Environmental Testing	Approach to Prevention
Allegheny County Health Department 1993/1997	Active: In-House Urinary Antigen (UA) Testing	If Environment Positive—Active Clinical Surveillance	Yes: Annually; Transplant Hospital: More Often	Consider Disinfection if >30% Sites Positive; Empiric Antimicrobial Therapy Macrolide or Quinolone
Maryland Health Department	Acute Care: UA In-House; if Transplant Hospital: Culture on Site	Test Pneumonia Cases for *Legionella*	Yes: Routine Culture	If Cases Identified, Disinfection Recommended
Texas Department of Health	Acute and Long Term: UA In-House; Transplant Hospitals: Culture on Site	Active Case Detection After Case Identified	Routine: No; If High Risk of Cases: Yes	Enhanced Clinical Surveillance and Remediation if Cases Identified
Centers for Disease Control	Routinely Test Without Knowledge of Environment Status	Educate Regarding Diagnosis per 400+ Beds Equals UA/ Culture In-House	No: Unless Cases Identified or Transplant Unit	Disinfect Only if Source Identified

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Table 1: Guidelines for prevention of Legionnaires' disease for U.S. health-care facilities.

dence-based data should be viewed as weak. If followed, these recommendations would provide uncertain benefit for institutions and patients.

Using evidence-based criteria for evaluating recommendations is becoming the norm. An evidence-based grading system for evaluating medical recommendations has recently been adopted by the online medical resource www.uptodate.com. Its recommendations are based on an evidence-based grading system that categorizes the recommendation as strong or weak based on objective criteria. A similar type of grading system is used for recommendations found in guidelines published by the Centers for Disease Control and Prevention.[5]

An evidence-based grading system would also improve the utility of ASHRAE Guideline 12-2000. Such a system would provide the engineer with the independent ability to ascertain the strength or weakness of a recommendation with respect to scientific foundation. Currently, engineers have no way of knowing whether recommendations are evidence-based or not.

Applying an Evidence-Based Grading System

How might such a grading system be applied to ASHRAE Guideline 12? Using the New York Department of Health's (NYDOH) updated guidance for hospitals as an example, the recommendations can be graded with respect to their scientific foundation (*Table 2*).[6] Several recommendations can be assessed as strong or weak based on the previously mentioned criteria. Their guidance on diagnosis is strong: both culture and urinary antigen testing are recommended for patients. Many of the engineering recommendations are weak. In fairness to the NYDOH, the recommendations that were incorporated in the NYDOH guidance had been used previously by other organizations without objective scrutiny.[1]

Many guidelines now include recommendations to restrict showering as a preventive method or in response to identified cases of Legionnaires' disease. Many studies have explored the hypothesis that showering was a mode of transmission for hospital-acquired Legionnaires' disease. Interestingly, most failed to link showering to *Legionella* infection.[7] In fact, a case-control study following the first study that reported a possible link failed to show that showering was a risk factor.[7] An observational study reported that a patient did not bathe or shower, but did ingest tap water during a period of highly impaired cell-mediated immunity.[8]

One case-control study found the risk of hospital-acquired Legionnaires' disease was associated with procedures that increased the risk of aspiration. Aspiration of secretions from the upper airway is a mode of transmission for Legionnaires' disease—particularly in hospitalized patients.[9]

At the University Hospital of Wales, investigators found that for several cases of hospital-acquired Legionnaires' disease, "There were no epidemiological data to suggest aerosol inhalation as the route of infection."[10]

Restricting showering for all patients does not meet the basic criteria that the action is evidence-based, practical and cost-effective. This recommendation would fall into the weak category. Given the increased susceptibility to infection of transplant/severely immune-compromised patients, it would be prudent to recommend sterile/bottled water. Point-of-use filters have been used to provide sterile water to these patient populations.

One recommendation often found in guidance documents, including the NYDOH guidelines, is to "Remove showerheads and aerators monthly for cleaning with chlorine bleach."[11] A large, acute-care hospital could have thousands of showerheads and faucet aerators. Does data suggest that this will have any long-lasting effect on *Legionella* colonization? A study[12] examined how showerheads were opened weekly and taps monthly for mechanical cleaning with a brush and disinfected in 1,000 ppm (1000 mg/L) chlorine. The study's conclusion was that mechanical cleaning and disinfection *did not* reduce the concentration of *Legionella* in tap and shower waters. Descaling, disinfection and/or replacement of faucets and showerheads also was found to be ineffective in minimizing *Legionella* colonization in hospitals in France and Taiwan.[13,14]

It has been suggested that routine maintenance programs for plumbing systems are important in minimizing/preventing *Legionella* colonization. This has been refuted by two independent studies.[15]

Health-Care Facility Function	Strong Recommendation (Cost-Effective, Practical, Evidence-Based)	Weak Recommendation (Costly, Impractical, Not Evidence-Based)
Infection Control	1. Quarterly Culturing of the Potable Water System of Transplant Units for *Legionella* Species (Spp.)* 2. Sterile Water for Rinsing Nasogastric Tubes and for Enteral Nutrition for Transplant Patients*	1. Any *Legionella* Spp. Detected, Decontaminate the Water Supply, Remove Aerators, Restrict Showering†
Engineering Environmental Care & Maintenance	1. Complete Eradication of *Legionella* Is Not Feasible and Regrowth May Occur After System Disinfection† 2. Disinfect Dormant Water Lines in Patient-Care Areas Prior to Being Returned to Service‡ 3. Store Hot Water at 140°F (60°C)†	1. Routine Thermal Disinfection (At Least Semiannually) of the Hot Water System. Flush Each Outlet ≥5 Min. at 160°F (71°C) or ≥2 ppm Free Chlorine† 2. Remove, Clean, Disinfect Showerheads and Faucet Aerators Monthly in Transplant Units† 3. Eliminate Dead End or Capped Pipes‡

Recommendations grading system used in an online medical resource at www.uptodate.com. *Consistent/reproducible evidence from controlled prospective studies. †Consistent/reproducible evidence from case studies. ‡Anecdotal reports that are not peer-reviewed.

Table 2: The New York State Department of Health guidelines for the protection of patients from hospital-acquired Legionnaires' disease: an evidence-based assessment.

Many guidelines recommend that the hot water temperature at the tank be 140°F (60°C) and the circulating hot water temperature be 124°F (51°C).[16] Will this eliminate *Legionella* from distal outlets (faucets and showers)? The aforementioned study[12] showed that peripheral sites remained heavily colonized despite elevated recirculation temperatures (>140°F [>60°C]). *Legionella* colonization was ultimately reduced in a Swedish hospital after it raised the temperatures even higher, to 149°F (65°C) at the tank and 133°F – 142°F (56°C – 61°C) at the outlets.[17] Unfortunately, these temperatures are not allowed in hospitals by many state regulations.

Environmental Monitoring and Risk Prediction

The role of environmental monitoring in *Legionella* prevention has been the source of debate for many years.[3] However, several studies exist that provide evidence for the use of monitoring in the prevention of hospital-acquired Legionnaires' disease. Two studies from Spain show that *Legionella* colonization was extensive

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in Barcelona hospitals, and that environmental monitoring followed by intensive clinical surveillance identified previously unrecognized cases of hospital-acquired Legionnaires' disease.[18]

The Allegheny County Health Department in Pennsylvania recommends periodic environmental monitoring of acute care facilities as part of their recommended prevention plan (*Table 1*). The effect of this approach recently was evaluated and the results showed a significant decrease in the number of health care-associated cases of Legionnaires' disease after the preventive guideline was in place.[19]

Based on these and other results, the CDC recommendations now state that monitoring for *Legionella* in transplant units can be performed as part of a prevention strategy. The NYDOH went further and mandates quarterly monitoring for *Legionella* in transplant units. Routine periodic environmental monitoring for *Legionella* in hospital water systems is now recommended in France, Italy, Spain, Germany, and the Netherlands.

There continues to be confusion regarding the interpretation of *Legionella* monitoring results. It has been shown that there is an increased risk of hospital transmission if a high proportion of water sites are positive for *Legionella* species (particularly *L. pneumophila*), and that the proportion is more predictive of risk than the concentration (CFU/mL). This has been validated by several studies.[10,20,21] Conversely, a relationship with a predetermined concentration of *Legionella* from a given site to the risk of illness has not been scientifically validated. Furthermore, complete elimination of *Legionella* from a hospital water supply has not been necessary to reduce or eliminate hospital-acquired Legionnaires' disease.[17,22]

Disinfection of Hospital Water Systems

Remediation in response to the identification of cases also is included in many guidelines. However, adequate validation of some of these disinfection methods has not been performed. We recommend that each disinfection method undergo a four-step evaluation of efficacy.[22] This includes:

- Demonstrated efficacy in vitro;
- Anecdotal experience in individual hospitals;
- Controlled studies of sufficient duration (years) in single hospitals; and
- Confirmatory reports from multiple hospitals (validation step).

A number of disinfection methods exist that have been used for control of *Legionella* in hospital water systems. These include thermal eradication (heat and flush), hyperchlorination, copper-silver ionization, point-of-use filters, and chlorine dioxide.[23,24] Each of these methods has completed some of the evaluation criteria. All four steps of the evaluation criteria have been fulfilled for copper-silver ionization.[23]

The original recommendations for performing a thermal eradication (heat and flush) recommended multiple 30-minute flushes of distal outlets with 158°F (70°C) water.[25] The CDC recommended that the duration of the heat and flush be greater than five minutes.[5] Unfortunately, this modification of the thermal disinfection method was not validated prior to making the recommendation. Consequently, failures have been reported. A recent evaluation of the short (five-minute) duration thermal eradication was performed in Taiwan. Investigators found that the abbreviated duration of five minutes was ineffective in reducing *Legionella* positivity.[13] The greater than five-minute flush is recommended in both the NYDOH guideline and current ASHRAE guideline.

Also included in the NYDOH guideline, as well as other guidance documents, is the removal of dead leg sections of pipe. Note that this recommendation is untested and unconfirmed. One study in the literature noted that removal of dead legs had no effect on reducing *Legionella* positivity in hospital water systems.[24]

Benefits of an Evidence-Based Standard

The benefits to ASHRAE from creating an evidence-based *Legionella* standard include:

- A scientific document based on evidence that will have sustained value;
- ASHRAE will avoid the loss of credibility that will come when nonevidence-based recommendations fail; and

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• ASHRAE will be the first organization to use a scientific evidence-based grading system to support its recommendations for minimizing *Legionella* in building's water systems.

Soon, ASHRAE members will have the opportunity to comment on the new *Legionella* standard. I would encourage you to evaluate the document critically, and with an evidence-based perspective. Your input will determine whether the document will do more good than harm.

References

1. Fields, B. 2006. "Control of *Legionellae* in the environment: a guide to the U.S. guidelines." *ASHRAE Transactions* 112(1):691–699.
2. Stout, J. 2003. "Hospital-acquired Legionnaires' disease: new developments." *Curr. Opin. Infect. Dis.* 16(4):337–341.
3. Yu, V. 1998. "Resolving the controversy on environmental cultures for *Legionella*." *Infect. Cont. Hosp. Epid.* 19:893–897.
4. Stout, J. 2001. "*Legionella* in the hospital water supply: a plea for decision making based on evidence-based medicine." *Infect. Cont. Hosp. Epid.* 22:670–672.
5. Centers for Disease Control and Prevention. 2004. "Guidelines for preventing health-care-associated pneumonia." *Morb. Mort. Wkly. Rep.* 53(RR-3):1–36.
6. State of New York Department of Health. 2005. "New York State Department of Health. Prevention and control of Legionnaires' disease." www.health.state.ny.us/nysdoh/infection/guidelin.htm.
7. Sabria, M. 2002. "Hospital-acquired legionellosis: solutions for a preventable disease." Lancet Infect. Dis. 2:368–373.
8. Stout, J.E. 2006. "Controlling *Legionella* in hospital water systems: facts versus folklore." In: Cianciotti, N.P.; Kwaik, Y.A.; Edelstein, P.H.; Fields, B.S.; Geary, D.F.; Harrison, T.G.; Joseph, C.A.; Ratcliff, R.M.; Stout, J.E.; Swanson, M.S. (eds.), *Legionella: State of the Art 30 Years After its Recognition.* Washington D.C.:ASM Press. pp. 469–472.
9. Blatt, S.P. 1993. "Nosocomial Legionnaires' disease: aspiration as a primary mode of transmission." *Am. J. Med.* 95:16–22.
10. Hosein, K. 2005. "Point-of-care controls for nosocomial Legionellosis combined with chlorine dioxide potable water decontamination: a two year survey at a Welsh teaching hospital." *J. Hosp. Infection* 61:100–106.
11. Centers for Disease Control and the Healthcare Infection Control Practices Advisory Committee. 2003. "Guidelines for environmental infection control in health-care facilities." *Morb. Mort. Wkly. Rep.* 52:RR-10.
12. Kusnetsov, J. 2003. "Colonization of hospital water systems by *Legionellae*, mycobacteria and other heterotrophic bacteria potentially hazardous to risk group patients." *APMIS* 111:546–556.
13. Chen, Y. 2005. "Abbreviated duration of superheat-and-flush and disinfection of taps for *Legionella* disinfection: lessons learned from failure." *Am. J. Infect. Cont.* 33(10):606–610.
14. van der Mee-Marquet, N. 2006. "*Legionella anisa*, a possible indicator of water contamination by *Legionella pneumophila*." *J. Clin. Microbiol.* 44:56–59.
15. Flannery, B. 2006. "Reducing *Legionella* colonization of water systems with monochloramine." *Emer. Infect. Dis.* 12(4):588–596.
16. ASHRAE Guideline 12-2000, *Minimizing the Risk of Legionellosis Associated with Building Water Systems.*
17. Darelid, J. 2002. "Control of nosocomial Legionnaires' disease by keeping the circulating hot water temperature above 55°C: experience from a 10-year surveillance programme in a district general hospital." *J. Hosp. Infect.* 50:213–219.
18. Sabria, M. 2004. "Environmental cultures and hospital-acquired Legionnaires' disease. A 5-year prospective study in 20 hospitals in Catalonia, Spain." *Infect. Cont. Hosp. Epid.* 25:1072–1076.
19. Squier, C. 2005. "A proactive approach to prevention of healthcare-acquired Legionnaires' disease: the Allegheny County (Pittsburgh) experience." *Amer. J. Infect. Cont.* 33(6):360–367.
20. Kool, J. 1999. "Hospital characteristics associated with colonization of water systems by *Legionella* and risk of nosocomial Legionnaires' disease: a cohort study of 15 hospitals." *Infect. Cont. Hosp. Epid.* 20:798–805.
21. Boccia, S. 2006. "Prospective three-year surveillance for nosocomial and environmental *Legionella*: implications for infection control." *Infec. Cont. Hosp. Epid.* 27(5):459–465.
22. Stout, J. 2003. "Experiences of the first 16 hospitals using copper-silver ionization for *Legionella* control: implications for the evaluation of other disinfection modalities." *Infect. Cont. Hosp. Epid.* 24:563–568.
23. Sheffer, P. 2005. "Efficacy of new point-of-use water filters for preventing exposure to *Legionella* and waterborne bacteria." *Amer. J. Infect. Cont.* 33(6):S20–S25.
24. Sidari, F.P., J.E. Stout, J.M. VanBriesen, et al. 2004. "Keeping *Legionella* out of water systems." *J. Amer. Water Works Assoc.* 96:111–119.
25. Best, M. 1984. "Heat eradication measures for control of hospital-acquired Legionnaires' disease: implementation, education, and cost analysis." *Am. J. Infect. Control* 12:26–30.

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