

## Editorial

# Resolving the Controversy on Environmental Cultures for *Legionella*: A Modest Proposal

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The two rigorous reports in this issue by investigators at the Centers for Disease Control and Prevention (CDC) make for exciting reading.<sup>1,2</sup> These two reports demonstrate the importance of shoe-leather epidemiology, highlight the power of the new molecular biology with its subtyping capabilities, and deal with the drama of a disease that has, in the two hospitals described, a mortality of 35% to 40%. When one reads Kool et al's description of the intense attempts to track down the source of the organism and the heroic effort to disinfect the water supply, it is no wonder that legionnaires' disease continues to command such attention 22 years after the outbreak at the 1976 American Legion Convention.

Are there any new lessons to be gleaned from these two reports? After all, the major conclusions in these two reports have been reiterated in numerous publications and are standard knowledge in medicine textbooks: they include the link to water distribution systems, the link to intubation and the possibility of aspiration; the recognition that the clinical presentation of legionnaires' disease is nonspecific, such that special laboratory tests are needed; and the high risk for contracting legionnaires' disease in transplant recipients and in patients administered corticosteroids. However, there are a number of salient points that illustrate the need for prevention, and I will focus on them.

What is remarkable to me is the number of outbreaks of hospital-acquired legionnaires' disease that still are occurring. How can this be after so many reports, dating back to 1982, have linked the contamination of water distribution systems by *Legionella* to subsequent discovery

of legionnaires' disease on the hospital ward? More reports with the same theme will be published in 1999. The epidemiological version of Koch's postulates<sup>3</sup> have been fulfilled for linking *Legionella* colonization in hospital water supplies to hospital-acquired legionnaires' disease.<sup>4,5</sup> (Koch's postulates have not been fulfilled for linking cooling tower reservoirs to legionnaires' disease). Since the reservoir for dissemination has been so well established, as in the two CDC reports in this issue, why have measures not been enacted to prevent this disease?

Pittsburgh investigators have recommended routine environmental cultures of the hospital water supply since 1986, so as to screen for the possibility of occult legionnaires' disease in the hospital (Figures 1 and 2).<sup>6</sup> Obtaining surveillance cultures of water distribution systems in hospitals performing transplants is mandatory, in our opinion.<sup>7,8</sup> This is a proactive, scientifically based approach that is inexpensive and focuses attention on those patients and hospitals at the highest risk.

The two CDC articles both conclude that intensive surveillance for hospital-acquired legionellosis is necessary for prevention. Conspicuous by its absence is the alternative approach suggested by Pittsburgh investigators and mandated by the Allegheny County Health Department guidelines for prevention of *Legionella* infections<sup>9</sup> (Figures 1 and 2). I am concerned that to perform patient surveillance without environmental cultures is to ignore the epidemiological data that have been collected by so many investigators, including the CDC. Knowledge of the reservoir for the organism can be applied to prevention! It

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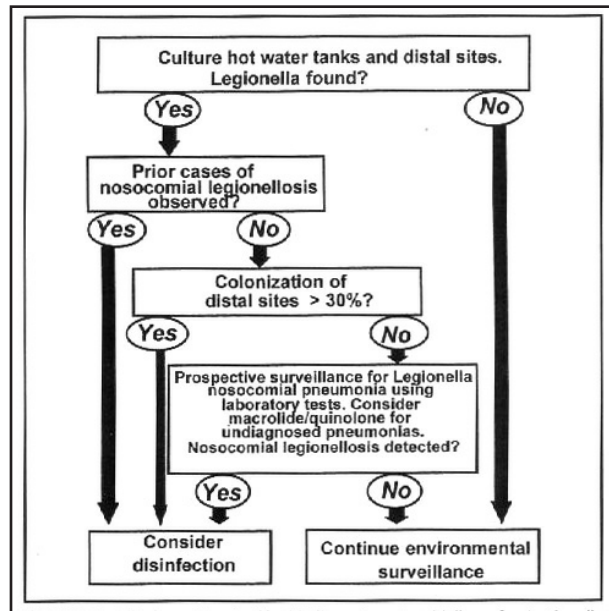


FIGURE 1. Allegheny County Health Department guidelines for *Legionella* environmental cultures and surveillance.<sup>9</sup>

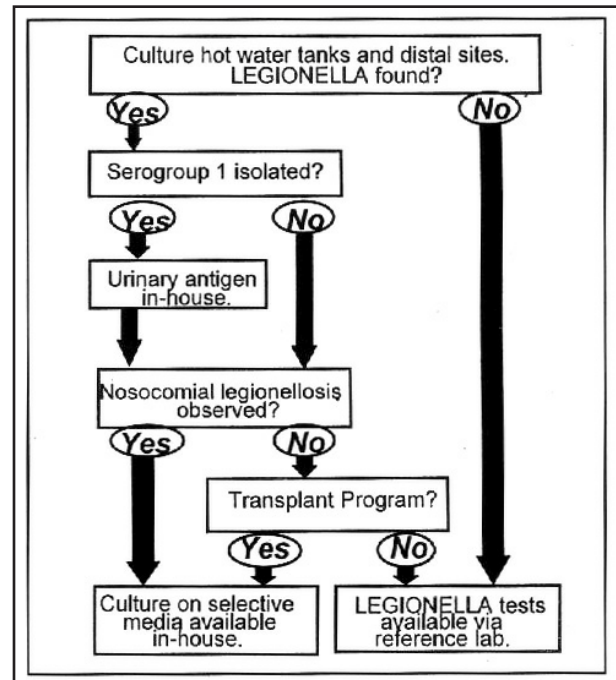


FIGURE 2. Allegheny County Health Department guidelines concerning capabilities for *Legionella* laboratory testing for patients.<sup>9</sup>

makes little sense to me to initiate environmental cultures *after* cases of hospital-acquired legionnaires' disease have been discovered, as recommended by the CDC. Lepine et al make the telling points that hospital-acquired legionellosis rarely is an isolated event and that the discovery of a single case suggests that previous cases have been overlooked.<sup>2</sup> Kool et al, note that the discovery of legionnaires' disease in their hospital was triggered by routine examination of autopsy lung specimens for *Legionella* in eight patients who died; this is hardly an elegant approach for preventing legionnaires' disease.<sup>1</sup>

If the water system is free of *Legionella*, positive tests for *Legionella* from inpatient specimens will approach zero (if a positive culture occurs, it is likely that the patient was a transfer from another hospital or a patient with community-acquired pneumonia that was overlooked). In hospitals in North Carolina and Minnesota in which *Legionella* could not be isolated from the water supply, no cases of hospital-acquired legionnaires' disease were uncovered despite intensive surveillance (VLY, unpublished data, 1993). In four controlled studies comparing legionnaires' disease attack rates in colonized versus noncolonized hospitals, hospital-acquired legionnaires' disease did not occur if *Legionella* was absent from the water supply.<sup>5,10-12</sup> As a stark example, if one took CDC recommendations literally, that all hospitals initiate intensive surveillance without knowledge of the colonization status of *Legionella* within the water supply, 500 to 1,500 sputum cultures a year for *Legionella* could be obtained from hospitalized patients, depending on bed size, and all of these cultures would be negative. Thus, we advocate applying *Legionella* tests for hospital-acquired pneumonia only in patients residing in hospitals colonized with *Legionella*, so as to derive a reasonable yield. This is a common-sense approach for a fis-

cally conscious era in which laboratory resources must be conserved carefully.

One reason given by the CDC for not recommending routine environmental cultures is the oft-cited claim that *Legionella* colonization is ubiquitous; the implication is that virtually all hospital water supplies are colonized by *Legionella*. However, this inference is refuted in six environmental surveys from Canada, the United States, and the United Kingdom (Table 1), as well as the studies the CDC has cited in Table 2. The proportion of hospitals colonized with *Legionella* ranged from 12% to 70% (Table 1)<sup>8,13-16</sup>; thus, the organism is not ubiquitous in hospital water supplies. Differing environmental factors, especially temperature of the hot water, affect colonization of *Legionella* in hospital water distribution systems.<sup>8,14,15,17</sup>

CDC spokesmen repeatedly have stated that *Legionella* can colonize water distribution systems without causing disease, implying that colonization in water is not associated with disease in inpatients.<sup>18,19</sup> This implication, if true, is a powerful argument against obtaining routine cultures of hospital water supplies. Thus, it becomes critical to review the data that support this assertion. The articles most frequently cited by the CDC to support this contention are listed in Table 2. In two studies, case finding for legionnaires' disease was not pursued, and the duration of follow-up was extremely limited.<sup>20,21</sup> These studies, by Tobin et al and Dennis et al, were not designed to assess the risk of legionnaires' disease in hospitalized patients. Instead, they were surveys of hotels or hospitals (interestingly, only 20% to 30% of buildings sampled yielded *Legionella pneumophila*). No case finding was performed,

**TABLE 1**  
HOSPITAL SURVEYS FOR *LEGIONELLA* CONTAMINATION OF WATER DISTRIBUTION SYSTEMS

Reference	Location	Hospitals	% With <i>Legionella</i>	Isolate
HMSO <sup>13</sup>	United Kingdom	40	70%	<i>Legionella pneumophila</i> , serogroup 1
Alary <sup>14</sup>	Quebec	84	68%	<i>L pneumophila</i> , serogroups 1-8
Vickers <sup>15</sup>	Western Pennsylvania	15	60%	<i>L pneumophila</i> , serogroups 1-6
Patterson <sup>8</sup>	United Kingdom	69	55%	<i>L pneumophila</i> , <i>Legionella</i> species
Marrie <sup>16</sup>	Nova Scotia	39	23%	<i>L pneumophila</i> , <i>Legionella longbeachae</i>
Liu <sup>31</sup>	United Kingdom	17	12%	<i>L pneumophila</i> , serogroups 1,4,6

and diagnostic tests for *Legionella* were not employed in any patients! The Alary and Joly study was also a survey, in which *Legionella* was found in 68% of the hospitals studied (Table 2).<sup>14</sup> Of note, in a follow-up of 20 hospitals in a subsequent case-control study (10 hospitals with *Legionella* colonization and 10 without *Legionella* colonization), the same authors found that “hospitals with a water supply contaminated by *Legionella* were more likely to have cases of legionellosis ( $P=.054$ ; Table 3).”<sup>11</sup>

In the CDC “Guidelines for Prevention of Nosocomial Pneumonia,”<sup>19</sup> the study by Marrie et al<sup>22</sup> is explicitly cited: “no cases of legionellosis occurred in a urology ward during a 3.5-month period when 70% of water samples were culture-positive for *L pneumophila*.” However, that 52 cases of legionnaires’ disease were found in that same hospital on the other wards was not mentioned in the CDC guidelines.<sup>19,22</sup> In a 1982 survey of the University of Pittsburgh teaching hospitals (Montefiore, Presbyterian University Hospital, Eye and Ear Hospital, Children’s Hospital), high colonization rates were reported without the presence of disease, and the authors concluded that “existence of these bacteria in the plumbing systems and tanks was not necessarily associated with disease.”<sup>23</sup> However, all of the hospitals experienced outbreaks within several years thereafter, with the total number of cases exceeding 100.<sup>5,24-26</sup> Persistent clinical surveillance, with *Legionella* laboratory testing in patients with hospital-acquired pneumonia and follow-up for several years, was necessary to uncover these cases.

This issue has been argued by Pittsburgh investigators and the CDC for years, culminating in a debate at the 1996 annual meeting of the Society for Healthcare Epidemiology of America.<sup>27</sup> In science, legitimate differences of opinion should be resolved by further studies with improved focus and greater rigor. With apologies to Jonathan Swift, I suggest a modest proposal. A large-scale, prospective, observational study of the number of cases of hospital-acquired legionnaires’ disease occurring in hospitals colonized with *Legionella* versus hospitals not colo-

**TABLE 2**  
LITERATURE CITED AS EVIDENCE THAT COLONIZATION BY *LEGIONELLA* IS NOT ASSOCIATED WITH HOSPITAL-ACQUIRED LEGIONNAIRES’ DISEASE

Reference	Case Finding*	No. Institutions	Weakness
Tobin <sup>20</sup>	No	31 hotels and hospitals	<i>Legionella</i> testing for patients not available
Dennis <sup>21</sup>	No	52 hotels	<i>Legionella</i> testing for patients not available
Wadowsky <sup>23</sup>	No	4 hospitals	Cases ultimately discovered at all hospitals after publication
Alary <sup>14</sup>	No	84 hospitals	Subsequent study by the same investigators linked colonization to hospital-acquired legionnaires’ disease <sup>11</sup>
Marrie <sup>22</sup>	Yes	1 hospital	52 cases of hospital-acquired legionnaires’ disease during study period

\* Surveillance for patients with hospital-acquired pneumonia using laboratory methodology for *Legionella*.

nized with *Legionella* is in order. Some might argue that doing nothing in hospitals colonized with *Legionella* is unethical and unconscionable, but this is, in fact, the current state of the art. Virtually all authorities on legionnaires’ disease have accepted the CDC viewpoint (to our chagrin). Thus, observing the natural outcome of hospitals colonized with *Legionella* in a controlled study would not affect the public health.

However, adherence to the Allegheny County Health Guidelines (Figures 1 and 2) can minimize morbidity and mortality. Once suspicion is raised, one can take advantage of the fact that legionnaires’ disease is readily treatable; macrolides and quinolones can be used to treat hospital-

TABLE 3

PROSPECTIVE STUDIES IN WHICH HOSPITAL-ACQUIRED LEGIONNAIRES' DISEASE WAS DISCOVERED AFTER INITIATING CLINICAL SURVEILLANCE BASED ON POSITIVE ENVIRONMENTAL CULTURES

Reference	Location	Hospitals	Colonization* (% of Sites Positive)	No. of Cases	Study Duration
Muder <sup>32</sup>	Pittsburgh	Mercy Hospital	Yes (64%)	6 <sup>†</sup>	3 mo
		VA hospital	Yes (65%)	15 <sup>†</sup>	
Rudin <sup>24</sup>	Pittsburgh	Montefiore Hospital	Yes (NA)	6 <sup>†</sup>	5 mo
Johnson <sup>5</sup>	Pittsburgh	Eye and Ear	Yes (67%)	8	6 mo
		Eye and Ear post-disinfection	Yes (3.5%)	0	6 mo
		VA hospital	No (0)	0	12 mo
Yu <sup>10</sup>	Pittsburgh	2 hospitals	Yes (2%-22%) <sup>‡</sup>	0	12 mo
	Buffalo	VA hospital	Yes (18%)	3	
Joly <sup>11</sup>	Quebec	10 case hospitals	Yes (NA)	4 in 4 hospitals	9 mo
		10 control hospitals	No (0)	0	
Goetz <sup>28</sup>	Pittsburgh	4 hospitals	Yes (10%-30%)	12 in 3 hospitals	12 mo
Modol <sup>12</sup>	Catalonia	16 hospitals	Yes (12.5%-100%)	20 in 3 hospitals	Ongoing
		4 hospitals	No (0)	0	

Abbreviations: NA, not available; VA, Veterans' Affairs.

\* Water system colonized by *Legionella pneumophila*.

<sup>†</sup> Includes cases of *Legionella micdadei*.

<sup>‡</sup> Twenty-two percent of distal sites positive for *Legionella pneumophila*, serogroup 5.

acquired pneumonias of uncertain etiology. A low frequency of site contamination does not necessarily require disinfection (Figure 1). Many Pittsburgh hospitals with minimal contamination have elected not to disinfect the water supply but to treat infected patients if encountered.<sup>28</sup> If the level of contamination increases, the option to disinfect the water supply can be exercised.

This issue of *Infection Control and Hospital Epidemiology* also provides an important report by Stout et al, of a cost-effective approach to disinfection.<sup>29</sup> In the past, knowledge of *Legionella* colonization meant the tedious application of superheat and flush, as vividly described in the Kool et al report, or hyperchlorination with its attendant disadvantages of corrosion, expense, and erratic efficacy. (In the Kool et al report, the lack of success with the superheat-and-flush method can be attributed to flushing with hot water at 160°F for only 10 minutes instead of the recommended 30-minute duration<sup>30</sup>). Copper-silver ionization systems now have been installed in more than 75 US hospitals at the time of this writing; all three hospitals described in this issue of *Infection Control and Hospital Epidemiology*, including the hospital in the Kool et al report, have adopted such systems (Liqui-Tech, Willowbrook, IL). So, technology not only has improved our diagnostic capability and our ability to make epidemiological links but it also has furnished us with a viable solution.

What should hospital epidemiologists and infection control professionals do today while awaiting the ideal controlled study? I recommend that each hospital initiate their own observational study. As Goetz et al found in their study, "Seek and ye shall find."<sup>28</sup> The approach shown in Figures 1 and 2 is implemented easily. If colonization by *Legionella* is demonstrated, surveillance with sputum cultures (and

urinary antigen, if the *L pneumophila* in the water is serogroup 1) could be initiated for every case of hospital-acquired pneumonia. If no cases of legionnaires' disease were uncovered in a 2- to 3-year period, then this outcome must be published and would support the CDC's position.

On the other hand, if cases of legionnaires' disease are discovered within 2 to 3 years, patient lives will have been saved, and the negative publicity in the lay media and the expensive litigation that accompanies an outbreak of hospital-acquired legionnaires' disease will have been avoided. Equally importantly, these data would add to the accumulating evidence that colonization of hospital water supplies presages clinical infections among inpatients. Such a study would contribute to resolving a debate that, given the high case-fatality rate of hospital-acquired legionnaires' disease, must be considered one of the most important unsettled issues in infection control today.

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