

State of Maryland

Department of Health and Mental Hygiene



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Report of the Maryland Scientific Working Group to Study Legionella in Water Systems in Healthcare Institutions

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INTRODUCTION

During 1999, several cases of Legionnaire's disease were identified in healthcare settings in Maryland. The occurrence of these cases raised questions about the need for further public health guidelines to reduce the risk of legionella infections associated with water systems. In October, 1999, Georges Benjamin, MD, Secretary, Maryland Department of Health and Mental Hygiene (DHMH), formed a Scientific Working Group to review scientific and technical data and gather information from experts on the current status of prevention and management of water system-related legionella bacteria. Membership was drawn from faculty and staff at the University of Maryland School of Medicine, the Johns Hopkins University School of Medicine and School of Public Health, community healthcare organizations, and state and county departments of health (Appendix A). The Scientific Working Group was headed by Dr. J. Glenn Morris, Jr., Professor and Chairman, Department of Epidemiology and Preventive Medicine, University of Maryland School of Medicine.

Current strategies and data were presented in a series of three public scientific meetings, held on November 16, November 23, and December 7, 1999. Topics covered included 1) Epidemiology, 2) Diagnostic Considerations, 3) Water Systems, and 4) Approaches to Guidelines. As outlined in Appendix B, eleven expert speakers made presentations; the list of speakers included representatives from government agencies (the Centers for Disease Control and Prevention [CDC], the Environmental Protection Agency [EPA], and the Maryland DHMH and Department of the Environment), academia, and professional organizations. Additional data were obtained through a systematic search of the medical literature, using PubMed, the search service of the National Library of Medicine (www.ncbi.nlm.nih.gov). At the request of the Scientific Working Group, the Epidemiology and Disease Control Program, Maryland DHMH, surveyed all 92 hospitals and 270 nursing homes in Maryland regarding legionella-related surveillance and diagnosis. The survey was conducted by using an anonymous, two page questionnaire, which was faxed back to DHMH by respondents. Recommendations of the Scientific Working Group were developed and finalized in meetings held on December 21, 1999, January 11, and April 26, 2000. This report summarizes the key findings obtained during this process, and presents the recommendations of the Scientific Working Group, based on their review of available data.

DATA SUMMARY

Background

Legionella bacteria were first recognized in association with an outbreak of pneumonia that occurred among attendees of an American Legion convention in Philadelphia in 1976 [1]. In the intervening years, we have come to recognize more than 39 species of legionella bacteria and greater than 61 serogroups [2]. While more than half of these species/serogroups have been associated with human disease [3,4], L.

pneumophila, the first legionella bacterial species identified, accounts for approximately 90% of infections, with illness most frequently associated with serogroups 1, 4, and 6 [5].

Legionella can cause Pontiac Fever, an often undiagnosed and generally mild and self-limiting upper respiratory infection [6]. They also cause Legionnaire's disease, a potentially severe bacterial pneumonia that is accompanied by cough, fever, and fatigue [7]. Based on studies in several parts of the country, Legionnaire's Disease may account for 5-15% of all pneumonias among persons living in the community [8]. Without appropriate antibiotic therapy, infection can cause serious complications and even death. Patients with Legionnaire's Disease have signs and symptoms that resemble other bacterial pneumonias, and the diagnosis generally can not be made by a physician in the absence of specialized laboratory testing [9]. Many of the antibiotics which are used to treat typical community-acquired bacterial pneumonias have only limited, if any, efficacy against legionella species [10,11]; the more effective newer antibiotics include macrolides such as azithromycin and quinolones such as levofloxacin.

Certain populations are clearly at greater risk than others for developing severe legionella infections [12-15]. The most important host risk factors for developing illness include: immunosuppressive therapy (anti-rejection therapy to prevent graft rejection in bone marrow and solid organ transplant patients, chemotherapy for neoplastic disease, current steroid therapy [>20 mg/day]), or chronic underlying illnesses such as hematologic malignancies or end-stage renal disease. There is a moderately increased risk of illness among the elderly (age > 65 years), those who smoke tobacco products, or who have chronic lung disease, diabetes, or congestive heart failure. The disease is extremely rare among children.

Number and distribution of Legionnaire's disease cases

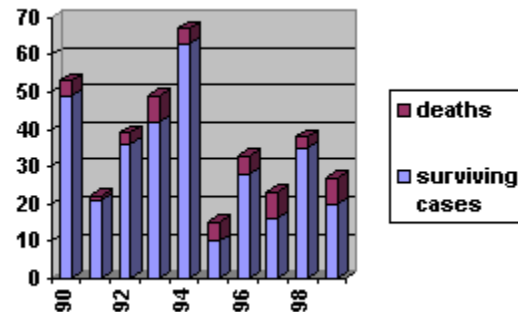
The CDC estimates that between 10,000 and 20,000 cases of Legionnaire's disease occur each year in the United States. Of these, 1500 to 1800 are reported to public health authorities. There has been a general increasing trend in the number of cases reported per year, which is probably due to improvements in physicians' ability to diagnose the disease associated with introduction of new diagnostic assays. Twenty three percent of Legionnaire's disease cases reported to CDC are hospital-acquired (nosocomial) infections. These nosocomial cases have a higher mortality rate than community-acquired cases (40% vs. 20%)[14]. It is not unusual to find unrecognized nosocomial outbreaks of Legionnaire's disease occurring over multiple years in one institution [16,17]. In a national survey of 192 hospitals, 29% reported having at least a single case of nosocomial Legionnaire's disease and 16% reported greater than five cases. Of these surveyed hospitals, 60% had on site testing capabilities, but only 21% had established routine legionella testing [18].

In Maryland, health care providers are required, under the Code of Maryland Regulations (COMAR), to report cases of legionellosis disease to local health departments. Between 1990 and 1999, there were 366 "confirmed" legionella cases reported to the Maryland DHMH (Figure 1). Patients in 46 (13%) of the 366 cases died. Prior to 1997, "probable" cases were also recorded; from 1990-1996, there were 37 probable legionella infections. Cases were reported from 22 of the 23 Maryland counties, with no obvious geographic clustering. Sufficient data were available to say that in at least 33 of the cases the infection may have been acquired in a hospital; 10 (30%) of these possible nosocomial case patients died. Definitions for confirmed, probable, and nosocomial cases (based on CDC definitions [14,19,20]) are summarized in Appendix C. As in the national data bases, it is likely that there is substantial underreporting of legionella cases in Maryland. In this context, it should be noted that clinical laboratories are not required to report positive assay results for legionella to the health department (as is required for certain other diseases of public health significance, such as salmonellosis and meningococcal meningitis). Test results are reported to the patient's health care provider, who then reports the case to the local health department.

The Maryland DHMH undertook 18 investigations of potential legionella cases/outbreaks between 1988-1999. Cases included as part of investigations occurred in hospitals, assisted living facilities, manufacturing plants, and long-term care facilities. Fourteen were single cases investigations, while 4

were definite outbreaks (more than 1 case linked to the site). The largest Maryland outbreak occurred in 1988 in a rehabilitation hospital, involving 16 confirmed and 5 probable cases.

Figure 1: Number of confirmed Legionnaires' disease cases and deaths, Maryland, 1990-1999



Clinical Diagnosis

Laboratory tests used in the diagnosis of legionella infection are summarized in Table 1. Among these, the recent availability of urinary antigen testing has had the most profound impact on diagnosis of the disease, providing a simple, rapid means of identifying infected patients. There are currently two FDA-approved rapid antigen detection assays designed to detect legionella-specific antigens in urine specimens [17,21,22]. The first is an enzyme-linked immunoassay (EIA) that requires special laboratory instrumentation and takes approximately three hours to perform. The second, which has just recently been introduced, is a rapid antigen card test (a paper chromatography based assay) that requires less than 30 minutes to perform and no instrumentation. Both tests have comparable sensitivity and specificity, but are only capable of detecting *L. pneumophila* serogroup 1.

To be able to identify other legionella species and serogroups, and to actually obtain the legionella bacterium responsible for the infection for comparison with legionella bacteria which may be isolated from associated environmental sources [23,24], it is necessary to culture the organism. This requires use of a specialized panel of differential and selective media, which are generally not included in the routine procedures for culturing of respiratory samples in clinical microbiology laboratories. Respiratory specimens are plated onto these media (Buffered Charcoal Yeast Extract agar [BCYE], BCYE/PVA [contains polymixin B, anisomycin, and vancomycin], and BCYE/PAC [contains polymixin B, anisomycin, and cefamandole]) and incubated at 35-37°C (95-98.6°F) for up to 14 days [2]. Suspicious colonies are subjected to direct fluorescent antibody testing, using genus-specific antibodies, to confirm the isolation of legionella. The ideal specimens for culture are bronchial washings, bronchial lavages, or bronchial brushes. If a sputum is the only specimen that can be obtained, results are improved if the sample is pretreated with 0.2 M KCl/HCl solution (pH=2.2) for 4 minutes to decrease numbers of endogenous bacteria that can grow on the BCYE agar [25]. In experienced hands, culture results can usually be obtained in 3 to 5 days.

Other diagnostic modalities have less utility. Even with a high level of expertise on the part of the technician doing the screening, DFA testing of respiratory samples has relatively low sensitivity, depending as it does on actual visual identification of fluorescing legionella bacteria in a sample. There are also limitations with antibody testing (serology). For optimal results, serology requires a comparison of legionella antibody levels in two blood samples, one drawn at the time of the acute illness (before antibodies have developed) and a second drawn anywhere from 2 to 8 weeks later (when antibodies should be detectable, at levels at least four

Table 1: Laboratory methods for clinical diagnosis of legionella infection

Technique	Description	Sensitivity	Specificity	Processing time	Disadvantages

Culture	Growing of bacterium from clinical sample, such as sputum, on specialized culture media	80%	100%	3-5 days	Requires that laboratory technicians have specialized training and expertise
Urinary antigen test	Screening of urine sample for the presence of specific legionella antigen (cell markers)	80%	95%	within hours	Will only diagnose infections with L. pneumophila serogroup 1
Direct fluorescent antibody (DFA) stain of sputum or other sample from lung	Visual screening of sputum or other sample from lung for legionella bacteria; screening is done under a UV microscope, using fluorescently-tagged antibodies to "light up" bacteria	33-70%	95-100%	within hours	Easy to miss bacterium on microscope slide; results difficult to interpret; requires that laboratory technicians have specialized training and expertise
Antibody testing (serology)	Screening of blood sample for antibodies to legionella; generally requires comparison of results from two samples, one collected during acute illness and the other 2-8 weeks later	40-60%	95-100%	2-8 weeks	Sensitivity is low; for optimal results, requires collection of second blood sample

times higher than those seen in the original sample). Even if results are positive, they do not provide assistance in managing an acute case. From a practical standpoint, it is also difficult to arrange for collection of a second blood sample from a patient weeks after he or she has recovered from an illness (and been discharged from an acute care facility).

The availability (and use) of appropriate diagnostic tests for legionella infection in Maryland tends to be low. In the survey of hospitals conducted by the Epidemiology and Disease Control Program as part of the Scientific Working Group activities, only 11 (23%) of the 47 hospitals which responded had "in-house" legionella testing available. Only 9 (19%) routinely screened patients with nosocomial pneumonia for legionella.

The Laboratories Administration, Maryland DHMH, has the ability to perform legionella cultures, urinary antigen testing, and serology. However, the number of samples submitted to the state laboratory has declined steadily during the past decade. Between 1988 and 1999, the DHMH laboratory performed 1777 clinical legionella cultures. Of these, less than 50 were performed in 1999. Only 17 (1%) of the 1777 cultures were positive for a legionella species. It is unclear whether this low rate reflects the actual low rate of positives; difficulties with technique in the laboratory; or loss of viable organisms as a result of specimen handling, transportation conditions, and/or the amount of elapsed time between collection and plating of the specimen in the DHMH laboratory.

Ecology/Environmental Sampling

Legionella is widely distributed in aquatic environments. The bacteria survive and grow particularly well in man-made environments, especially if water is in a temperature range of 25-42°C (77-108°F), sediment and scaling are present, and water flow is relatively stagnant. Growth may also be facilitated by the presence of certain other microorganisms capable of supporting intracellular growth of the organism. Legionella die rapidly at 55°C (131°F) (3 log reduction within 1 hour), and are killed almost immediately at temperatures over 60°C (140°F). In hospitals and other institutions, legionella are found primarily in two

locations: 1) potable hot water systems (defined as all building plumbing systems that distribute water for direct human contact)[26], and 2) water in cooling towers. In hot water systems, concentrations of the bacterium are highest in biofilms within the system and at openings of water outlets. While data are limited, aerosolization and ingestion/aspiration of potable water from hot water systems are thought to represent the major routes by which the organism is transmitted to patients in nosocomial legionella cases [27-31]. Exposure to aerosols from cooling towers containing the organism has been more frequently associated with community outbreaks [32-34], although this route has also been implicated in nosocomial cases.

Many, but not all, hospital hot water systems are colonized with legionella (Table 2). It is hypothesized that the organism is introduced into institutional water distribution systems from public/municipal water systems. Municipal water systems, both nationally and in Maryland, do not routinely screen water for the presence of legionella. As legionella is chlorine tolerant, it will survive many of the standard municipal water treatment protocols. Once present in a hospital hot water system, legionella is able to survive and multiply, particularly as hot water temperatures are kept relatively low to minimize the scald risk for patients [35]. In Maryland, state regulations for nursing homes limit temperatures at the outlet to < 110°F [43°C](COMAR 10.07.02); while COMAR does not deal specifically with water temperature in hospitals, many hospitals appear to adhere to the 110°F limit. Factors which determine whether a specific hospital water system will be colonized with legionella are not well understood, but probably include the age and condition of the pipes, the degree of scaling and sediment, and the potential for biofilm formation within the system. Methods for obtaining cultures from water systems are not well standardized, and it is clear that results can vary widely depending on the methodology used. The survey conducted by the Epidemiology and Disease Control Program, Maryland DHMH, found that 16 (34%) of 47 of the respondent Maryland hospitals performed routine legionella testing on potable hot water systems and 29 (62%) of 47 performed routine legionella testing on cooling towers. Ten (63%) of the 16 hospitals doing routine water system testing had initiated testing since the summer of 1999, after a well-publicized hospital outbreak.

location	# hospitals	% with legionella	reference
United Kingdom	40	70%	HMSO [36]
Quebec	84	68%	Alary [37]
Western PA	15	60%	Vickers [38]
United Kingdom	69	55%	Patterson [39]
Nova Scotia	39	23%	Marrie [40]
United Kingdom	17	12%	Liu [41]
San Antonio	15	73%	Kool [42]

Table 2: Hospital surveys for legionella contamination of water systems (adapted from Yu, 1998 [43])

Elimination or reduction of legionella colonization in a hot water "ecosystem" is possible, although difficult. Success depends on the design and condition of the system, as well as the remediation methodology used. If a system is old, cleaning and descaling may be an important component of a legionella control program. As legionella is killed by temperatures over 55°C (131°F), superheating of water (raising of water temperature above the normal set point for the system) within a system may be efficacious [44]. CDC recommendations call for flushing of the hot water system for a minimum of 5 minutes with the hot water superheated to at least 65°C (149°F). It should be noted that investigators at Pittsburgh do not feel that this time is adequate, as it fails to allow sufficient time to penetrate water system biofilms; they recommend that water outlets be flushed for at least 30 minutes. While superheating may result in a reduction in system colonization, legionella is usually not eradicated, and often recolonizes the system

within a matter of weeks, necessitating recurrent superheating cycles. As an alternative to superheating, CDC recommends "shock" hyperchlorination (>10 mg/liter of chlorine in water, flush all outlets for at least 5 minutes)[45,46]. Again, this method may only suppress legionella, permitting subsequent recolonization. Continuous hyperchlorination has been attempted by several institutions, but has generally been discontinued because of its corrosive effect on plumbing [47]. For example, three years after implementation of hyperchlorination at the University of Iowa hospital, the incidence of pipe leaks was 30 times the rate before chlorination.

Success with long-term disinfection has been obtained with continuous copper-silver ionization techniques, although this requires an initial capital investment on the part of a hospital to buy and install the necessary equipment [48-53]. There are recent reports of such a system losing efficacy over time [54], although the factors responsible for this remain to be determined. UV light systems may be useful for localized disinfection, keeping in mind that there are no distal, residual effects [55,56]. At the University of Virginia, a UV light disinfection system was placed on the municipal water intake at the time its new hospital building was built in 1989. Despite having had substantial problems with legionella in its old hospital building, the potable hot water in this new building has remained consistently culture-negative for legionella (with no nosocomial legionella cases)[57], suggesting that it is possible to prevent initial colonization of newly constructed hot water systems. There are also now intriguing data that suggest that use of monochloramine as a disinfectant in municipal and hospital systems (rather than the more traditional free chlorine) is effective in eradicating legionella [58,59]. In the recent CDC study in Texas [42], all 11 hospitals on municipal water systems using free chlorine for disinfection had legionella in their water systems; in contrast, all 4 hospitals on municipal water systems using monochloramine for disinfection had water systems that were culture-negative for legionella (and had no cases of nosocomial legionella infection). A Maryland hospital recently reported installation of a monochloramine system in an administration building of a hospital that had had ongoing problems with legionella in patient care areas; placement of the system resulted in a significant decrease in the Legionella counts in the building's potable hot water system [60]. Further details regarding methods for minimizing the risk of legionella in building water systems (including cooling towers and other water sources) can be obtained from the recent guidelines published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)[61].

While it is well recognized that legionella can colonize a hospital hot water system, the linkage between specific levels of colonization and risk of nosocomial legionella infection remains controversial. In a longitudinal study at the Pittsburgh Veterans Affairs hospital reported in 1983, cases of nosocomial legionella infection were most likely to occur when more than 30% of 10 selected distal sites in the hospital water system were culture-positive for legionella [62]. Based on these findings, the Allegheny County, Pennsylvania, health department established guidelines ([63]; also included as Appendix D) under which hospitals are advised to routinely culture their water systems for legionella, and initiate control efforts for legionella in the water system when >30% of distal sites are culture-positive for the organism. Since these guidelines were put in place in 1992, the percent of total reported legionella infections in Allegheny County, PA, that are hospital-acquired has dropped from 50% (23 of 46 cases) to 13% (4 of 30 cases)[64]. This 30% "action level," while demonstrating utility in controlling nosocomial legionella infections in the Pittsburgh area, has not been substantiated in studies in other geographic areas. However, it is also unclear that other locales have the same heightened awareness of nosocomial cases, or the same diagnostic capability for legionella, making comparisons difficult. In the recent CDC study in San Antonio [42], there was a suggestion that risk of nosocomial illness correlated with the overall proportion at each institution of water system sites from which legionella was recovered; however, the association (in this relatively small sample) was not statistically significant, nor was the 30% level validated.

There do not appear to be sufficient data to substantiate use of quantitative legionella counts (i.e., actual counting of legionella bacterial colonies on a plate, rather than simply reporting a culture as positive or negative) to predict risk of illness. It is also clear that quantitative values can vary dramatically depending on sampling and culture techniques.

Guidelines for prevention of nosocomial legionella infection

In 1994, the CDC proposed guidelines to prevent and control nosocomial pneumonia (including Legionnaires' disease); these guidelines were most recently updated in 1997 [14]. The guidelines advocate active surveillance and good casefinding strategies in hospitals, including establishment of appropriate diagnostic capabilities for legionella. CDC guidelines/recommendations do not advocate routine culturing of water systems for legionella, noting the overall high rate of colonization of hospital water systems with the bacterium, and citing the lack of data to substantiate any one "action level" for positive cultures. CDC investigators have also expressed concern that negative culture results will give physicians a "false sense of security" that legionella cases will not occur in their facility. Instead, CDC recommends that environmental sampling be conducted when nosocomial legionella cases are identified in hospitals with high risk patients (see Hospital Infection Control Practices Advisory Committee [HICPAC] recommendations [15], also included in Appendix E). Decontamination is recommended if infections are traced to a specific source (such as the water system), with the effectiveness of decontamination monitored by sampling every 2 weeks for 3 months and, if negative, sampling monthly for another 3 months. As CDC investigators do not feel that a "safe" level of legionella in a water system can be determined, monitoring and decontamination efforts should be continued until cultures are negative. CDC guidelines also note the need for routinely maintaining cooling towers (also see ASHRAE guidelines [61]); and using only sterile water for the filling and terminal rinsing of nebulization devices. More recently, in a departure from the above stance, CDC has published draft guidelines for Prevention of Opportunistic Infections Among Bone Marrow Transplant Recipients that state "periodic routine culturing for legionella from the units potable water supply may be considered part of an overall strategy to prevent Legionnaires' disease in transplant patients." These draft guidelines further state that "the goal of environmental surveillance for legionella should be to maintain water systems [in transplant units] with no detectable organisms."

In contrast to the approach taken by CDC, Allegheny County, PA, has implemented a control strategy for nosocomial legionella infection that incorporates regular environmental sampling. The Allegheny County guidelines state that: "All hospitals should perform an environmental survey yearly. If transplants are performed, then a survey should be performed more often. An environmental survey should consist of: a) all hot water tanks, b) distal sites (faucets or showerheads). If hospital beds are less than 500, a minimum of 10 distal sites should be surveyed. If bed size is greater than 500, 2 distal sites per 100 beds are recommended. The distal sites should be taken from units housing patients at higher risk for acquiring Legionnaire's disease (COPD, immunosuppression, transplant)."

The Allegheny County, PA, guidelines also emphasize the need for good surveillance for nosocomial legionellosis, and the associated need for optimal diagnostic capabilities for legionella in hospitals. Regardless of environmental findings, remediation efforts are triggered by identification of a nosocomial case. These guidelines recognize that total elimination of legionella from a water system may not be possible, or necessary: the goal is to reduce legionella levels to a point (<30% of distal sites positive) where risk of nosocomial legionella infection is felt to be minimized.

In hospitals in which nosocomial cases are identified, there may be some benefit in limiting exposure of immunocompromised patients to potential sources of infection, pending reduction/elimination of legionella colonization of the water system. It has been suggested that this be accomplished by prohibiting patient showers, and using only sterile water for oral consumption [15; Appendix E].

RECOMMENDATIONS OF THE SCIENTIFIC WORKING GROUP

In preparing recommendations, the Scientific Working Group was aware that data linking levels of legionella colonization in water systems and the occurrence of illness are limited. The recommendations presented below reflect the expert opinion of the Working Group, drawing on available published data, material presented by speakers at the public scientific sessions, and the expertise and experience of Working Group members. Because of the recognized lack of data, Working Group recommendations focus on development of an individualized risk management approach for hospitals, rather than the

imposition of blanket guidelines. There have not been good cost benefit studies in this field, and the Scientific Working Group did not attempt to develop further or assess cost data. As noted in the data summary, many hospitals in Maryland perform or have initiated environmental testing of water systems and cooling towers for legionella. The Scientific Working Group did not have access to/was unable to obtain such data from individual hospitals.

While legionella infection can occur in virtually any setting in which there are exposures to water and water systems, illness is most likely among persons who are receiving immunosuppressive therapy or who have serious chronic underlying diseases. Because of this, the Scientific Working Group focused its recommendations on acute care hospitals, where the highest concentration of high risk persons might be assumed to be present. However, risks of infection exist in a number of other settings, including other healthcare institutions (nursing homes, assisted living facilities) and industrial settings. There should be an awareness of these risks, and routine precautions undertaken to decrease the risk of legionella infection, as outlined in material such as that produced by the Occupational Safety and Health Administration (www.osha-slc.gov/SLTC/legionnairesdisease/index.html) and ASHRAE [61]. While the recommendations in this report do not encompass nursing homes/extended care facilities, a scenario from such an institution has been included in Appendix F.

Finally, there should be an awareness that Legionnaire's disease is only one of a number of different types of pneumonia that can be acquired by patients while they are hospitalized. While there is a need to limit the risk of legionella infection in hospitals, the importance of surveillance and implementation of control measures for other types of nosocomial pneumonia must be clearly recognized [14]. This, in turn, requires that hospitals provide adequate support for infection control programs and professionals within their institution.

Recommendations

I. Primary Prevention

A. Patient-Based Surveillance and Diagnosis

1. All Maryland acute-care hospitals should have ready access to appropriate laboratory tests for the diagnosis of legionella pneumonia.

A) All acute-care hospitals should provide legionella urinary antigen testing in-house, or contract with another laboratory to provide 24 to 48 hour turn-around time for test performance and reporting.

B) All hospitals that routinely perform and care for patients with solid organ and/or bone marrow transplants should have the ability to perform legionella culture on site. All others should have a mechanism in place that allows them to submit specimens for legionella cultures to a microbiology laboratory within 24 hours of specimen collection.

C) The DHMH laboratory should serve as a reference laboratory for legionella, with the capability of serotyping, species identification, and molecular characterization of isolates.

(Notes: It is clear that there is not optimal availability of laboratory testing for legionella within Maryland. With the recent availability of the urinary antigen test for legionella, every acute-care hospital in the state should be able to offer rapid [and preferably, on-site] testing. At the same time, it must be recognized that urinary antigen testing only works if the patient is infected with Legionella strains in serogroup 1. Hospitals dealing with large numbers of high risk patients [i.e., those with active transplant programs] need to have on-site culture capabilities. Because of issues related to specimen transport and handling, the DHMH laboratory should not have primary responsibility for isolation of legionella from clinical samples. However, it should have the resources to provide reference laboratory services, including the ability to serotype and speciate isolates, and conduct molecular epidemiologic investigations, as needed.)

2. Surveillance and prevention strategies for legionella pneumonia should be implemented by acute-care hospitals.

A) Clinicians should always consider legionella species in their differential diagnosis for nosocomial (and community-acquired) pneumonia.

B) The hospital clinical laboratory should report to the infection control practitioner results of all positive assays for legionella.

C) Institutions should develop surveillance strategies to identify legionella cases. This may include algorithms that recommend that all sputum obtained from high-risk patients with pneumonia be sent for legionella culture, or urine sent for antigen detection; or all bronchoscopy specimens obtained from patients with pneumonia be sent for culture and appropriate antigen tests.

D) Infection control practitioners should use CDC definitions to determine whether the case is nosocomial. All nosocomial legionella cases should be investigated with a thorough epidemiologic and environmental investigation to determine the likely environmental sources such as potable water, cooling towers, hot water tanks, nebulizers, etc.

E) Nebulizers and other semi-critical respiratory care equipment should be cleaned with sterile water.

F) Nasogastric tubes should be flushed with bottled or sterile water.

G) Units with high-risk patients should not use large volume humidifiers that create aerosols unless they are sterilized with a high level disinfectant daily.

H) Cooling towers should be designed and constructed so that tower drift is directed away from the hospital's air intake system and the volume or aerosol drift is minimized. For all operational cooling towers, hospitals should:

- install drift eliminators
- use a biocide regularly
- maintain towers according to manufacturers recommendations
- keep adequate maintenance records

(Notes: Many of these recommendations [including recommendations for specific interventions] follow previously published CDC guidelines for nosocomial pneumonia [14] or the proposed guidelines for the Prevention of Opportunistic Infections Among Bone Marrow Transplant Recipients. As reflected in the recommendations, surveillance is an important component of any disease prevention and control program. Surveillance is most effective when targeted to high risk patients and guided by the local epidemiology and previous history at an institution. Thus, the Scientific Working Group strongly supports plans that allow institutions to individualize their approach and implement case finding strategies that fit the patient case mix and institutional resources.)

3. Efforts should be made to optimize public health reporting of legionella pneumonia

A) Laboratory identification of a legionella infection should be added to the Annotated Codes of Maryland as a Laboratory Reportable Disease. This would require revision by the legislature.

B) Hospitals should assure reporting of cases of Legionnaires' disease to their local health departments, and complete the CDC "Supplemental Case Report" form for legionella cases.

(Notes: Development and implementation of effective legionella control programs in Maryland require collaboration between hospitals and the Maryland DHMH; this, in turn, requires that the DHMH have accurate information on disease occurrence within the state. Based on experience with other diseases, accuracy and completeness of reporting would be substantively enhanced by making legionella a laboratory reportable disease. Similarly, when legionella cases are identified, hospitals should make every effort to obtain requested/necessary case report data.)

B. Environmentally-Based Surveillance

1. Water distribution systems within acute care hospitals (i.e., all building plumbing systems that distribute water for human contact) should be routinely cultured, with the time schedule determined by risk assessment for each institution.

A) The periodicity and interpretation of environmental testing should be determined as part of an overall risk assessment process. Such a risk assessment process should consider both institutional risk factors and remediation efforts.

Risk factors are defined by

- Engineering
 - a) Age, complexity, sedimentation, number of hot water systems
- Patient mix
 - a) Solid organ transplant
 - b) Bone marrow transplant
 - c) Patients with cancer undergoing chemotherapy
 - d) COPD
- Prior history
 - a) History of legionella identified among patients
 - b) History of positive water cultures from the potable water system and outlets or coolingtowers

Remediation efforts include

Type of treatment being utilized by a healthcare facility

- a) Super heating of water
- b) Hyperchlorination
- c) Copper-Silver ionization
- d) Monochloramine treatment
- e) Ultraviolet treatment

(Notes: The committee felt that sufficient data existed to recommend routine environmental testing of water sources/systems within hospitals. In particular, there were concerns that relying solely on identification of nosocomial legionella cases as a trigger for further investigation may underestimate the occurrence of nosocomial legionellosis in Maryland hospitals; and initial screening of water systems may prevent cases which might otherwise occur.

At the same time, there were not felt to be adequate data to provide uniform guidelines regarding timing and "action levels" for environmental sampling. It was the opinion of the Scientific Working Group that such decisions are best individualized, depending on hospital-specific risk and performance criteria. As a guide to possible approaches, the working group has prepared several "scenarios," which summarize

what appear to be appropriate responses under a variety of circumstances [Appendix F]. Preparation of an appropriate risk assessment profile may require consultation with engineers and industrial hygienists with appropriate training in these areas. Hospitals in which this type of assessment is not possible or practical may wish to consider implementation of the Allegheny County guidelines (with a clear recognition of their potentially limited applicability to hospitals in Maryland).

In keeping with the spirit of the Allegheny County recommendations, the intent is not to insist that hospitals have consistently culture-negative water systems: it is recognized that persistence of legionella in many instances will be inevitable, and may be of minimal significance from a public health standpoint. As is inherent in the "risk assessment" approach, hospitals with large populations of high risk patients may be less tolerant of a low frequency of positive legionella cultures than are hospitals with fewer such patients. Hospitals are expected to maintain good, active surveillance for nosocomial legionella cases; identification of a nosocomial case should be a clear indication that further efforts need to be made to reduce legionella colonization of the water supply. Hospitals that do not have the infection control expertise to interpret data should work with the local health department, and may need to retain the services of an expert in this field. However, except in special circumstances [such as an outbreak], it is not intended that environmental culture results be routinely reported to the health department)

2. The DHMH Laboratories Administration should establish standard procedures for environmental sampling, and serve as a reference laboratory for environmental testing. The laboratory should also have the capability for molecular typing of environmental legionella isolates, to permit matching of environmental isolates with isolates from patients.

(Notes: It is clear that results of environmental sampling can vary widely depending on techniques used for sampling and culturing. To facilitate consistency of data, the DHMH Laboratories Administration should assume responsibility for establishing and maintaining standard environmental sampling protocols for use within the state; should maintain a list of commercial laboratories that are able to appropriately perform environmental testing; and should provide reference capabilities for serotyping, speciation, and molecular studies.)

3. Results of environmental cultures should generally be qualitative for the presence or absence of legionella species. Quantitation is neither recommended nor encouraged. Serotyping, and where necessary species identification, should be included in the results.

C. Standard remediation

1. The Code of Maryland Regulations should be amended to set the upper limit on hot-water temperatures in hospitals and other institutional settings at 122°F (50°C).

(Notes: This is in keeping with recent suggestions by CDC investigators [42][although the CDC Guidelines for Prevention of Nosocomial Pneumonia [14] note that the cost-benefit ratio for this intervention needs further evaluation for hospitals in which cases have not occurred]. The suggested temperature limit would only minimally increase the scald risk, but should create a more unfavorable environment for legionella in institutional hot water systems.)

2. In any new construction or remodeling that requires the installation of a new water distribution system, measures should be taken to prevent or reduce legionella growth in the system, especially for areas that will house high risk patients.

A) Serious consideration should be given to installation of an acceptable water treatment system prior to operation of the system.

(Notes: As noted in the data summary, it may be possible to prevent initial colonization of water systems in new construction; such an approach may cost less [and result in fewer cases] than subsequent efforts to decontaminate an already colonized system.)

B) Where practicable, the following engineering measures should be incorporated into the design and operation of the system:

- Instantaneous or semi-instantaneous water heaters should be used instead of tanks. If tanks are used, horizontal tanks are preferred over vertical tanks, and steps should be taken to maintain adequate circulation to minimize cool spots within tanks. Hot water system recirculation pumps should run continuously.
- Hot water should be generated or stored at 60°C (140°F) and reduced as required for distribution.
- Installation of fail-safe thermostatic mixing valves and pressure independent mixing valves will permit maintaining a higher temperature in the water distribution system while minimizing the risk of scalding.
- The design should eliminate "dead legs" and other areas of stagnant water. Standby pumps and piping connections should be cycled regularly. The hot water recirculating system should be installed to serve the fixture farthest from supply.
- Studies indicate that copper is the most resistant of piping materials for legionella colonization. Natural rubber gaskets should be avoided.
- Pay attention to the materials and workmanship of pipe insulation. This will help keep hot water pipes hot, and cold water pipes cold.
- Potable water piping should be disinfected in accordance with the method recommended by the local plumbing authority.

3. Hospitals with legionella present in their water systems at levels above what they would regard as an acceptable risk threshold should initiate remediation efforts. Approaches to remediation may differ from institution to institution, and should be developed in consultation with engineers familiar with legionella control programs. The ASHRAE guidelines [61] are a reference source for approaches to legionella control within water systems.

D. Staff Education/Planning

1. The results of environmental cultures should be discussed with hospital physicians in a straightforward manner in order to heighten awareness of the possibility of legionella as a cause for nosocomial pneumonia.

2. Utilizing a team approach, each hospital should formulate a group of representatives (a "Legionella Team") from various departments, such as infection control, engineering and maintenance, risk management, employee health, and administration, to prevent and control legionellosis.

A) Depending on the administrative/organizational structure of the institution, this may be best accomplished through the Infection Control Committee.

B) This team should develop a written legionellosis control plan. This operational plan should encompass several components including:

- surveillance
- environmental culturing
- remediation (if and when necessary)
- reporting

Secondary Prevention: Interrupting Transmission

Identification of nosocomial legionella cases should initiate a series of actions on the part of a hospital or institution. These include:

A. Enhancement of surveillance activities

1. Review of recent nosocomial pneumonia cases

2. Consideration of the possibility of hospital-acquired cases among employees
 3. Initiation of case control studies, as appropriate
 4. Consideration of mandating legionella testing for all nosocomial pneumonia cases
 5. Reassessment of the availability of laboratory tests for legionella
 6. Enhancement of environmental surveillance, including additional cultures of water systems and sources
- B. Immediate initiation of enhanced remediation efforts, to reduce levels of legionella colonization in the hospital water system

(Notes: Recommendations for immediate remediation have been previously published by the CDC in the Guidelines for Prevention of Nosocomial Pneumonia [14]; and are covered in the ASHRAE [61] and Allegheny County guidelines [63]. Development of long-term remediation plans will require consultation with experts in this field. The CDC position that remediation efforts should be continued until all environmental cultures are negative may be unrealistic. Depending on the risk profile of the facility, reduction in the number of colonized distal sites may be an acceptable endpoint.)

C. Consideration of other methods to limit exposure of high risk patients to potentially contaminated water sources, pending successful reduction in levels of legionella colonization within the hospital water system

1. Possible restrictions on showering.
2. Consideration of restrictions on use of potable hot water, with a shift to use of sterile or bottled water for bathing and drinking.

(These latter recommendations are drawn from the CDC Guidelines for Prevention of Nosocomial Pneumonia and the HICPAC Recommendations for Prevention of Legionnaires' Disease [included in Appendix E]; while not unreasonable, there are not strong data to support their utility.)

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APPENDIX A

Membership and staff of the Maryland Scientific Working Group to Study *Legionella* in Water Systems

Scientific Working Group to Study *Legionella* in Water Systems

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APPENDIX B

Schedule of Public Scientific Meetings, Legionella Scientific Working Group

MARYLAND LEGIONELLA WORKING GROUP Scientific Sessions

**November 16, 1999, 2:00-5:00 PM, University of Maryland
Location: Health Science Conference Room # 171,
Health Science Facility, 685 W. Baltimore Street**

Session 1, Epidemiology

Dr. David Blythe, DHMH
Current reporting on legionella in Maryland
Results of recent Maryland hospital survey
Dr. Barry Fields, CDC
National data on occurrence of legionella

Session 2a, Diagnostic Considerations

Dr. Barry Fields, CDC
Approaches to diagnosis
Recommendations regarding availability of specific tests for hospital and state laboratories

**November 23, 1999, 2:00-5:00 PM, University of Maryland
Location: Medical School Teaching Facility (MSTF) Atrium**

Session 2a, Diagnostic Considerations (continued)

Dr. Lena Trivedi, Laboratory Administration, DHMH, and Carmela Groves, DHMH
Summary of methods for legionella identification/diagnosis available in local hospitals and at DHMH,
including methods for screening of water systems

Dr. Janet Stout
University of Pittsburgh
Diagnostic methods – current approaches, appropriate clinical methodology for hospitals, appropriate
methodologies for environmental screening

Session 2b: Water systems

Maryland Department of the Environment
Maryland guidelines/issues related to legionella in water systems

Dr. Al Dufours
Director, Microbiological and Chemical Exposure Assessment Research Division, EPA
EPA approaches to legionella in water systems

Dr. Eason Lin
University of Pittsburgh
Current research on legionella in water systems/water system disinfection

**December 7, 1999, 2:00-5:00 PM, University of Maryland
Location: MSTF Atrium**

Session 3: Approach to guidelines

Dr. Richard Besser, Chief, Legionella Activity, CDC
Current CDC guidelines

Dr. Victor Yu, Chief, Infectious Diseases Section
Department of Veterans Affairs Pittsburgh Healthcare Systems
Allegheny Count, PA, guidelines

David F. Geary, Chairman, ASHRAE GPC-12 Committee
ASHRAE Legionella Guidelines

Dr. Barry Farr, Professor of Medicine and Hospital Epidemiologist
University of Virginia Health Sciences Center
Society of Healthcare Epidemiologists of America (SHEA)

APPENDIX C

CDC Criteria for Identification of a Legionella Case as "Confirmed," "Probable," or "Nosocomial"

DEFINITIONS

Legionellosis (Revised 9/96)

Source: CDC.MMWR. Case Definitions for Infectious Conditions Under Public Health Surveillance. May 2, 1997/Vol. 46/ No. RR-10.

Clinical description

Legionellosis is associated with two clinically and epidemiologically distinct illnesses: Legionnaires' disease, which is characterized by fever, myalgia, cough, pneumonia, and Pontiac fever, a milder illness without pneumonia.

Laboratory criteria for diagnosis

- Isolation of Legionella from respiratory secretions, lung tissue, pleural fluid, or other normally sterile fluids, or
- Demonstration of a fourfold or greater rise in the reciprocal immunofluorescence antibody (IFA) titer to ≥ 128 against Legionella pneumophila serogroup 1 between paired acute- and convalescent-phase serum specimens, or
- Detection of L. pneumophila serogroup 1 in respiratory secretions, lung tissue, or pleural fluid by direct fluorescent antibody testing, or
- Demonstration of L. pneumophila serogroup 1 antigens in urine by radioimmunoassay or enzyme-linked immunosorbent assay

Case classification

Confirmed: a clinically compatible case that is laboratory confirmed

"Probable Case"

The previously used category of "probable case," which was based on a single IFA titer, lacks specificity for surveillance and is no longer used.

Legionellosis (Legionnaires' Disease) Note: old definitions

Source: CDC. MMWR. Case Definitions for Public Health Surveillance. October 19, 1990/Vol. 39/ No. RR-13.

Clinical description

An illness with acute onset, commonly characterized by fever, cough, and pneumonia that is confirmed by chest radiograph. Encephalopathy and diarrhea may also be included.

Laboratory criteria for diagnosis

- Isolation of Legionella from lung tissue, respiratory secretions, pleural fluid, blood or any other normally sterile sites, or
- Demonstration of a fourfold or greater rise in the reciprocal immunofluorescence (IF) antibody titer to ≥ 128 against Legionella pneumophila serogroup 1, or
- Demonstration of L. pneumophila serogroup 1 in lung tissue, respiratory secretions, or pleural fluid by direct fluorescence antibody testing, or
- Demonstration of L. pneumophila serogroup 1 antigens in urine by radioimmunoassay

Case classification

Probable: a clinically compatible illness with demonstration of a reciprocal antibody titer ≥ 256 from a single convalescent-phase serum specimen

Confirmed: a case that is laboratory confirmed

Definition of Nosocomial Legionnaires Disease

Source: CDC. MMWR. Guidelines for Prevention of Nosocomial Pneumonia. January 3, 1997/Vol. 46/ No. RR-1.

The incubation period for Legionnaires' disease is usually 2-10 days; thus, for the purposes of this document and the accompanying HICPAC recommendations laboratory-confirmed legionellosis that occurs in a patient who has been hospitalized continuously for ≥ 10 days before the onset of illness is considered a definite case of nosocomial Legionnaires' disease, and laboratory-confirmed infection that occurs 2-9 days after hospital admission is a possible case of the disease.

APPENDIX D

Protocol of Allegheny County Health Department for Primary Prevention of Legionella Infection

APPENDIX E

Hospital Infection Control Practices Advisory Committee (HICPAC) guidelines for prevention of nosocomial Legionnaire's disease

Hospital Infection Control Practices Advisory Committee

(Last update: Tuesday, March 26, 1996)

Source: www.cdc.gov/ncidod/diseases/hip/pneumonia/2_legion.htm

Recommendations for Prevention of Nosocomial Legionnaires' Disease

I. STAFF EDUCATION AND INFECTION SURVEILLANCE

A. Staff Education

Educate (1) physicians to heighten their suspicion for cases of nosocomial Legionnaires' disease and to use appropriate methods for its diagnosis, and (2) patient-care, infection-control, and engineering personnel about measures to control nosocomial legionellosis.(659-661)

CATEGORY IA

B. Surveillance

1. Establish mechanism(s) to provide clinicians with appropriate laboratory tests for the diagnosis of Legionnaires' disease.(386,414,415,419,704) CATEGORY IA

2. Maintain a high index of suspicion for the diagnosis of nosocomial Legionnaires' disease, especially in patients who are at high-risk of acquiring the disease (patients who are immunosuppressed, including organ-transplant patients, patients with AIDS, and patients receiving systemic steroids; are >65 years of age; or have chronic underlying disease such as diabetes mellitus, congestive heart failure, and chronic obstructive lung disease). (385,386,400,402-406,412) Refer to the accompanying background document for definition of nosocomial legionellosis. CATEGORY II

3. No Recommendation for routinely culturing water systems for Legionella spp.(271,385,429,433,435,436,438-440,456,705) UNRESOLVED ISSUE

II. INTERRUPTION OF TRANSMISSION OF LEGIONELLA SPP.

A. Primary Prevention (Preventing Nosocomial Legionnaires' Disease When No Cases Have Been Documented)

1. Nebulization and other devices

a. (1) Use sterile (not distilled, nonsterile) water for rinsing nebulization devices and other semicritical respiratory-care equipment after they have been cleaned and/or disinfected. (258,271,706) CATEGORY IB

(2) No Recommendation for using tap water as an alternative to sterile water to rinse reusable semicritical equipment and devices used on the respiratory tract, after they have been subjected to high-level disinfection, whether or not rinsing is followed by drying with or without the use of alcohol. UNRESOLVED ISSUE

b. Use only sterile (not distilled, nonsterile) water to fill reservoirs of devices used for nebulization.(241,252,258,271,706) CATEGORY IA

c. Do not use large-volume room-air humidifiers that create aerosols (eg, by venturi principle, ultrasound, or spinning disk) and thus are really nebulizers, unless they can be sterilized or subjected to high-level disinfection daily and filled only with sterile water.(252,706) CATEGORY IA

2. Cooling towers

a. When a new hospital building is constructed, place cooling tower(s) in such a way that the tower drift is directed away from the hospital's air-intake system, and design the cooling towers such that the volume of aerosol drift is minimized.(422,707) CATEGORY IB

b. For operational cooling towers, install drift eliminators, regularly use an effective biocide, maintain the tower according to manufacturers' recommendations, and keep adequate

maintenance records. (422,464,708) CATEGORY IB

3. Water-Distribution System

a. No Recommendation for routinely maintaining potable water at the outlet at => 50°C or <20°C, or chlorinating heated water to achieve 1-2 mg/L free residual chlorine at the tap.(385,429,440,447-450) UNRESOLVED ISSUE

b. No Recommendation for treatment of water with ozone, ultraviolet light, or heavy-metal ions.(391,460-463,466) UNRESOLVED ISSUE

B. Secondary Prevention (Response to Identification of Laboratory-Confirmed Nosocomial Legionellosis)

When a single case of laboratory-confirmed, definite nosocomial Legionnaires' disease is identified, OR if two or more cases of laboratory-confirmed, possible nosocomial Legionnaires' disease occur within 6 months of each other (refer to background document for definition of definite and possible nosocomial Legionnaires' disease.):

1. Contact the local or state health department or the CDC if the disease is reportable in the state or if assistance is needed. CATEGORY IB

2. If a case is identified in a severely immunocompromised patient such as an organ-transplant recipient, OR if the hospital houses severely immunocompromised patients, conduct a combined epidemiologic and environmental investigation (as outlined from II-B-3-b-1 through II-B-5, below) to determine the source(s) of Legionella spp. CATEGORY IB

3. If the hospital does not house severely immunocompromised patients, conduct an epidemiologic investigation via a retrospective review of microbiologic, serologic, and postmortem data to identify previous cases, and begin an intensive prospective surveillance for additional cases of nosocomial Legionnaires' disease. CATEGORY IB

a. If there is no evidence of continued nosocomial transmission, continue the intensive prospective surveillance (as in II-B-3, above) for at least 2 months after surveillance was begun. CATEGORY II

b. If there is evidence of continued transmission:

(1) Conduct an environmental investigation to determine the source(s) of Legionella spp. by collecting water samples from potential sources of aerosolized water, following the methods described in Appendix C [see CDC web page for this appendix] and saving and subtyping isolates of Legionella spp. obtained from patients and environment.(241,258,422-428,452,454) CATEGORY IB

(2) If a source is not identified, continue surveillance for new cases for at least 2 months, and, depending on the scope of the outbreak, decide on either deferring decontamination pending identification of the source(s) of Legionella spp., or proceeding with decontamination of the hospital's water distribution system, with special attention to the specific hospital areas involved in the outbreak. CATEGORY II

(3) If a source of infection is identified by epidemiologic and environmental investigation, promptly decontaminate it.(466) CATEGORY IB

(a) If the heated-water system is implicated:

i. Decontaminate the heated-water system either by superheating (flushing for at least 5 minutes

each distal outlet of the system with water at 65°C), OR by hyperchlorination (flushing for at least 5 minutes all outlets of the system with water containing > or = 10 mg/L free residual chlorine).(450,452,456,457) Post warning signs at each outlet being flushed to prevent scald injury to patients, staff, or visitors. CATEGORY IB

ii. Depending on local and state regulations regarding potable water temperature in public buildings,(458) maintain potable water at the outlet at 50°C or <20°C, or chlorinate heated water to achieve 1-2 mg/L free residual chlorine at the tap in hospitals housing patients who are at high risk of acquiring nosocomial legionellosis (eg, immunocompromised patients).(385,429,440,447-450) (See Appendix B.) CATEGORY II

iii. No Recommendation for treatment of water with ozone, ultraviolet light, or heavy-metal ions.(391,460,461,463) UNRESOLVED ISSUE

iv. Clean hot-water storage tanks and water heaters to remove accumulated scale and sediment.(393) CATEGORY IB

v. Restrict immunocompromised patients from taking showers, and use only sterile water for their oral consumption until Legionella spp. becomes undetectable by culture in the hospital water.(430) CATEGORY II

(b) If cooling towers or evaporative condensers are implicated, decontaminate the cooling-tower system using the protocol outlined in Appendix D.(464) CATEGORY IB

(4) Assess the efficacy of implemented measures in reducing or eliminating Legionella spp. by collecting specimens for culture at 2-week intervals for 3 months. CATEGORY II

(a) If Legionella spp. are not detected in cultures during 3 months of monitoring, collect cultures monthly for another 3 months. CATEGORY II

(b) If Legionella spp. are detected in one or more cultures, reassess the implemented control measures, modify them accordingly, and repeat decontamination procedures. Options for repeat decontamination include the intensive use of the same technique utilized for initial decontamination, or a combination of superheating and hyperchlorination. CATEGORY II

(5) Keep adequate records of all infection control measures, including maintenance procedures, and of environmental test results for cooling towers and potable-water systems. CATEGORY II

APPENDIX F

Scenarios: Legionella monitoring in hospital water systems

We have developed several scenarios to help define recommended practices in different healthcare settings. We assume the following for all of the listed scenarios.

We define high risk patients as:

solid organ transplant
bone marrow transplant
person on high doses of steroids (>20 mg/day) or other immunosuppressive agent

We anticipate that each facility will have a "Legionella Team," as outlined in the Recommendations of this report. As part of this team effort, the infection control practitioner will meet with facility personnel to

review maintenance practices. Facility personnel should maintain a log that includes dates and type of water system maintenance, including hot water tank cleaning, dates of temperature adjustments, etc. Equipment should be maintained per manufacturer's recommended practices. Facilities personnel should inform infection control practitioners of the location of the cooling towers, and conduct (and log) routine and regular maintenance of cooling towers and water systems. Cooling towers should be directed away from the air intakes of the facility and equipped with drift eliminators. All positive clinical and environmental cultures for legionella should be reported to the hospital Infection Control office. Construction, renovation or installation of new equipment should follow local plumbing code for potable water systems and should be in keeping with the facilities construction policy.

Scenario 1 applies to hospitals of > 400 beds.

Scenario 1: A large tertiary care teaching hospital with 700 beds, of which 100 are licensed intensive care beds, has active renal, liver, heart and lung transplant programs and an active oncology service that offers bone marrow transplants. The hospital has hot water tanks that supply heated potable water; the hospital physical plant is older, and there is substantive scaling and sediment in the system. No nosocomial legionella infections have occurred in the past two years.

Approaches:

- Educate healthcare workers and maintain a heightened suspicion for legionella as a cause of nosocomial pneumonia
- Have urine antigen testing and the ability to do legionella cultures available in hospital laboratory
- Culture/test all high risk patients with community and hospital acquired pneumonia for legionella.
- Use sterile water in respiratory equipment including devices that nebulize.
- Limit or eliminate humidifiers.
- Create a Legionella Team that answers to the hospital Infection Control Committee.
- Environmental culturing would be appropriate:
- Quarterly from at least 14 distal sites (showerheads and faucets): some distal sites located in intensive care, bone marrow transplant and solid organ transplant or other high risk units.
- Quarterly from all hot water tanks and sources (instantaneous hot water systems).

In the initial testing, 48% of distal sites are culture positive for legionella, including sites in the bone marrow transplant unit. No cases of nosocomial legionella infection are identified, despite heightened surveillance efforts. However, because of the presence of many high risk patients, the hospital initiates a program of superheating, combined with cleaning and descaling of the hot water system. While there is an initial reduction in percent positive sites to 20%, the percentage positive returns to 45% when the system is re-tested four weeks later. Under these circumstances, the hospital installs a copper-silver ionization system in the hot water supply. Within two months, all cultures are negative for legionella.

After one year of negative cultures, the hospital decreases the frequency of culturing to once every six months, and only cultures from distal sites on the solid organ transplant and bone marrow transplant unit. The hospital continues to culture/test all high risk patients with community and hospital acquired pneumonia for legionella.

Scenario 2 applies to hospitals of <400 beds and assumes that bone marrow and solid organ transplants are not performed. If bone marrow or solid organ transplants are performed, follow scenario 1.

Scenario 2: A mid-sized community hospital with 180 beds, of which 15 are licensed intensive care beds, has an active oncology service, and has hot water tanks that supply heated potable water. The current hospital facility was built within the past five years. No nosocomial legionella infections have occurred in the past two years.

Recommendations:

- Educate healthcare workers and maintain heightened suspicion for legionella as a cause of nosocomial pneumonia
- Implement urine antigen testing in hospital laboratory and assure ready access for specimens to a laboratory that can perform cultures
- Culture/test high-risk patients with community and hospital acquired pneumonia for legionella.
- Use sterile water in respiratory equipment including devices that nebulize.
- Limit or eliminate humidifiers.
- Establish a "Legionella Team" that answers to the hospital Infection Control Committee.
- Environmental culturing would be appropriate:
- Semi annually from at least 10 distal sites (showerheads and faucets): some distal sites located in intensive care and high-risk units.
- Annually include all hot water tanks and sources (instantaneous hot water systems)

The hospital finds that, while some sites are culture-positive for legionella, the percent of sites positive never exceeds 10%. Under these circumstances, remediation efforts are not attempted. However, the hospital continues to maintain careful surveillance for nosocomial legionella, particularly among its oncology patients; continues regular environmental surveillance; and carefully maintains the hot water system.

Scenario 3: A small community hospital with 60 beds, of which 5 are licensed intensive care beds, does not have an inpatient oncology service, and has hot water tanks that supply heated potable water. The current hospital facility was built 15 years ago. No nosocomial legionella infections have been diagnosed in the past two years.

Recommendations:

- Educate healthcare workers and maintain heightened suspicion for legionella as a cause of nosocomial pneumonia
- Implement urine antigen testing in hospital laboratory and assure access to a laboratory that can perform cultures
- Culture/test high-risk patients with community and hospital acquired pneumonia for legionella.
- Use sterile water in respiratory equipment including devices that nebulize.
- Limit or eliminate humidifiers.
- Place responsibility for Legionella control with the hospital Infection Control Committee, making certain that a representative from facilities management is on the committee.
- The hospital elects to follow the Allegheny County, PA, guidelines, and undertakes annual environmental testing from 10 distal sites and all hot water tanks.

The hospital finds that 20% of cultures are positive for legionella. Remediation efforts are not attempted. However, the hospital continues to maintain careful surveillance for nosocomial legionella, including urinary antigen testing in suspected cases of nosocomial pneumonia; continues regular environmental surveillance; and carefully maintains the hot water system.

Scenario 4 applies to all nursing homes, rehabilitation and intermediate care facilities regardless of number of beds.

Scenario 4: A 100 bed licensed nursing home admits patients with diabetes, cancer, and lung and heart disease for care. The hot water tanks supply heated potable water. No known nosocomial legionella infections have occurred in the past two years.

Recommendations:

- Educate healthcare workers and maintain heightened suspicion for legionella as a cause of nosocomial pneumonia
- Identify a laboratory which can perform urinary antigen and culture for legionella in a timely fashion, and make certain that physicians who have patients within the facility are aware of the availability of such testing

- Encourage physicians to culture/test high risk patients with community and hospital acquired pneumonia for legionella.
 - Notify the institution's infection control practitioner of a suspected case of nosocomial pneumonia among patients.
 - Use sterile water in respiratory equipment including devices that nebulize.
 - Limit humidifiers
 - Place responsibility for legionella control with the institution's infection control practitioner, working together with a designated representative from facilities management.
 - Environmental culturing would be appropriate when:
 - a case of nosocomial legionella pneumonia is identified or
 - a previously documented cluster of nosocomial legionella cases has occurred (past 2 years), or
 - an ongoing endemic problem of legionella disease among patients is identified.
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