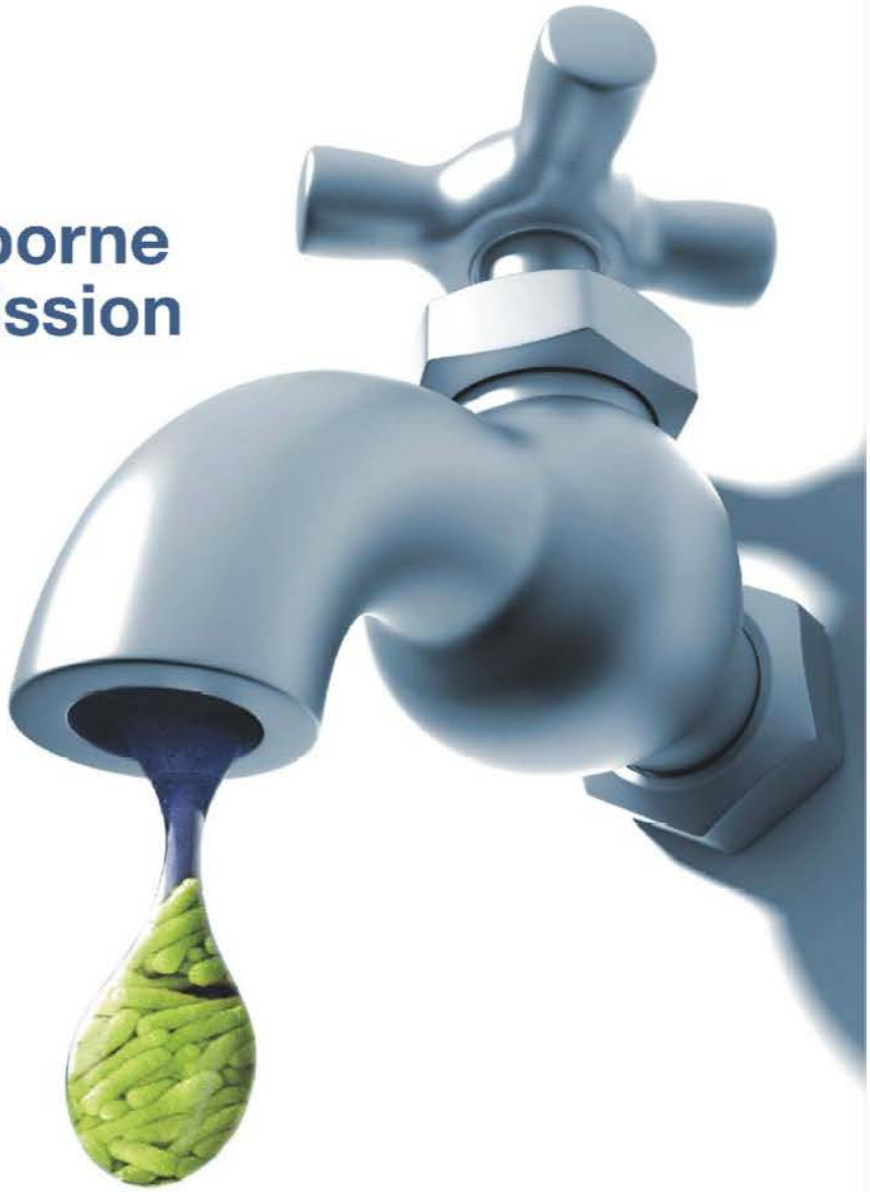
Preventing Waterborne Pathogen Transmission



By Kelly M. Pyrek

Researchers have emphasized that hospital water distribution systems might be the most overlooked, important and controllable source of healthcare-associated infections (HAIs).

As Kanamori, et al. (2016) remind us, "Hospital water and water-related devices as well as moist environments and aqueous solutions can serve as a reservoir of waterborne pathogens in healthcare settings. The hospital environment may allow contamination by waterborne pathogens, in part because water temperatures are suitable for bacterial growth, and the complex structure of hospital water systems often leads to stagnation, corrosion, and biofilm formation. A variety of water reservoirs have been linked to nosocomial outbreaks including potable water, sinks, faucet aerators, showers, tub immersion, toilets, dialysis water, ice and ice machines, water baths, flower vases, eyewash stations, and dental-unit water stations. Waterborne pathogens have included Legionella, other Gram-negative bacilli, nontuberculous mycobacteria (NTM), fungi, protozoa, and viruses. Transmission of these pathogens from a water reservoir may occur by direct and indirect contact, ingestion and aspiration of contaminated water, or inhalation of aerosols. Waterborne outbreaks caused by these pathogens and reservoirs have occurred among patients in healthcare settings and have been a serious threat to high-risk patients, especially critically ill patients and immunocompromised hosts, leading to substantial morbidity and mortality."

"The issue is real and serious," says Tim Keane, a consultant with Philadelphia area-based Legionella Risk Management, Inc. "Many in the healthcare industry have a perception that the issue is overblown, many have looked at comments in the CDC 2003 Environmental Infection Control Guideline and taken out of context the recommendations to conclude that if you test the water you will find Legionella, if you find Legionella you have to do something, so the best thing to do is nothing. Although what is stated in CDC 2003 EIC is largely incorrect and superseded by ASHRAE standard 188, many still believe this CDC document has precedence; that should not be the case. Some believe because Joint Commission came out with an environment-of-care standard in 2001 requiring all Joint Commission-accredited facilities have a risk management plan in place for waterborne pathogens and then apparently did little to enforce this standard, that it wasn't important."

Keane continues, "Because of issues created by CDC and Joint Commission, there is probably no industry with more misperceptions about Legionella than healthcare. The CMS memo, however, has clearly addressed the issue and requires that all healthcare facilities have a Legionella risk management plan and all inspection agencies are required to check for that plan, no longer allowing Joint Commission to give short shrift to the issue. The problem now is that many of these agencies now required to check for implementation of a Legionella risk management plan per CMS don't know what to look for."

On July 6, 2018, the Centers for Medicare and Medicaid Services (CMS), issued the aforementioned revision (via QSO-17-30-Hospitals/CAHs/NHs) to clarify expectations for healthcare providers, accrediting organizations and surveyors, reiterating that "facilities must develop and adhere to policies and procedures that inhibit microbial growth in building water systems that reduce the risk of growth and spread of Legionella and other opportunistic pathogens in water." The policy memorandum applies to hospitals, critical-access hospitals (CAHs) and long-term care (LTC) facilities, and supercedes the June 2, 2017 memo.

To review, the bacterium Legionella can cause a serious type of pneumonia in persons at risk. Those at risk include persons who are at least 50 years old, smokers, or those with underlying medical conditions such as chronic lung disease or immunosuppression. Outbreaks have been linked to poorly maintained water systems in buildings with large or complex water systems including hospitals and long-term care facilities.

Transmission can occur via aerosols from devices such as showerheads, cooling towers, hot tubs, and decorative fountains.

According to CMS, legionella infections increased 286 percent in the United States (U.S.) during 2000 to 2014, with approximately 5,000 cases reported to the Centers for Disease Control and Prevention (CDC) in 2014. Approximately 9 percent of reported legionellosis cases are fatal. In a recent review of LD outbreaks occurring from 2000 to 2014 in the U.S., 19 percent were associated with long-term care facilities and 15 percent with hospitals.

Outbreaks generally are linked to environmental reservoirs in large or complex water systems, including those found in healthcare facilities such as hospitals and long-term care facilities. Transmission from these water systems to humans requires aerosol generation, as can occur from showerheads, cooling towers, hot tubs, and decorative fountains. Legionella is less commonly spread by aspiration of drinking water or ice, and only one case of possible person-to-person transmission has been reported.

Legionella bacteria can grow in parts of building water systems that are continually wet, and certain devices can spread contaminated water droplets via aerosolization. Examples of these system components and devices include hot and cold water storage tanks; water heaters; water-hammer arrestors; pipes, valves and fittings; expansion tanks; water filters; electronic and manual faucets; aerators; faucet flow restrictors; showerheads and hoses; centrally-installed misters, atomizers, air washers and humidifiers; non-steam aerosol-generating humidifiers; eyewash stations; ice machines; hot tubs/saunas; decorative fountains; cooling towers; and medical devices such as CPAP machines, hydrotherapy equipment, bronchoscopes and heater-cooler units.

Keane says many healthcare institutions are lacking in awareness about the reservoirs and transmission routes of waterborne pathogens, giving them a grade of C-minus or D in this area.

"There is confusion in some facilities on who's on first base," Keane says. "There are three parts to this issue. Part one is the clinical aspect, which falls under the purview of infection control. This includes disinfection protocols for clinical equipment as well as patient surveillance. Part two is the building water system aspect, which falls under the purview of engineering. Part three is overall plan management which typically falls under infection control as well. In cases where infection control tries to manage the engineering aspect, that results in problems. Also, there are a lot of conflicting recommendations out there, which is a challenge for engineers relating to who to believe. One of the most problematic is VHA Directive 1061; many think that because the VA is the largest hospital system in the world, it must know the best way, the most cost-effective way to address this issue. Nothing could be further from the truth."

Department of Veterans Affairs VHA Directive 1061, called the Prevention of Healthcare-Associated Legionella Disease and Scald Injury From Potable Water Distribution Systems, establishes policy for the prevention and control of healthcare-associated Legionella disease in VHA-owned buildings in which patients, residents, or visitors stay overnight. This directive outlines controls such as maintenance of appropriate water temperatures in building water distribution systems and maintenance of biocide at a recommended level for legionella control.

Per industry standards, the main Legionella control measures include physical controls, temperature management, disinfectant levels, visual inspections, and environmental testing for pathogens.

As we have seen, healthcare institutions must develop and adhere to policies and procedures that inhibit microbial growth in building water systems that reduce the risk of growth and spread of Legionella and other opportunistic pathogens in water. An industry standard calling for the development and implementation of water management programs in large or complex building water systems to reduce the risk of legionellosis was published in 2015 by American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE). In 2016, the CDC and its partners developed a toolkit to facilitate implementation of the ASHRAE standard, providing environmental, clinical and epidemiologic considerations for healthcare facilities.

Pertinent CMS regulations include, but are not limited to:

- 42 CFR §482.42 for hospitals: "The hospital must provide a sanitary environment to avoid sources and transmission of infections and communicable diseases. There must be an active program for the prevention, control, and investigation of infections and communicable diseases."
- 42 CFR §483.80 for skilled nursing facilities and nursing facilities: "The facility must establish and maintain an infection prevention and control program designed to provide a safe, sanitary and comfortable environment and to help prevent the development and transmission of communicable diseases and infections."
- 42 CFR §485.635(a)(3)(vi) for critical access hospitals (CAHs): CAH policies must include: "A system for identifying, reporting, investigating and controlling infections and communicable diseases of patients and personnel." Expectations for Healthcare Facilities CMS expects Medicare and Medicare/Medicaid certified healthcare facilities to have water management policies and procedures to reduce the risk of growth and spread of Legionella and other opportunistic pathogens in building water systems. Facilities must have water management plans and documentation that, at a minimum, ensure each facility conducts a facility risk assessment to identify where Legionella and other opportunistic waterborne pathogens (such as Pseudomonas, Acinetobacter, Burkholderia, Stenotrophomonas, nontuberculous mycobacteria and fungi) could grow and spread in the facility water system; develops and implements a water management program that considers the ASHRAE industry standard and the CDC toolkit; specifies testing protocols and acceptable ranges for control measures, and document the results of testing and corrective actions taken when control limits are not maintained; maintains compliance with other applicable federal, state and local requirements.

Let's review the key reservoirs and infection prevention strategies against waterborne pathogens.

Potable water, tap water and hospital water systems can be significant reservoirs

- Hot water temperature at the outlet at the highest temperature allowable, preferably >51°C.
- Water disruptions: post signs and do not drink tap water.
- Maintain standards for potable water (<1 coliform bacterium/100 mL).
- Rinse semi-critical equipment with sterile water, filtered water, or tap water followed by alcohol rinse.
- Some experts have recommended periodic monitoring of water samples for growth of Legionella.
- Potential methods of eradication include filtration, ultraviolet, ozonization, heat inactivation (>60°C), hyperchlorination, and copper-silver ionization (>0.4 ppm and >0.04 ppm, respectively)

Sinks: Some studies demonstrate a transmission link between a colonized sink and infected patients.

Gram-negative bacilli can survive wet environments, including sinks, for as long as 250 days. Transmission can be caused by splashing of water droplet from contaminated sinks to hands of healthcare personnel, followed by transient colonization of hands.

- Use separate sinks for handwashing and disposal of contaminated fluids
- Decontaminate or eliminate sinks as a reservoir if epidemic spread of gram-negative bacteria via sinks is suspected

Faucet aerators may serve as a platform for accumulation of waterborne pathogens

- Routine screening and disinfection or permanent removal of all aerators are not warranted at present
- For Legionella outbreaks, clean and disinfect faucet aerators in high-risk patient areas periodically or consider removing them in the case of additional infections

Showers: Some outbreaks are linked to contaminated shower heads or inhalation of aerosols

- Prohibit use of showers in neutropenic patients
- Control Legionella colonization of potable water

Ice and ice machines: Patients can acquire pathogens by sucking on ice, ingesting iced drinks, or use of contaminated ices for cooling medical procedure and patients' skin

- Do not handle ice by hand
- Do not store pharmaceuticals or medical solutions on ice for consumption
- Use automatic dispenser rather than open chest storage compartments in patient areas
- Clean and disinfect ice-storage chests regularly
- Meaningful microbial standards for ice and ice machines do not exist
- Routine culturing of ice machines are not recommended
- A regular disinfection program for ice machines is recommended
- Eyewash stations: Stationary and portable eyewash stations may not be used for months or years, and the water source may stand in the incoming pipes at room temperature for a long period
- Use sterile water for eye flush or regularly (such as monthly) flush eyewash stations

Bathing, tub immersion, and hydrotherapy can cause cross-transmission, transmission from environmental reservoirs, or auto-transmission

- Consider routine cleaning, disinfection, and changing of water in water baths
- Add germicide to water bath or use plastic overwrap of blood products and keep the surfaces dry

Electronic faucets are likely to be contaminated by several waterborne pathogens than handle-operated faucets

- Electronic faucets need to be designed so that they do not promote the growth of microorganisms
- No guideline (but some authors have recommended) to remove electronic faucets from high-risk patient-care areas
- Some studies have recommended periodic monitoring of water samples for growth of Legionella.

Decorative water wall fountains have been associated with some Legionella pneumonia cases

- Avoid installation, especially in healthcare facilities serving immunocompromised patients or in areas caring for high-risk patients
- Perform maintenance regularly and monitor water safety strictly unless removed

Risk Assessment and Management

Regarding the key elements of a risk identification and reduction strategy based on current guidelines and recommendations, Keane emphasizes that the healthcare institution's engineering department must take ownership of building water systems.

"If infection preventionists (IPs) try to take ownership of the engineering aspects, the results may be very high costs and low risk reduction," he says. "IPs just don't have the knowledge base to address issues related to building water systems. Instead, they should review plans and provide oversight to the overall plan, make sure engineering complies with the CDC Toolkit, ASHRAE 188 and ASHRAE Guideline 12, making sure that engineering takes the lead on plan development for the hospital water systems."

Keane continues, "If the facility wants to hire a consultant to assist in plan development, I strongly recommend hiring an engineer that is a building water system expert who specializes in risk management for building water systems. There are lots of salesman out there selling services for legionella risk management, so the best thing to do is to hire someone who can provide a good engineering audit of your systems, identify root cause problems if any exist, implement most cost-effective solutions and then — and only then — finalize any type of risk management plan, including treatment, testing, monitoring, etc. If you hire a water treatment company to do your plan, likely the result will be to buy their chemicals and if you hire someone that provides testing services then you are likely to be paying for a lot of testing. I disagree with CDC on some of their positions on this issue but one document they produced that offers good direction is titled *Considerations When Working with Legionella Consultants*."

In that document, the CDC makes the following recommendations regarding factors to discuss with consultants:

- Level of experience: For example, what kind of Legionella-specific experience do the employees of this company have? Do the employees have appropriate training in critical fields (e.g., engineering, environmental health or industrial hygiene, water treatment, plumbing, microbiology)? Does the company have Legionella-specific experience with a facility of your size/type? Do they have experience with water system remediation, implementation of water management programs to prevent Legionnaires' disease, or both?
- Laboratory expertise: For example, is the laboratory they use accredited for environmental testing? Does it participate in a proficiency testing program for Legionella? Does their laboratory perform culture for Legionella (which is particularly important following remediation to ensure adequacy of the remediation process)? What level of identification (species/serogroup) can their laboratory perform? Is their laboratory willing to save samples and isolates and share them with public health laboratories if requested during an outbreak investigation?
- Environmental assessment expertise: For example, how much experience does the company have with environmental assessments and/or sampling for Legionella? Can they describe situations where they performed an environmental assessment and/or Legionella sampling in a facility of your size/type?

- Remediation expertise: For example, how frequently does the company provide remediation services and can they describe situations where they remediated Legionella from a building water system in a facility of your size/type? Can the company discuss the benefits and challenges associated with multiple approaches to remediation?
- Water management expertise: For example, how much experience does the company have creating water management programs compliant with industry standards for a facility of your size/type? What level of support does the company provide with creation and implementation of water management programs? What is the spectrum of services they offer once the water management program is established?
- Knowledge of codes, standards, and regulations: For example, does the company have previous experience working in your state and/or jurisdiction? How familiar is the company with state and local building codes in your jurisdiction, water treatment regulations, healthcare accreditation and survey requirements, and public health reporting requirements? Local building code officials or your health department may be good resources for knowledge about existing codes, standards, and regulations.
- Potential conflicts of interest: For example, does the company have interest in promoting specific services or products?

Let's review the basics of risk management relating to waterborne transmission.

Spagnolo, et al. (2016) remind us that the CDC provides guidelines for water quality in healthcare facilities. The CDC recommendations include strategies to minimize the growth and persistence of Gram-negative waterborne bacteria, such as the recommendation that cold water in healthcare facilities should be stored and distributed at temperatures below 20°C and that hot water should be stored above 60°C and circulated with a minimum return temperature of 51°C. In 2011, the WHO issued guidelines on the quality of water for human consumption, including hospital water supplies. These guidelines recommend the adoption of a Water Safety Plan (WSP) for water-risk management which provides for implementing active surveillance of infections; preventing contamination during storage and distribution; monitoring the quality of water sampled at the most significant points of the water system in the healthcare facility and adopt procedures for sanitation (to eliminate or reduce contamination); and for the maintenance of plumbing systems.

Freije (2005) provides useful touch points relating to the development of a risk reduction strategy which takes into consideration three factors that are required for waterborne illness to occur: contaminated water, transmission of pathogens to a person, and a susceptible host:

- What is the incidence and severity of associated illness?
- Is water the predominant source?
- Are problems with this pathogen rooted primarily in the water supply (e.g., city water), or in plumbing systems within buildings?
- Are accurate environmental detection methods available at a reasonable cost? If not, you will be unable to determine potential risk or measure the effectiveness of your environmental preventive efforts.
- Are effective preventive and remedial measures available? If not, you should focus on protecting patients from exposure.
- What is the hospital's potential liability if this pathogen is implicated in nosocomial disease? Although patient care should be the foremost concern, legal and financial implications must also be considered.

Freije (2005) recommends the following action steps, based on published guidelines and studies:

1. Form a team, appoint a leader, and establish communication. The team should include members from facilities management, infection control, risk management, administration, and the medical staff. Write a management plan for waterborne pathogens and meet periodically to ensure that the plan is being implemented, to review results, and to consider revisions.
2. Identify high-risk building areas based on water exposure and patient susceptibility.
3. Establish patient surveillance for Legionnaires' and other waterborne disease, per CDC guidelines. Provide the laboratory tests required to diagnose Legionnaires' disease and encourage clinician suspicion for it.
4. Conduct an environmental risk assessment. Have an outside expert evaluate the cooling towers, potable water systems, and other aerosolizing devices for conditions that promote growth of waterborne pathogens.
5. Implement reasonable environmental preventive measures. Designing, constructing, operating, and maintaining potable water systems, cooling towers, and other aerosolizing devices to minimize pathogens can reduce the risk of waterborne illness. In addition to implementing remedial measures, write policies for regular maintenance and operation of systems.
6. Consider routine environmental sampling to indicate the success of preventive measures. An important issue, practically and legally, is deciding which patients are "high risk." Where should you draw the line? In making this recommendation, the CDC cited patients who have had transplants as an example, but in various CDC documents, it has suggested that cancer patients, patients on antirejection medication or steroids, surgical patients, dialysis patients, and patients with chronic underlying illnesses are also at high risk of acquiring Legionnaires' disease, and smokers and persons more than 65 years old are at moderately high risk. As Freije (2005) notes, "In my opinion, based on experience in conducting Legionella risk assessments of hospitals and as an expert in litigation related to Legionnaires' disease, Legionella environmental sampling is a wise investment if carried out properly and for the right reasons; it can play an important part in reducing risk of disease for the patient and in reducing legal risk for the hospital. For other pathogens, routine sampling may not make sense on the basis of available detection methods, cost, and other factors. For some pathogens, however, water sampling should be considered if associated nosocomial illness occurs."
7. Write a disease response plan. Outline steps for epidemiologic as well as environmental aspects of an investigation, and for emergency disinfection of cooling towers and potable water systems. Include it in your management plan.
8. Implement appropriate remedial measures. Preventive maintenance, including high hot water temperatures, is not a guarantee against waterborne pathogens, so installing a continuous disinfection system or point-of-use filters is sometimes necessary. Disinfection technology is available to control Legionella and most other bacteria at a reasonable cost.

The World Health Organization (WHO)'s Water Safety Plan contained in its Guidelines for Drinking Water Quality calls for a systematic risk assessment to be conducted, with special emphasis on the identification of relevant pathogens, knowledge of their infecting pathways (from source to patient), and their public health consequences. The following steps must be included:

1. Hazard identification
2. Exposure assessment
3. Dose-response assessment
4. Risk characterization combined with knowledge of ecologic criteria (identification of the source and reservoirs of waterborne pathogens in the distribution system)

The development of a control strategy of waterborne pathogens must be based on two aspects: the reduction of the number of microbes that can harm the patient and the specific protection of patients at high risk for infection.

Spagnolo, et al. (2016) emphasize, "Only WSPs based on locally adapted interventions and continuous surveillance can effectively prevent such nosocomial infections as legionellosis. By providing safe water, proper implementation of the WSP ensures patient safety and reduces costs, in that waterborne infections increase morbidity, mortality, treatment costs and compensation claims, and prolong hospitalization.

Exner, et al. (2005) say that prevention and control strategies to address waterborne pathogens in healthcare institutions should take into consideration the following points:

- Because the association between waterborne pathogens and HAIs has not been well known until now, a strong education strategy will be essential to communicate new information to all people involved in water utilities, building architecture, hospitals, etc.
- Clinicians, infection preventionists, risk managers, facilities engineers, and other professionals involved in healthcare must be aware of the fact that plumbing systems and water outlets are now regarded as important reservoirs of infection.
- Complete prevention of the penetration of waterborne pathogens into the hospital water supply may be regarded as unattainable. However, the risk can be minimized by filtration and disinfection processes.
- The installation of disinfection systems such as copper/silver ionization, chlorine dioxide, chlorine, and ultraviolet light irradiation may prevent the formation of biofilms but preventing biofilm formation is only attainable if these disinfection systems are placed into operation from the first moment of water flow into the plumbing system.
- If biofilms have developed in a hospital plumbing system, it appears to be very difficult to subsequently bring their formation completely under control.
- Strategies to prevent biofilm formation must be stringent.
- An important strategic step in the control of waterborne pathogens is control of systemic contamination of the plumbing system. If systemic contamination by Legionella and other waterborne pathogens exists, it will not be possible to flush them from water outlets.
- Much greater attention must be paid to the possible contamination of water outlets. Non-touch fittings in hospitals have been identified as possible sources of P aeruginosa and Legionella spp. This alarming situation must be controlled through the development of technical procedures to reduce and/or eliminate contamination of non-touch fittings.
- The application of sterile point-of-use filters on faucets and shower heads has become a part of the infection control program not only for the prevention of Legionella but also of P. aeruginosa infections.
- The discussion concerning whether to perform environmental cultures should be brought to conclusion in the near future. The purposes of environmental cultures are as follows: (1) to provide information about the status of the contamination of a plumbing system with different waterborne pathogens and (2) to permit verification and validation of the quality of the control measures applied.
- In the case of systemic contamination from Legionella or P. aeruginosa, clinicians should be promptly informed that there is an infection risk which should be recognized.
- Surveillance for infections from Legionella, P. aeruginosa, and other waterborne pathogens is important. If there is a high incidence or an increase in infections attributable to these microorganisms, the water system must be considered as an infection reservoir, and control measures must be introduced.

Knowing that waterborne infections are a viable threat, should hospitals go on the offense, or play defense when it comes to risk reduction. As Freije (2005) acknowledges, "The question is whether to take a proactive approach that aims to minimize pathogens in water systems or a reactive approach that considers environmental measures only after disease is identified. This issue must be considered for a given pathogen on the basis of severity of associated illness, sources of contamination, data on preventive measures, available detection and remedial technology, and legal issues. Hospitals should have a waterborne pathogens team that includes members from facilities management, infection control, risk management, administration, and the medical staff. The team should write a management plan that paints a clear picture of the overall risk reduction strategy and outlines detailed preventive measures for potable water systems and cooling towers, and then meet periodically to ensure that the plan is being implemented, to review results, and to consider revisions." ICT

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