

Nosocomial legionnaires' disease discovered in community hospitals following cultures of the water system: Seek and ye shall find

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Background: The reservoir for hospital-acquired legionnaires' disease is the water distribution system. The Allegheny County (Pa.) Health Department recommended environmental cultures for all health care facilities for the prevention of hospital-acquired *Legionella* infection including facilities with no known cases of legionnaires' disease.

Methods: Environmental cultures of hot water tanks, faucets, and showerheads were performed in six health care facilities according to health department guidelines. If hot water tanks, faucets, or showerheads yielded *Legionella*, monitoring with *Legionella* culture and urinary antigen was performed for all cases of nosocomial pneumonia.

Results: *Legionella* was isolated from the water distribution system in 83% (five of six) of facilities. Three facilities dropped out of the study; two decided to disinfect the water and one had no *Legionella* in the water system. The other three facilities all discovered cases of legionnaires' disease during the 1-year study period after introduction of *Legionella* testing. *L. pneumophila*, serogroups 1, 3, and 5, caused 12 cases of hospital-acquired legionnaires' disease. Positive diagnostic tests included: 10 of 12 (83%) urinary antigen, 6 of 8 (75%) respiratory cultures, and 2 of 5 (40%) serology. Molecular typing confirmed that the source of infection was the water supply in two hospitals.

Conclusion: Routine environmental cultures for *Legionella* in the water distribution system are recommended even if the hospital had not previously recognized cases of hospital-acquired legionnaires' disease. The Allegheny County Health Department guidelines were inexpensive to implement and resulted in the discovery of cases that would have otherwise been undiagnosed. (AJIC Am J Infect Control 1998;26:8-11)

In 1980 *Legionella pneumophila* was isolated from a water fixture in the room of a patient who had legionnaires' disease.¹ Subsequently, *L. pneumophila* colonization of hospital water systems has been linked to hospital-acquired legionnaires' disease in many investigations.²

We have advocated the utility of routine environmental cultures to increase the index of suspicion for legionnaires' disease in patients with nosocomial pneumonia.^{3,4} If the water supply is colonized by

Legionella, legionnaires' disease should be included in the differential diagnosis for hospital-acquired pneumonia. It has been well established that specialized laboratory tests for *Legionella* (culture on selective media, urinary antigen, serology) are required for diagnosis because the clinical syndrome is nonspecific. However, most community hospitals do not have these specialized *Legionella* laboratory tests available in-house.

In 1993 the Allegheny County Health Department in conjunction with local experts in medicine, public health, plumbing and drinking water regulatory agencies, and representatives from the Three Rivers/Pittsburgh Chapter of the Association for Professionals in Infection Control and Epidemiology (APIC) developed guidelines for the prevention and control of *Legionella* infection in health

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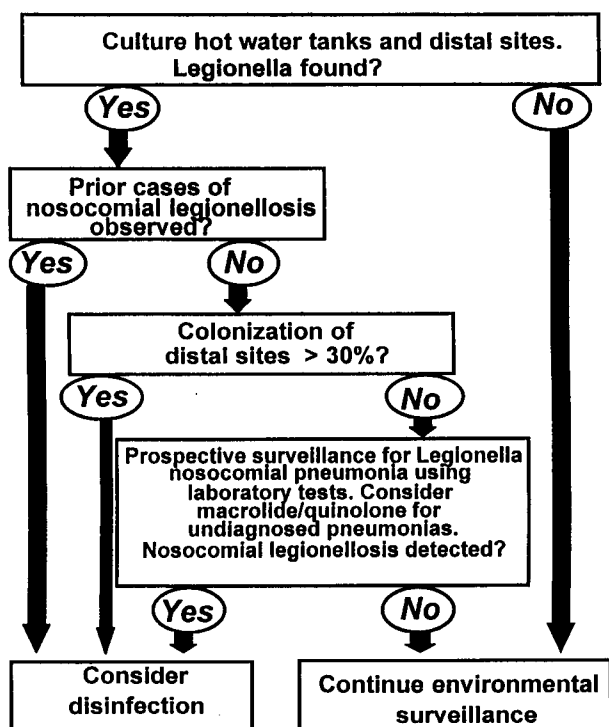


Fig. 1. Approach to surveillance and disinfection based on results of environmental cultures.⁶

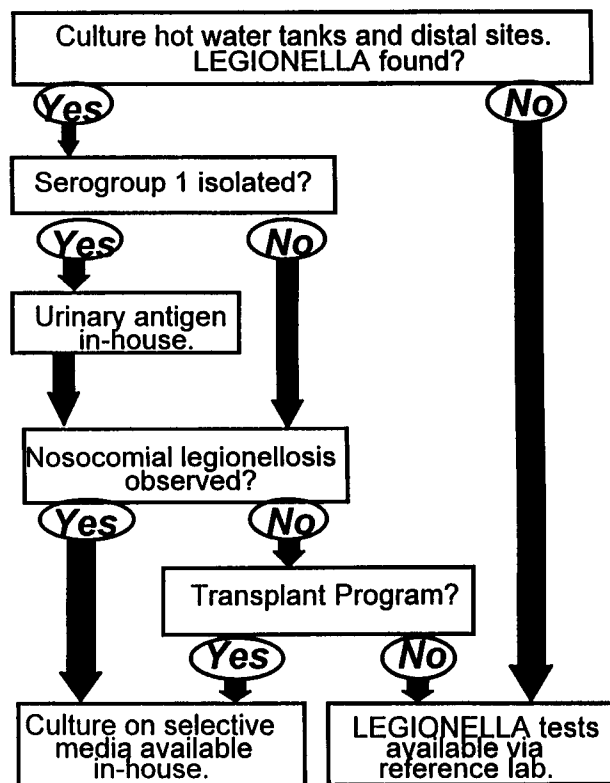


Fig. 2. Recommendations for laboratory capability based on results of environmental cultures.⁶

care facilities.⁵ The Allegheny County Guidelines recommend implementing specialized diagnostic testing for *Legionella* if the hospital water supply is colonized with *Legionella* (Figures 1 and 2). Several health care facilities voluntarily joined a prospective study to address the utility of these guidelines. These guidelines included a protocol for environmental surveillance, approaches to disinfection of the water system, and recommendations for *Legionella* laboratory capability for hospitals.

METHODS

The 1997 Allegheny County Health Department Guidelines, which are a modification of the original 1993 guidelines, are summarized in Figures 1 and 2.⁶ The guidelines recommend environmental surveillance for *Legionella* in all health care facilities in the county. Culture protocols, options for disinfection, and maintenance measures for water distribution systems are included.

Participants

Between June 1994 and May 1995, four community hospitals and two extended care facilities in Allegheny County, Pennsylvania, voluntarily joined a prospective study of environmental and nosocomial pneumonia surveillance for *Legionella*.

Surveillance for hospital-acquired pneumonia

All hot water tanks were cultured for *Legionella*. The number of distal sites (hot water, faucets, and showerheads) cultured was based on total bed capacity, for example, 10 distal sites were recommended for facilities with a total capacity of less than 500 beds.^{5,6} The protocol for environmental sampling has been published previously.⁷ Once environmental culturing identified the presence of *Legionella* in the potable water system in a specific hospital, all patients with hospital-acquired pneumonia in that hospital were monitored by the infection control professional so that the appropriate laboratory tests were performed; these include sputum for *Legionella* culture and direct fluorescent antibody stain, urine for urinary antigen, and acute and convalescent sera for antibody detection by enzyme-linked immunosorbent assay. Monoclonal antibody subtyping⁸ and pulse-field gel electrophoresis of whole-cell DNA⁹ were performed for *Legionella* isolated from patients and environments.

Molecular subtyping using monoclonal antibody subtyping and pulse-field gel electrophoresis showed that the subtype of *L. pneumophila* isolat-

Table 1. Environmental culture results of six health care facilities

Facility	Hot water tanks	Percent positive	Distal sites	Percent positive	Serogroup
CH1	5	80%(4/5)	10	0	‡Lp 5
CH2	2	100%(2/2)	20	25%(4/20)	‡Lp 1
CH3	0	0	10	10%(1/10)	‡Lp 1,3
CH4	2	50%(1/2)	8	25%(2/8)	‡Lp 1
EC1	1	0	10	0	
EC2	3	100%(3/3)	16	19%(3/16)	‡Lp 1,3

CH, Community hospital; EC, Extended care facility; Lp, *Legionella pneumophila*

ed from the water was identical to that isolated from the patients in two of the hospitals. A sputum specimen could not be obtained from the patient in the remaining community hospital so no patient isolate was available.

Risk factors

The patients in the study group ranged in age from 41 to 91 years with a mean age of 68 years; seventy-five percent were men. The length of hospital stay before the development of hospital-acquired *Legionella* pneumonia ranged from 6 to 28 days with a mean of 11 days. Other positive risk factors included consumption of hospital water 83% (10 of 12), receiving respiratory therapy 83% (10 of 12), chronic underlying pulmonary disease 75% (9 of 12), receiving corticosteroids 75% (9 of 12), diabetes mellitus 33% (4 of 12), cigarette smoking 17% (2 of 12), and cancer 25% (3 of 12).

DISCUSSION

Hospital-acquired legionnaires' disease has been discovered in several Pittsburgh hospitals since 1982.^{4,10-17} In comparison, most community hospitals and extended care facilities in western Pennsylvania have neither diagnosed cases of legionnaires' disease nor performed environmental cultures of their potable water systems. However, it should be noted that none of these facilities had specialized *Legionella* testing available in-house.

Because of the numerous cases of legionnaires' disease discovered in Pittsburgh, the Allegheny County Health Department frequently fielded questions concerning *Legionella* from the community hospitals, especially when local hospital outbreaks were reported by the news media. Thus, a task force of experts was convened by the Allegheny County Health Department to formulate guidelines for *Legionella* surveillance (Figures 1 and 2), which were sent to all chief executive officers of Allegheny County health care facilities and members of the

Table 2. Criteria for diagnosis of legionnaires' disease

Facility	No. of patients with legionnaires' disease	No. of beds	Sputum culture	Urine antigen	Serology
CH 1	3	337	100%(3/3)	33%(1/3)	50%(1/2)
CH 2	8	267	75%(3/4)	100%(8/8)	50%(1/2)
CH 3	1	334	0%(0/1)	100%(1/1)	0%(0/1)

CH, Community hospital

local APIC Chapter.⁵ Medical facilities were invited to join a prospective study to assess the utility of these guidelines.

Six medical facilities joined the study. However, after the results of environmental cultures, three facilities dropped out of the study; one did not find *Legionella* in its water supply, and the other two disinfected their water systems despite not having any known cases of legionnaires' disease in their facility. In the remaining three facilities, prospective surveillance of patients with hospital-acquired pneumonia uncovered cases of legionnaires' disease within 1 year after specialized laboratory tests were made available to all patients with hospital-acquired pneumonia. In the two hospitals in which isolates from sputum cultures of patients were available, the isolates from the hospital water supply were found to be identical to the patient isolates by molecular subtyping. The cost of the environmental cultures in 1 year, as performed by the Pittsburgh VA Special Pathogens Laboratory (a national reference laboratory), was approximately \$1300 per hospital with a range of \$350 to \$2500.

There were weaknesses in this survey. First, the sample size was small. Second, the denominator for total number of hospital-acquired pneumonias was not available to calculate the incidence of *Legionella* at each facility. Third, patient surveillance was not performed in the extended care facility where *Legionella* was absent from the potable water supply. However, it has been previously shown that hospitals without *Legionella* in their water supply do not have hospital-acquired legionnaires' disease.^{18,19}

It should be emphasized that none of the hospitals suspected that hospital-acquired legionellosis might be a problem at their facility. The positive *Legionella* culture results from environmental cultures raised the index of suspicion of physicians and ICPs for legionnaires' disease. Once specialized laboratory tests for *Legionella* were introduced into the hospitals cases were discovered.

There is controversy about the advisability of routine environmental cultures for *Legionella*. The Centers for Disease Control and Prevention remains opposed to this approach,²⁰ and the merits of this recommendation have been debated elsewhere.²¹ However, this study provides further support for this approach in all hospitals, especially those hospitals that have never had patients with known cases of hospital-acquired legionnaires' disease.

SUMMARY

This study reflected the importance of a team approach for the prevention of *Legionella*. The educational booklet released by the health department to all medical facility administrators and ICPs guided each facility through the process of identifying and controlling *Legionella*. Because of the health department's directive, administrators were willing to release funds for environmental culturing and patient tests. Once environmental results for *Legionella* were shared with physicians by the ICP or the microbiology department, physicians ordered specialized tests for *Legionella* for patients with hospital-acquired pneumonia.

This proactive approach proved to have several advantages when compared with a passive, defense-oriented approach in which an outbreak of cases would stimulate a search for the environmental reservoir. First, in outbreak situations retrospective review has consistently determined that undiscovered cases of *Legionella* had likely occurred before the discovery of the outbreak. Thus patient lives were saved as a result of an approach directed at prevention. Second, the media clamor and unfavorable publicity that often accompanies an outbreak was prevented. Finally, the expensive litigation by patients and next-of-kin after an outbreak was preempted by the routine use of an inexpensive culture protocol.

References

1. Tobin JO. Legionnaires' disease in a transplant unit: isolation of the causative agent from shower baths. *Lancet* 1980;2:118-21.
2. Goetz A, Yu VL. Legionella Infection. In: Mayhall CG, editor. Hospital epidemiology and infection control. Philadelphia: Williams and Wilkins; 1996. p. 385-99.
3. Goetz A, Yu VL. Screening for nosocomial legionellosis by culture of the water supply and targeting of high-risk patients for specialized laboratory testing. *Am J Infect Control* 1991;19:63-6.
4. Yu VL, Beam TR, Lumish RM, Vickers RM, Fleming J, McDermott C, et al. Routine culturing for Legionella in the hospital environment may be a good idea: a three-hospital prospective study. *Am J Med Sci* 1987;294:97-9.
5. Allegheny County Health Department. Approaches to prevention and control of Legionella infection in Allegheny County health care facilities. 1st ed. Pittsburgh: Allegheny County Health Department; 1993. p. 1-15.
6. Allegheny County Health Department. Approaches to prevention and control of Legionella infection in Allegheny County health care facilities. 2nd ed. Pittsburgh: Allegheny County Health Department; 1997. p. 1-15.
7. Vickers RM, Stout JE, Yu VL, Rihs JD. Manual of culture methodology for Legionella. *Semin Respir Infect* 1987;2:274-9.
8. Stout JE, Joly J, Para M, Plouffe J, Ciesielski C, Blaser MJ, et al. Comparison of molecular methods for subtyping patients and epidemiologically-linked environmental isolates of *L. pneumophila*. *J Infect Dis* 1988;157:486-94.
9. Chang FY, Jacobs SL, Colodny SM, Stout JE, Yu VL. Nosocomial legionnaires' disease caused by Legionella pneumophila serogroup 5: laboratory and epidemiological infection. *J Infect Dis* 1996;174:1116-9.
10. Stout JE, Yu VL, Vickers RM, Zuravlev J, Best M, Brown A, et al. Ubiquitousness of Legionella pneumophila in the water supply of a hospital with endemic legionnaires' disease. *N Engl J Med* 1982;36:466-8.
11. Vickers RM, Yu VL, Hanna SS, Muraca P, Diven W, Carmen N, et al. Determinants of *L. pneumophila* contamination of water distribution systems: 15-hospital prospective study. *Infect Control* 1987;8:357-63.
12. Rudin J, Wing E. Prospective study of pneumonia: unexpected incidence of legionellosis. *South Med J* 1986;79:417-9.
13. Muder RR, Yu VL, McClure J, Kominos S. Nosocomial legionnaires' disease uncovered in a prospective pneumonia study: implications for underdiagnosis. *JAMA* 1983;249:3184-8.
14. Green M, Wald ER, Dashefsky B, Barbadora K, Wadowsky RM. Field inversion gel electrophoretic analysis of Legionella pneumophila strains associated with nosocomial legionellosis in children. *J Clin Microbiol* 1996;34:175-6.
15. Matulonis U, Rosenfeld CS, Shaddock RK. Prevention of Legionella infections in a bone marrow transplant unit: multifaceted approach to decontamination of a water system. *Infect Control Hosp Epidemiol* 1993;14:571-5.
16. Johnson JT, Yu VL, Best M, Vickers RM, Goetz A, Wagner R, et al. Nosocomial legionellosis uncovered in surgical patients with head and neck cancer: implications for epidemiologic reservoir and mode of transmission. *Lancet* 1985;2:298-300.
17. Nouri K, Posey K, Ruben F, Wingenroth J, Pasculle AW, Wing E. Installation of metal ionization system for the reduction of Legionella pneumophila at a university hospital: black water and other complications 5[abstract]. *Infect Control Hosp Epidemiol* 1996;17:16.
18. Yu VL, Kroboth FJ, Shonnard J, Brown A, McDearman S, Magnussen MH. Legionnaires' disease: new clinical perspective from a prospective pneumonia study. *Am J Med* 1982;73:357-61.
19. Joly J, Alary M. Occurrence of nosocomial legionnaires' disease in hospitals with contaminated potable water supply. In: Barbaree JD, Breiman RF, Dufour AP, editors. Current status and emerging perspectives. *Am Soc Microbiol* 1994:39.
20. Tablan OC, Anderson LJ, Arden NH, Breiman RF, Butler JD, McNeil MD, et al. Guidelines for prevention of nosocomial pneumonia. *Am J Infect Control* 1994;22:274-92.
21. Yu VL, Breiman RF. Point-counterpoint: surveillance cultures for Legionella. 6th Annual Meeting of the Society for Healthcare Epidemiology of America, 1996 April 21-23, Washington, DC (available from Audio Archives, LaCrescenta, CA, 91214, #I60421090; Symposium IV, Compromised hosts).