Organizing Legionnaires’ Disease Outbreak Investigations
SEPTEMBER 10, 2019, 9:00 am Pacific

Please mute all microphones (telephone and computer).
Agenda

> 9:00 – 10:00 AM Introduction and background
  • Brief overview of Legionella
  • Response strategies of public health agencies
  • Water management plans – making a sufficiency determination of the plan and its implementation – common gaps that drive risk

> 10:00 – 11:00 AM Flow diagrams – where is water moving; what systems are involved; prioritizing where to look

> 10:15 AM Break

> 11:00 – 12:00 PM Organizing the walkthrough for potable, utility, and medical water systems

> 12:00 – 12:30 PM Tracing systems – identifying risk factors – examples of well-maintained and poorly maintained systems – examples of poor design that drive risk factors

> 12:30 – 2:00 PM Lunch
Agenda

> 2:00 – 2:30 PM  Tracing systems (cont.)
> 2:30 – 3:00 PM  Medical devices/medical engineering – breaking down the systems and their risk profiles
> 3:00 – 3:30 PM  Sampling strategies for different types of water systems and developing the sampling plan based on environmental assessments
> 3:15 PM         Break
> 3:30 – 5:00 PM  Moderated exercises applying what was learned – real-world examples of environmental investigations
Learning Objectives

> Gain an understanding of the tools necessary to perform an environmental investigation of a healthcare facility during an outbreak of Legionnaires’ disease

> How to evaluate the implementation of water management programs

> How to use a facility flow diagram to follow the path of water

> How to identify potential hazardous conditions
Introduction
Introductions

Source: Centers for Disease Control and Prevention.
Raw count of Legionnaires’ Disease as of November 30, 2015, as reported to the CDC. Legionnaires’ Disease is a nationally notifiable disease, meaning that any cases must be reported to the local public health department, which in turn will report it to the CDC.
OUR MISSION

NSF International is dedicated to being the leading global provider of public health and safety-based risk management solutions while serving the interests of all stakeholders, namely the public, the business community, and government agencies.

NSF International is a global, independent public health and safety organization. Our mission and focus has always been protecting and improving human health.
In 1944, NSF was founded as the National Sanitation Foundation in the University of Michigan’s School of Public Health.

Today, we are NSF International, with corporate headquarters in Ann Arbor, MI, USA, and 62 office and lab locations worldwide.
Ron George, CPD, President
Plumb-Tech Design and Consulting Services LLC

> 40+ years Designing Plumbing, HVAC & Piping systems to prevent *Legionella* bacteria growth and scalding
> Member ASHRAE 188 Committee – Legionellosis: Risk Management for Building Water systems
> Member ASHRAE Guidelines 12 Committee – Guidelines to Minimize Legionellosis in Building Water Systems
> Member ASHRAE 514 committee – Prevention of Disease and Injury Associated with Building Water Systems standard
> Member ASSE Legionella Research Committee
> Developed the [LegionellaPrevention.org](http://LegionellaPrevention.org) Website & [ScaldPrevention.org](http://ScaldPrevention.org) Website (for Education on control of scalding and Legionnaires’ disease)
> Member ASHRAE TC 6.6 – Service Water Heating
> Former member ASPE Hot Water System Design Standard Committee
> Member ASSE Product Standards Committee covering product standards for domestic hot water system temperature control devices, and water heaters with temperature control
> Contributing member to various standards dealing with: plumbing products, water heaters burner control thermostats, water heater testing, plumbing codes
> Contributing member – ASHRAE TC 3.6 Water Treatment and various water quality committees
> Monthly columnist for *Plumbing Engineer Magazine* since 1994
Legionella and Other Opportunistic Pathogens
Legionella

> #1 cause of waterborne disease outbreaks
  > 7,458 reported cases of Legionnaires’ disease in 2017
> Bacteria found naturally in soil, surface water, and groundwater
> 60+ species with *Legionella pneumophila* causing most of the reported cases of disease
> Legionellosis
  > Legionnaires’ disease – fatal
  > Pontiac fever – not fatal
> *Legionella* may travel from the source water through a treatment system and into a building water system

The Cost of Disease

> CDC: In one year alone, insurance companies paid out an estimated $434 million for claims arising from Legionnaires’ disease infection, and total health care costs per patient averaged $38,000.

> $1 billion annual economic cost of opportunistic pathogens
  - *Legionella pneumophila*
  - *Mycobacterium avium*
  - *Pseudomonas aeruginosa*
  - *Acanthamoeba*

Prevention of Outbreaks is Possible with Effective Water Management

People definitely got Legionnaires’ disease from a health care facility in 76% of locations reporting exposures.

Legionnaires’ disease kills 25% of those who get it from a health care facility.

Most problems leading to US health care-associated outbreaks could be prevented with effective water management.

15% of outbreaks associated with hospitals
19% of outbreaks associated with nursing homes

Other Waterborne Hazards

Not just Detroit: Lead in drinking water plagues schools nationwide

Lori Higgins, Detroit Free Press
Published 9:00 a.m. ET Sept. 14, 2018 | Updated 12:26 p.m. ET Sept. 17, 2018

ORIGINAL ARTICLE

Outbreak of Multidrug-Resistant *Pseudomonas aeruginosa*
Colonization and Infection Secondary to Imperfect Intensive Care Unit Room Design

Susy Hota, MD; Zahir Hirji, MHSc; Karen Stockton, MHSc; Camille Lemieux, MD, LLB; Helen Dedier, MLT; Gideon Wolfardt, PhD; Michael A. Gardam, MD, MSc
Healthcare Acquired Infections (HAI)

> Nosocomial infections
> 1 in 25 U.S. patients develop a HAI during a hospital stay

> Transmission pathways
  • Direct contact (hydrotherapy)
  • Ingestion (contaminated ice)
  • Indirect (improper instrument reprocessing)
  • Inhalation (cooling towers)
  • Aspiration (ventilators)
Responding to Cases and Outbreaks of Disease
New Jersey Department of Health Investigating Cluster of Legionnaires’ Cases in Union County

As of May 23, NJDOH is aware of 22 confirmed cases of Legionnaires’ disease in individuals who reside in or visited Union County, New Jersey. The people became ill between March 8 through May 13, 2019. Five deaths have been reported among older adults who had other significant medical conditions. NJDOH is currently working with the U.S. Centers for Disease Control and Prevention and local health departments in Union County to investigate this cluster.

MAY 29, 2019

22 cases of pneumonia-like Legionnaires’ disease popped up in one New Jersey county

Five deaths tied to the disease have been reported in Union County

Legionnaires’ Disease in Northern NJ: A Possible Link to Water Treatment Failures?

July 10, 2019    Erik D. Olson
New Brunswick confirms 7 cases of legionellosis in Greater Moncton area

New Brunswick confirms 9 cases of legionnaires’ disease in Moncton area

There is still no word on the source of the disease but all cases are believed to be linked by time and location.

Outbreak of legionnaires’ disease in Moncton grows to 12 confirmed cases

The province says it is waiting on tests from a lab in Quebec to confirm that the strain of bacteria found at a contaminated site is the same as the strain found in affected patients, all of which are believed to be linked in time and location.

Canada

N.B. confirms 16 cases of legionnaires’ disease in Moncton, still won’t reveal source of outbreak
Legionella Outbreaks are Generally Approached from the Framework of Emergency Management

> Few proactive prevention requirements exist

> Best practices regarding water management should be adopted to incorporate prevention strategies along with consistent emergency management

> Outbreak prevention along with better emergency management will increase efficiencies, maximize resources, and save lives
Improving Emergency Management Response

- Public health professionals should adopt best practices to incorporate prevention strategies along with consistent emergency management.
- Incorporating prevention along with better emergency management will increase efficiencies, maximize resources, and save lives.
- Evidence-based, cost-effective, and anticipatory – instead of reactive – measures are necessary to prevent Legionnaires’ disease outbreaks.
Steps to Improve Public Health Outcomes

> Given that Legionellae are often found within our building water systems, Health Departments should see the prevention of Legionellae outbreaks as central to their public health missions.

> Recognize that the lack of standards of practice for identifying, responding, and communicating risks results in inconsistent public health outcomes across Health Departments.

> There needs to be better integration between environmental health and disease surveillance in order to create successful prevention and response strategies.
Example: New York State DOH

- Established regulations for the control of *Legionella* and other waterborne pathogens in 2016 as part of NYS Sanitary Code setting for minimum requirements for:
  - Environmental Assessment that capture minimum criteria following standardized template and update requirements based on data/facility changes
  - Creation of a sampling and monitoring plan following detailed guidance
  - Criteria for labs that can report *Legionella* results for regulatory purposes and minimum responses to *Legionella* results
  - Record keeping time frames and materials
Centers for Medicare and Medicaid Services (CMS)

- Conduct a facility risk assessment to identify where *Legionella* and other opportunistic waterborne pathogens (e.g. *Pseudomonas, Acinetobacter, Burkholderia, Stenotrophomonas*, nontuberculous mycobacteria, and fungi) could grow and spread in the facility water system.

- Develops and implements a water management program.

- Specifies testing protocols and acceptable ranges for control measures, and document the results of testing and corrective actions.
Centers for Medicare and Medicaid Services (CMS)

- Water systems
  - Faucet flow-restrictors
  - Showerheads and hoses
  - Centrally-installed misters, atomizers, air washers, and humidifiers
  - Non-steam aerosol-generating humidifiers
  - Eyewash stations
  - Whirlpools/spas
  - Decorative fountains
  - Cooling towers
  - Medical devices (CPAP machines, hydrotherapy equipment, bronchoscopes, heater-cooler units)
Centers for Medicare and Medicaid Services (CMS)

> CMS typically cites problems with *Legionella* water management under Tags A-0747 and A-0749 under the Infection Control Conditions of Participation (CoP), as set out in the State Operations Manual Appendix A of interpretive guidelines for state surveyors.

  • “There must be an active program for the prevention, control, and investigation of infections and *communicable diseases*.”

> Hospitals have also been cited under the CoP for Quality Assurance and Performance Improvement (QAPI), under Tag A-0273, which requires hospitals to have a data collection and analysis program...
Compliance with QSO-17-30

> A hospital in Baltimore was cited for not having an updated water management plan as part of its QAPI program. The WMP was > 7 years old and there was no evidence that the plan was reviewed or updated with 2017 CDC recommendations or 2018 CMS requirements.

- “In addition, in November 2018, the hospital identified an outbreak of a bacterial infection...there is no evidence that the outbreak spurred the hospital to revise its water management plan.”

Compliance with QSO-17-30

> A hospital in Oregon was cited for not having a water management plan at all

- Said the facilities manager: “We haven’t put our water program together yet. It’s a work in progress.”
- A waterborne risk assessment was conducted; however, the hospital had yet to determine what information in it they were going to use (e.g. control measures, monitoring locations)
Compliance with QSO-17-30

A hospital in Florida was cited for failing to maintain an infection control program that minimized the risk of infections:

- Specification of testing protocols and acceptable ranges for control measures, and documentation of the results of testing and corrective actions taken when control limits are not maintained.
- Surveyors reviewed the incidence of pneumonia and associated water pathogens and found "a total of 28 hospital acquired pneumonias."
  - *Pseudomonas* (10 cases)
  - *Acinetobacter* (2)
  - *Burkholderia* (1)
  - *Stenotrophomonas* (4)
  - Nontuberculous mycobacteria (3)
  - *Candida albicans* fungus (4)
  - *Candida parapsilosis* fungus (4)
- The infection preventionist told surveyors the source of the hospital-acquired pneumonias was not identified. **Infections were not reported to facilities leadership.**
The Joint Commission Standards

> Environment of Care
  - Standard EC.01.01.01 – The hospital has a written plan for managing its utility system
  - Standard EC.02.01.01 – The organization manages safety and security risks
  - Standard EC.02.05.01 – The organization manages risks associated with its utility systems
  - Standard EC.02.05.05 – The organization inspects, tests, and maintains utility systems

> Infection Control
  - Standard IC.01.03.01 – The organization identifies risks for acquiring and transmitting infections
  - Standard IC.01.05.01 – The organization has an infection prevention and control plan
  - Standard IC.02.01.01 – The organization implements its infection prevention and control plan
  - Standard IC.03.01.01 – The organization evaluates the effectiveness of its infection prevention and control plan

Healthcare facilities may be cited under any of these standards if a water management program is absent or inadequate
Water Management Programs
World Health Organization

“The most effective means of consistently ensuring the safety of a drinking water supply is through the use of a comprehensive risk assessment and risk management approach that encompasses all steps in water supply”

Standards for Prevention of Disease and Injury

- General guidance documents are simply suggestions for how to approach evaluating and managing hazards in building water systems
- When relying on a general guidance document, there can be no reasonable expectation that risk will be managed consistently across diverse building types and uses
- Effective Standards provide a reasonable level of assurance that the desired outcome will be achieved and can be independently evaluated
- There are no national standards in the market place that provide a reasonable level of assurance that building water management plans are developed and implemented consistently
Specific Actions Must Be Taken

- **Water Management Team:** Name, job title, position/department, contact info, specific responsibilities associated with the program, certifications if any

- **Water System Site Survey:** Types of water systems, system’s operation, condition of the systems, procedures for each system, population exposed to each system
  - Subsequent systems may be necessary due to maintenance, building expansions or renovations
Specific Actions Must Be Taken

> **Process Flow Diagram:** Incoming water source(s), hot and cold water distribution, recirculation pumps, chemical injection points, ice machines, medical devices, fountains, spas, water softeners, flow restrictors, eyewash stations, water storage tanks, water heaters, etc..

> **Hazard Analysis:** Team evaluates each system, including all parts, components, pipe configurations, and zones with hazardous conditions.

  - Use to identify **Control Points**, **Control Measures**, and determine **Critical Limits**
Specific Actions Must Be Taken

> **Monitoring**: Scheduled measurement of physical, chemical, or temporal parameters associated with each control measure.
  > Means, method, frequency, and person responsible are required, along with documentation of all monitoring activities.

> **Corrective Actions**: Written procedure that describes the specific action in detail, who is responsible, response time, reasons for taking C.A., which action was taken with date and time, and outcome (restoration back to within control limits).
Specific Actions Must Be Taken

> **Verification**: Documentation of all monitoring records and results of components of the Program.

> **Validation**: Confirmation that the Program, when implemented as designed, is effectively controlling hazards/hazardous conditions within the System.
Construction and Renovation

> Prior to beginning construction or renovation, CMS and accrediting organizations require facilities to have an ongoing Legionella water management plan and to perform a risk assessment that includes any concerns about infection control.

> The Joint Commission’s Environment of Care standard EC.02.06.05 requires hospitals to manage the environment to reduce risks during renovation and construction.

  > Element of Performance (EP) 2 requires conducting a “preconstruction risk assessment” during planning, which must include an infection control plan.

  > EP 3 requires having a plan to minimize those risks.
Water Management Programs

> Plans and procedures should be developed for all water systems in a building

- Water source(s)
- Domestic cold water
- Domestic hot water
- Tank-type water heaters
- Instantaneous water heaters
- Expansion tanks
- Recirculation pumps
- Softeners

- Filtration
- Supplemental disinfection
- Showers
- Sinks and faucets
- Ice machines
- Irrigation
- Fire suppression
- Decorative fountains
- Emergency showers/eye-wash
Plans and procedures should be developed for **medical devices** that use water in addition to utility systems:

- Dental units
- Water baths
- Fluid warmers and slush machines
- Ultrasonic cleaners
- Splint pans
- Hydrocollators
- Probe disinfectors
- Endoscope reprocessors

- Liquid waste units
- Pre-rinse spray valves
- Sterilizers
- Heater-cooler units
- Hypohyperthermia units
- Humidifiers (heated, incubators)
- Hemodialysis units
- Birth pools
Implementation of Water Management Plans

> “Water management plans” (sometimes 1-2 pages) only include general guidance and suggestions for how to approach evaluating and managing hazards in building water systems

> When the facility only has a general policy document, there can be no reasonable expectation that risk will be managed consistently

> Effective WMPs provide a reasonable level of assurance that the desired outcome will be achieved

> WMPs should be independently evaluated to ensure necessary control measures are carried out consistently and expectations are being met

> Referring back to the WMP and detailed records makes the investigation
Making a Sufficiency Determination

> A water management plan is nothing without verification and validation records

> Verification and validation records are nothing without the water management plan
Preparing for the Environmental Investigation
When to Conduct a Full Investigation

> CDC recommends a full investigation for the source of *Legionella* in a facility upon identification of:
  > ≥ 1 case of definite healthcare-associated Legionnaires’ disease at any time
  > ≥ 2 cases of possible healthcare-associated Legionnaires’ disease at any time

> Use a 12-month timeframe for linking possible healthcare-associated cases with a common site of exposure
  > Increased sensitivity of outbreak detection
  > Accounts for periodic changes in risk (e.g. seasonality)
  > Cooling towers should have a shorter timeframe

> Information should include date of symptoms onset, travel history, history of exposure to high risk sources, risk factors, exposure dates, occupation, and place of residence of attendance at a facility or institution
Preparing for the Environmental Investigation

**Preparation**
- Review cases in the health department surveillance database to identify earlier cases with possible exposure to the healthcare facility
- Develop a line list of possible and definite cases ever associated with the facility
- Work with healthcare facility staff to identify all new and recent patients with healthcare-associated pneumonia and test for Legionella using both culture of lower respiratory specimens and the Legionella urinary antigen test
- Obtain post-mortem specimens, when applicable
- Consider recommendations for restricting water exposures or immediate control measures

**Investigation**
- Conduct the environmental assessment
  - Take environmental samples based on the assessment
  - Make recommendations for remediation of possible environmental sources

**Follow-up**
- Develop a risk communication plan
- Determine how long heightened surveillance and sampling should continue
- Work with facility staff to review and revise the water management program
- Subtype and compare clinical and environmental isolates
- Follow up to assess the effectiveness of implemented control measures
Who’s Involved

> Public health
  > District Epidemiologist – single point of contact for communication
  > State *Legionella* coordinator, if any
  > Testing laboratory
  > Health department inspectors

> Healthcare facility
  > Infection control manager – single point of contact for communication
  > Water management team
  > Facilities management
  > Medical microbiologist
  > Clinical engineering
  > Environmental health
  > Case patient or proxy
Preparing for the Environmental Investigation

Reporting Cases

> Case surveillance
  > National Notifiable Diseases Surveillance System (NNDSS): basic demographic info
  > Supplemental Legionnaires’ Disease Surveillance Systems (SLDSS): exposure history, method of diagnosis; allows for reporting of healthcare facilities

> Outbreak surveillance
  > Public health officials should report outbreaks through the Waterborne Disease Outbreak Surveillance System of the National Outbreak Reporting System (NORS)
Clinical Investigation

> Contact the case patient or proxy within 7 days of the report

> Interview regarding overnight stays, pool and spa use, treatments received, occupation
Organizing the Walkthrough
Goals of the environmental assessment

> Determine the most likely source of an outbreak
> Gather all supporting documentation that is available such as water quality monitoring, *Legionella* sample results, maintenance and cleaning records, and vendor reports
> Identify potential critical control points
Identifying critical control points after an outbreak requires a detailed understanding of the building water systems. The environmental assessment helps to identify those sites.

Facility areas to review

- Locations where aerosols can be created such as showers and taps, decorative fountains, whirlpools spas, cooling towers, humidifiers
- Areas that contain water at temperatures 68 °F – 122 °F
- Stagnant water, dead legs, poor water flow
- Infrequently used outlets or fixtures
- Construction, renovation, or maintenance sites that may have disrupted the water system or required water flow to be stopped and started again
Questions to Ask On-site

- Does the facility have a water management program? Last update?
- Are there any areas of tepid water temperatures? (Ask for temperature monitoring records)
- Are there any points of stagnation and low flow? (Where are the areas that are infrequently used?)
- Is the release of water spray controlled? (Ask about aerosolization devices)
- Are there areas of accumulated sediment in the system?
- Are medical devices and outlets disinfected to control biofilm formation?
- Is it possible for cooling tower emissions to be drawn into the building air intakes?
- Are there risks associated with thermal flushing (aerosols, scalding), restarting the water system (dislodging of biofilm due to water pressure), construction (dislodging of biofilm due to vibration)?
- What types of water treatment is utilized, if any (e.g. thermal disinfection, copper-silver ionization, ultraviolet radiation, ozone, chlorine, monochloramine, chlorine dioxide, hydrogen peroxide, POU filters)?
ORGANIZING THE WALKTHROUGH

CDC Environmental Assessment Form

BEFORE ARRIVING ON SITE

- Request the attendance of the lead facility manager as well as others who have a detailed knowledge of the facility’s water systems, such as a facility engineer or industrial hygienist.
- Request that they have maintenance logs and blueprints available for the meeting.
- Bring a plastic bottle, thermometer, pH test kit, and a chlorine test kit that can detect a wide range of residual disinfectant (<1 ppm for potable water and up to 10 ppm for whirlpool spas).
- If the epidemiologic information available suggests a particular source (e.g., whirlpool spa, cooling tower), request that they shut it down (but do not drain or disinfect) in order to stop transmission.
**CDC Environmental Assessment Form**

**LEGIONELLA ENVIRONMENTAL ASSESSMENT FORM**

*Persons completing the assessment:*

Name: ___________________________  Job Title: ___________________________  Organization: ___________________________

Telephone: ___________________________  E-mail: ___________________________

Name: ___________________________  Job Title: ___________________________  Organization: ___________________________

Telephone: ___________________________  E-mail: ___________________________

*Assessment details:*

Facility Name: ___________________________  Date of Assessment: ___________________________

Facility Address:

street  city  state  zip

*Person(s) interviewed during assessment:*

Name: ___________________________  Job Title: ___________________________

Name: ___________________________  Job Title: ___________________________

Name: ___________________________  Job Title: ___________________________
## CDC Environmental Assessment Form

### Facility Characteristics

1. Is this a healthcare facility or senior living facility with skilled nursing care (e.g., hospital, long term care/rehab/assisted living/skilled nursing facility, or clinic)?
   - **YES** ➔ If yes, skip to Q.3 & also complete Appendix A.
   - **NO**

2. If NO, indicate type of facility (check all that apply):
   - ☐ Senior living facility (e.g., retirement home without skilled nursing care)
   - ☐ Other residential building (e.g., apartment, condominium)
   - ☐ Hotel, motel, or resort
   - ☐ Recreational facility (e.g., health club, water park)
   - ☐ Office building
   - ☐ Manufacturing facility
   - ☐ Restaurant
   - ☐ Other __________________________

3. Total number of buildings on campus: __________ Total number of buildings being assessed: __________

4. Total number of rooms that can be occupied overnight (e.g., patient rooms, hotel rooms): __________

5. Does occupancy vary throughout the year?  ☐ YES  ☐ NO
   - If YES, seasons with lowest occupancy (check all that apply):
     - ☐ Winter  ☐ Spring  ☐ Summer  ☐ Fall

6. Are any occupant rooms taken out of service during specific parts of the year, e.g., low season?
   - **YES**  ☐ NO
   - If YES, which rooms?
CDC Environmental Assessment Form

7. Average length of stay for occupants (check one):
   ☐ 1 night ☐ 2-3 nights ☐ 4-7 nights ☐ >7 nights

8. Does the facility have emergency water systems (e.g., fire sprinklers, safety showers, eye wash stations)?
   ☐ YES ☐ NO
   If YES, are these systems regularly tested (i.e., sprinkler head flow tests)? ☐ YES ☐ NO
   If YES, how often and when was the last test? ____________________________

9. Are there any cooling towers or evaporative condensers on the facility premises?
   ☐ YES ➔ If yes, also complete Appendix B.
   ☐ NO

10. Are there any whirlpool spas, hot tubs, or hydrotherapy spas on the facility premises?
    ☐ YES ➔ If yes, also complete Appendix C.
    ☐ NO

11. Are there any decorative fountains, misters, water features, etc. on the facility premises?
    ☐ YES ➔ If yes, also complete Section D.
    ☐ NO
Organizing the Walkthrough

**CDC Environmental Assessment Form**

12. Does the facility have centralized humidification (e.g., on air-handling units) or any room humidifiers?
   - [ ] YES  [ ] NO
   - If YES, describe their location and operation: __________________________________________

13. Has there been any recent (last 6 months) or ongoing major construction on or around the facility premises?
   - [ ] YES → If yes, also complete Appendix E.
   - [ ] NO

14. Has this facility been associated with a previous legionellosis cluster or outbreak?
   - [ ] YES  [ ] NO
   - If YES, please describe number of cases, dates, source if found, and any interventions (immediate and long-term) to prevent recurrence: __________________________________________

15. Does the facility have a water safety plan or *Legionella* prevention program?
   - [ ] YES  [ ] NO
   - If YES, does the facility ever test for *Legionella* in water samples?
     - [ ] YES → If yes, obtain copies of results  [ ] NO
   - If YES, please describe the plan briefly here (does it include clinical disease surveillance and/or environmental *Legionella* surveillance?) and **obtain a written copy** of the program policy:


# CDC Environmental Assessment Form

16. Describe each building that shares water or air systems, including the main facility

<table>
<thead>
<tr>
<th>Building Name (List main facility building first)</th>
<th>Original Construction</th>
<th>Later Construction (renovation, expansion)</th>
<th>Stories or Levels</th>
<th>Occupancy rate (%)</th>
<th>Daily Census (yr. avg.)</th>
<th>Use (List all types of uses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year Completed</td>
<td>From/To or “N/A”</td>
<td>#</td>
<td>Rate (%) or “N/A”</td>
<td>#/day or “N/A”</td>
<td>e.g., occupant rooms, utilities, heating/AC plant</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>For healthcare, specify:</td>
<td>Outpatient = O</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inpatient (acute) = I</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Chronic = C</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Intensive care = ICU</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Transplant = Tx</td>
<td></td>
</tr>
</tbody>
</table>

*[occupancy rate = (# room occupied overnight/total # rooms) X 100]*
Organizing the Walkthrough

CDC Environmental Assessment Form

Water Supply Source

17. What is the source of the water used by the facility? (Check all that apply)
   
   - Municipal water if YES:
     Name of supplier ________________________________
     How is the municipal water disinfected? (Check one)  ☐ Chlorine  ☐ Monochloramine  ☐ Other ________
     Has treatment of municipal water changed in the past year?  ☐ YES  ☐ NO
     If YES, specify ________________________________
   
   - Non-municipal well if YES:
     How is the well water disinfected? (Check one)  ☐ Chlorine  ☐ Other ________  ☐ Not disinfected
     Is the water filtered onsite?  ☐ YES  ☐ NO
   
   - Other ________________________________

18. Have there been any pressure drops, boil water advisories, or water disruptions (e.g., water main break) to the facility in the past 6 months?  ☐ YES  ☐ NO
   If YES, describe what happened and which buildings or parts of buildings were affected: ________________________________

19. Does the facility monitor incoming water parameters (e.g., residual disinfectant, temperature, pH)?
   
   - YES → If yes, obtain copies of the logs  ☐ NO
   If YES, what is the range of disinfectant residual, temperature, and pH entering the facility? ________________________________
Organizing the Walkthrough

CDC Environmental Assessment Form

Premise Plumbing System

Note: It is important to gain an understanding of where and how water flows, starting where it enters the facility and including its distribution to and through buildings to the points of use. Understand water processes, including but not limited to: heating, storage, filtration, UV irradiation, and addition of secondary disinfectants. Refer to a facility map and blueprints; obtain copies of these and/or draw a diagram and include with the completed assessment.

20. Are cisterns and/or water storage holding tanks used to store potable water before it’s heated?
   - YES  
   - NO

21. Is there a recirculation system (a system in which water flows continuously through the piping to ensure constant hot water to all endpoints) for the hot water?
   - YES  
   - NO
   If YES, please describe where it runs and delivery/return temperatures if they are measured: ______________________________
   ______________________________
   ______________________________

22. Are thermostatic mixing valves used?
   - YES  
   - NO
   If YES, describe where they are located (ideally, mixing valves are close to the point of use): ______________________________
   ______________________________
   ______________________________
### CDC Environmental Assessment Form

23. How is the hot water system configured to deliver hot water to each building?

<table>
<thead>
<tr>
<th>Building name</th>
<th>Type of system (e.g., instantaneous heater, hot water heater with a storage tank, solar heating)</th>
<th>Name of system (e.g., Boiler #1, Loop #1)</th>
<th>Areas served (e.g., floor, rooms)</th>
<th>Date of installation</th>
<th>Total capacity (gallons)</th>
<th>Usual temperature setting (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CDC Environmental Assessment Form

24. What is the maximum **hot** water temperature at the point of delivery permitted by state / local regulations?
   
   _______ °F  or  _______ °C

25. Are **hot** water temperatures ever measured by the facility at the points of use?
   
   ☐ YES  ➔ If yes, obtain copies of the temperature logs
   
   If YES, what is the **lowest** documented **hot** water temperature measured at any point within the facility?
   
   _______ °F  or  _______ °C  documented on (Month/Date/Year) ______/______/______
   
   ☐ NO

26. Are **cold** water temperatures ever measured by the facility at the points of use?
   
   ☐ YES  ➔ If yes, obtain copies of the temperature logs
   
   If YES, what is the **highest** documented **cold** water temperature measured at any point within the facility?
   
   _______ °F  or  _______ °C  documented on (Month/Date/Year) ______/______/______
   
   ☐ NO
CDC Environmental Assessment Form

24. What is the maximum hot water temperature at the point of delivery permitted by state / local regulations?
   _______ °F or _______ °C

25. Are hot water temperatures ever measured by the facility at the points of use?
   - YES ➔ If yes, obtain copies of the temperature logs
     If YES, what is the lowest documented hot water temperature measured at any point within the facility?
     _______ °F or _______ °C documented on (Month/Date/Year) _______/______/_____
   - NO

26. Are cold water temperatures ever measured by the facility at the points of use?
   - YES ➔ If yes, obtain copies of the temperature logs
     If YES, what is the highest documented cold water temperature measured at any point within the facility?
     _______ °F or _______ °C documented on (Month/Date/Year) _______/______/_____
   - NO
## CDC Environmental Assessment Form

27. Are the potable water disinfectant levels (e.g., chlorine) ever measured by the facility at the points of use?

- [ ] YES ➔ If yes, obtain copies of the logs
  - If YES, how often are they measured?
  - If YES, list the range of disinfectant residuals
- [ ] NO

28. Does the facility have a supplemental disinfection system for long term control of *Legionella* or other microorganisms?

- [ ] YES  
- [ ] NO

If YES, obtain SOPs for routine use and maintenance as well as maintenance logs and records of disinfection levels, and complete the table:

| Buildings with supplemental disinfection | Type of system (e.g., chlorine, chlorine dioxide, copper-silver) | Date installed | Describe any maintenance in the past year (include routine and emergency) |
Organizing the Walkthrough

**CDC Environmental Assessment Form**

29. Please describe any maintenance (either routine or emergency) carried out on the potable water system in the past year. Obtain records/SOPs if available.

<table>
<thead>
<tr>
<th>Copy from table for question 23 (p. 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building name</td>
</tr>
<tr>
<td>----------------</td>
</tr>
</tbody>
</table>

30. Measured Water System Parameters (see instructions on p. 1)
CDC Environmental Assessment Form

APPENDIX A. HEALTHCARE FACILITIES

Note: Complete for all healthcare facilities, including but not limited to hospitals, long term care/rehab/assisted living/skilled nursing facilities, or clinics.

1. Type of healthcare facility (check all that apply):
   - [ ] Acute care hospital
     - If YES, does the facility have a solid organ or bone marrow transplant program?
       - [ ] YES   [ ] NO
   - [ ] Long term care facility (i.e., nursing home, long term acute care)
   - [ ] Rehabilitation facility or other skilled nursing care
   - [ ] Assisted living facility
   - [ ] Outpatient surgical center
   - [ ] Other outpatient clinic (describe): _______________________________________
   - [ ] Other healthcare facility (describe): _______________________________________
CDC Environmental Assessment Form

2. Number of beds: ____________

3. Are ice machines used to provide ice for patient consumption or processing medical equipment?
   - YES  - NO
   If YES, list manufacturer and model or catalog number: ____________________________________________

4. Has this facility experienced previous Legionnaires’ disease cases that were “possibly” or “definitely” facility-acquired?
   - YES  - NO
   If YES, describe (e.g., number of cases, dates): ________________________________________________
Environmental assessments may not identify all critical control points.

Some jurisdictions will require a third-party vendor to conduct a technical assessment of the facility and to develop a sampling plan.
Organizing the Walkthrough

Water Restrictions

> Restriction to areas of aerosolization especially for high-risk patients
  - Showers
  - Drinking fountains
  - Ice machines
  - Decorative fountains
  - High-powered spray hoses
  - Whirlpool/spas

> Restriction from drinking, brushing teeth with tap water, flushing nasogastric tubes or preparing medications with tap water, consuming ice from ice machines – use bottled water

> The potable water supply should not be turned off
Tracing Systems
Identifying Risk Factors
Premise Plumbing

Definition
• Water intended for human consumption, including domestic hot and cold water for drinking, bathing, showering, cooking, dishwashing, and maintaining oral hygiene.

Types of water use
• Water distribution
• Cold (drinking, handwashing, cleaning)
• Hot (food preparation, handwashing, cleaning, bathing)
• Recirculation
• Filtration
• Storage

Exposure risk
• Drinking
• Inhalation
• Aspiration
• Skin contact
Premise plumbing

> Hazards
  - Chemical
    - Lead
    - Disinfection by-products (e.g. trihalomethanes)
  - Physical
    - Water that can cause scalding
  - Microbial
    - Legionella
    - Pseudomonas
    - NTM (e.g. M. abscessus)
    - Protozoa
    - Naeglaeria

> Hazardous conditions
  - Sediment/solid buildup in low-flow areas
  - Low water temperatures in the distribution system (bacterial growth)
  - High temperatures from the outlets (scalding)
  - Water age due to low-flow fixtures, inconsistent turnover
  - Disinfectant residual too high or too low
  - Materials may be incompatible with the disinfectant chemical
  - Quality of water entering the building contaminated
  - Cross-connections can cause ingress of contaminants
  - Over-softening water causing corrosion
  - Filters/filter media not maintained or changed regularly
Control measures

- Premise plumbing
  - Flushing
  - Maintaining safe and effective disinfectant residuals
  - Establishing safe temperature controls
  - Backflow devices to prevent cross-connections
Green Hospitals

> What are the “green” strategies in the facility?
  • Collection and storage of water for on-site use
  • Low flow taps

> Every fixture point is a potential dead leg if it is not used

> How is temperature managed in the facility?
  • Are TMVs with remote monitoring installed to reduce the risk of scalding?
Cooling tower systems

Cooling tower systems

> Hazardous conditions
- Sediment buildup in the basin
- Algae growth in the tower
- Corrosion in the tower or heat exchanger
- Uneven flow distribution
- Scale on the fill material
- Temperatures conducive to bacterial growth
- Stagnant water in piping
- Inadequately maintained equipment
- Lack of regular cleaning
Cooling tower systems

> Control measures
  • Routine water treatment
  • Routine maintenance of pH levels
  • Routine corrosion control
  • Routine scale and deposits control
  • Routine management of cycles of concentration based on conductivity
  • Others
Cooling tower systems

> Monitoring

- Temperature sensor
- pH meter (automated, on line)
- Measure residual concentration of biocide (manual or automated, on line)
- Flow meters (make-up and blow down lines)
- Conductivity meter
- Others
Ice machines

> Hazards
  • *Legionella* and biofilm associated pathogens

> Hazardous conditions
  • Location in small, warm rooms (temperature fluctuation)
  • Excessive water piping (water age)
  • Warm condenser coil
  • Filter saturation
  • Lack of regular cleaning/sanitization
Control measures

> Ice machines

- Adequate ventilation and space
- Small micron (0.2 µm) filters on the machine to remove excess disinfectant
- Do not give ice to at-risk people
- Clean and disinfect wetted surfaces every 3-6 months
**Bathrooms**

- Is the cold water supply in series with the water closet connected to the final fixture?
- Are water closets piped separately from the sink and shower?
- Are filters installed on sinks?
- How frequently are faucets used?
- How are terminal devices cleaned (e.g. sink aerators, showerheads, misters, nozzles)?
- Laminar water flow out of the tap?
Sinks

- Are sinks in handwashing stations designed with deep basins to prevent splashing to places where patient care is performed?
- Are atmospheric vacuum breakers installed for hose bibs and sinks with threaded outlets, handheld showers, hydrotherapy?
  - Installed to prevent backflow of
    - non-potable liquids into the drinking water system
Showers for patient and staff use

> Are showerheads removed, cleaned, and disinfected on a regular basis?
> Are hoses either restricted or hung straight down?
Decorative fountains and indoor water features

> Hazards
  - Bacteria in pools < 1 m deep
  - Even clear water untreated can cause *Legionella* growth

> Hazardous conditions
  - Materials scrubbed from the air and returned with falling water droplets
  - Water age due to intermittent use
  - Higher outdoor temperatures facilitated by pumps/filters
  - Equipment and submerged lighting may raise temperature
  - Scale deposits
  - Fountains in patient care areas
  - Non-distilled makeup water
Control measures

> Decorative water fountains
  • Chemical disinfection
  • Filtration
  • Removal of algae
  • Maintain temperature below 65 °F (use of remote lights)
  • Copper, brass, stainless less conducive to biofilm
  • Softeners, RO, pH control to control scale
  • Run fountains min 6 hr/day to minimize biofilm
Medical devices/medical engineering - Breaking down the systems and their risk profiles
Medical Devices that Use Water

> All procedures developed for the management of medical devices MUST follow the manufacturer’s requirements

> Required procedures
  • Initial start-up
  • Shut down
  • Cleaning and disinfection
  • Inspection
  • Routine Maintenance
  • Testing
Medical Devices that Use Water

- Birth pools
- Dental units
- Endoscopy reprocessors
- Heater-cooler units
- Hemodialysis units
- Humidifiers (heated, incubator)
- Hypohyperthermia units
- Medical Ventilators
- Sterilizers
- Ultrasonic cleaners
Birthing Pools

Types of birthing pools at healthcare facilities may include single-use pools and spas-in-a-box.

Birthing pools may be filled with tap water up to 98.6 °F and then disposed of after use.

Risk

- 2016: 2 legionellosis cases in infants in Arizona

Hazardous conditions

- Water stagnation
- Low disinfectant residual
- Biofilm growth
- Intermittent use
- Water temperatures causing scalding
- Aerosol generation from jets

What to ask for

- Type of pools
  - Portable pools with liners and single-use pools are recommended
  - Pools with piped recirculating water systems that have heaters, jets, or overflow drains that cannot be easily cleaned may harbor biofilm
- Start-up procedures and records
- Cleaning and draining procedures and records after each use
- Inspection procedures and records
- Education and training of midwives
Dental Units

> Used for surgical and non-surgical procedures
> Supply water, air, and electrical power to the attached dental instruments
> Water supplied by potable water or a closed bottled water system
> Waterlines may allow for biofilm development due to the presence of long narrow-bore tubing, inconsistent flow rates, and retraction of oral fluids

> Hazardous conditions
  • Water stagnation
  • Biofilm in waterlines
  • Cross contamination
  • Aerosolization
  • Low halogen levels

> What to ask for
  • Inspection procedures and records
  • Cleaning and disinfection procedures and records
  • Flushing/drainage procedures and records
  • HPC testing records
Heater-cooler Units

- Includes tanks that provide temperature-controlled water to external heat exchangers or warming/cooling blankets
- Aerosol dispersion of NTM in the OR over a patient’s open surgical cavity

> Hazardous conditions
  - Water stagnation
  - Contaminated tubing and components
  - Aerosolization
  - Air or water filters installed incorrectly

> What to ask for
  - Inspection procedures and records
  - Start-up and shutdown procedures including filling with sterile water
  - Cleaning and disinfection procedures and records
  - HPC and NTM sampling records
  - Preventative maintenance procedures
Hemodialysis Units

- Used for continuous fluid management and therapeutic plasma exchange
- Indirect systems constantly circulate water through pretreatment/treatment even when machines are not in use
- Direct systems are one-way and when the machines are off, the water is stagnant

Hazardous conditions
- Bacterial contamination of tubing and basin
- Intermittent use
- Water stagnation
- Contaminated water source

What to ask for
- Water source (patients can be exposed to 300-600 L water per week)
- Testing procedures and records consistent with AAMI 2011 (or later) recommendations
- Dialysis system disinfection procedures and records
- RO distribution disinfection procedures and records
- Portable RO disinfection procedures and records
- Bacterial and endotoxin testing procedures and records
Humidifiers

- Either hospital provided or patient provided
- Patients should be educated on the proper use of the machine
- Intermittently used humidifiers can become contaminated with bacteria or deposits

- Hazardous conditions
  - Contamination
  - Intermittent use
  - Water stagnation
  - Aerosol generation

- What to ask for
  - Type of water used
  - Cleaning and disinfection procedures and records
  - Tubing replacement/cleaning procedures and records
  - Inspection and testing procedures and records
Incubator Humidifiers

- Infants at a high risk of contracting Legionnaires’ disease
- Humidifiers should be rinsed thoroughly and dried prior to next patient use
- Tubing may be used multiple times, but discarded prior to next patient’s use

Hazardous conditions
- Contamination
- Intermittent use
- Water stagnation
- Aerosol generation

What to ask for
- Type of water used
- Cleaning and disinfection procedures and records
- Tubing replacement/cleaning procedures and records
- Inspection and testing procedures and records
- Use frequency
Hypohyperthermia Units

> Regulating patient temperature by supplying temperature-controlled water through a connector hose to a blanket

> Stagnation is possible in the machine, the blanket, connector hose, and other components

> Hazardous conditions
  • Water stagnation
  • Contamination
  • Intermittent use
  • Biofilm growth in tubing

> What to ask for
  • Inspection procedures and records
  • Draining records
  • Cleaning and disinfection procedures and records
  • Replacement procedures and records
Medical Ventilators

> Used for surgical and non-surgical procedures
> Supply water, air, and electrical power to the attached dental instruments
> Water supplied by potable water or a closed bottled water system
> Waterlines may allow for biofilm development due to the presence of long narrow-bore tubing, inconsistent flow rates, and retraction of oral fluids

> Hazardous conditions
  • Water stagnation
  • Biofilm in waterlines
  • Cross contamination
  • Aerosolization
  • Low halogen levels

> What to ask for
  • Inspection procedures and records
  • Cleaning and disinfection procedures and records
  • Flushing/drainage procedures and records
  • HPC testing records
High Risk Environments

- Protective environments/transplant units – patients who have received HSCT or solid organ transplant are at highest risk for acquiring and dying from Legionnaires’ disease
  - Culture for *Legionella* spp. in potable water samples from transplant units at least quarterly
  - If *Legionella* spp. are determined to be present in the water supply
    - Decontaminate the water supply
    - Remove aerators from patient care areas
    - Restrict patients on the unit from taking showers
    - Provide patients with sterile water for tooth brushing, drinking, flushing nasogastric tubing
    - Notify patients on the need and rationale for the water restriction on the unit
When to use sterile water

- Rinsing nebulization devices and other semi-critical respiratory care equipment after they have been cleaned and disinfected
- Filling reservoirs of nebulizers
- Rinsing and filling humidifiers, especially large volume room-air humidifiers

Tap water should NEVER be used for rinsing semi-critical respiratory devices or filling reservoirs of respiratory equipment or devices that create aerosols due to the risk of exposing patients to waterborne organisms
Prevention

- Sterile water principles apply to respiratory equipment brought in by the patient
  - Document all of the following
  - Use of the device was recommended by the patient’s clinician
  - Use of the device was cleared by the designated person
  - Education of the use of the device occurred
  - Adequate supplies of sterile water are in the patient room for use
  - Daily cleaning and processing verification
Sampling Strategies
Performing surveillance

> Definitions
  - **Community-associated Legionnaires’ disease**
    - Patients were in the community for the entire incubation period of 2 to 10 days and presented with onset of illness within 48 hrs of admission
  - **Possible healthcare facility-associated Legionnaires’ disease**
    - Patients were not in the facility during the entire incubation period
  - **Definite healthcare facility-associated Legionnaires’ disease**
    - Patients were in the facility for the entire incubation period

> All cases of community-associated and healthcare facility-associated Legionnaires’ disease should be reported to the public health authority within 24 hrs of diagnosis
Performing surveillance

> Ensure the availability of laboratory tests for *Legionella* (i.e. culture and urinary antigen)

> Identify possible facility-associated cases of Legionnaires’ disease. **ALL** patients who are at greatest risk or moderately increased risk for acquiring Legionnaires’ disease should be tested for *Legionella* if they develop a facility-associated pneumonia

> Educate all clinicians to perform testing for *Legionella* for all patients who develop a facility-associated pneumonia or culture all respiratory specimens that are received by the laboratory

> Educate the facility on the prevention of *Legionella* and encourage them to use a water management plan

> **By organism**
  - Gram negative bacteria
  - *Mycobacteria*
  - *Legionella*
  - Protozoa

> **By device**
  - Endoscopes
  - Ventilators
  - Fountains
  - Showers

Environmental Sampling - When? How?

> Based on the environmental risk assessment and locations implicated by the epidemiological investigation, sampling sites can be selected on a priority basis.

> Sampling points should be continually reassessed as the investigation progresses and more results are collected.
Considerations on Legionella Testing

> To be comprehensive, a *Legionella* analysis should contain at least the following parameters:
  > *Legionella pneumophila* serogroup 1 identification and count
  > *Legionella pneumophila* sg 2-14 identification and count
  > *Legionella spp.* count
  > Total viable count

> The method used by the laboratory should follow ISO 11731 and be accredited to the CDC *Environmental* Legionella *Isolation Techniques Evaluation* (ELITE) program
**Sampling Materials**

- Sterile plastic 1L bottles
- Sterile plastic 15 mL screw top tubes for biofilm swabs
- Disposable non-cotton swabs with wooden or plastic stems
- Labels
- 0.1N sodium thiosulfate (if not already contained in bottles)
- Pipettes and bulbs for adding sodium thiosulfate into samples
- Sterile plastic 0.5-1L bottle for testing chlorine, pH, temperature
- pH and chlorine test kits
- Thermometer
- Sample data sheet
- Large cooler that fits multiple 1L bottles
### Possible sources and sampling sites for Legionella in potable water systems

<table>
<thead>
<tr>
<th>Sample sites</th>
<th>Type of sample</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incoming water main</td>
<td>Bulk water</td>
<td>When the temp is &gt; 20 °C; high organic content; high HBC count</td>
</tr>
<tr>
<td>Well/water tower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water heater</td>
<td>Bulk water, biofilm swab if drained</td>
<td>Taken from the drain valve, or swabs after draining the tank</td>
</tr>
<tr>
<td>Water softener</td>
<td>Bulk water</td>
<td>Before and immediately downstream of the softener</td>
</tr>
<tr>
<td>Expansion tank</td>
<td>Bulk water</td>
<td>Sampling at the bottom of the vessel</td>
</tr>
<tr>
<td>Shower and faucets</td>
<td>Bulk water, biofilm swab of shower head or inside of faucet (aerator)</td>
<td>Pre-flush samples of hot and cold water (represents water held within the tap and should be taken when the tap has not been used for several hours) Facilities should remove the shower head and aerators prior to sampling to minimize aerosol production, and to aid the inspection and sampling of biofilm inside the showerhead or aerator Post-flush samples should be taken to assess the degree of contamination within the pipework</td>
</tr>
</tbody>
</table>
### Possible sources and sampling sites for Legionella in whirlpool spas

<table>
<thead>
<tr>
<th>Sample sites</th>
<th>Type of sample</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water in the pool</td>
<td>Bulk water</td>
<td>Solid material samples and biofilm samples tend to have large numbers of Lp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the pool is drained, a sample can be collected from the overflow tank</td>
</tr>
<tr>
<td>Biofilm above the water line</td>
<td>Biofilm swabs</td>
<td>Areas above the water line may not be subject to disinfection</td>
</tr>
<tr>
<td>Water jets</td>
<td>Biofilm swabs</td>
<td>Several jets should be swabbed including the inner pipe</td>
</tr>
<tr>
<td>Filter</td>
<td>Solid material</td>
<td>Even if the pool is drained, filter material can contain Lp</td>
</tr>
</tbody>
</table>
## Possible sources and sampling sites for Legionella in other water sources

<table>
<thead>
<tr>
<th>Source</th>
<th>Sample sites</th>
<th>Type of sample</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decorative fountains</strong></td>
<td>Fountain reservoir</td>
<td>Bulk water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fountain trough</td>
<td>Biofilm swab</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Underwater lighting</td>
<td>Biofilm swab</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Decorative material such as foam stones</td>
<td>Solid material</td>
<td></td>
</tr>
<tr>
<td><strong>Sprinkler system</strong></td>
<td>Sprinkler jets</td>
<td>Bulk water and biofilm</td>
<td>Stagnant water</td>
</tr>
<tr>
<td><strong>Safety shower and eyewash stations</strong></td>
<td>Shower and eye wash</td>
<td>Bulk water and biofilm</td>
<td>Stagnant water</td>
</tr>
<tr>
<td><strong>Nebulizers, breathing ventilators</strong></td>
<td>Water used for cleaning</td>
<td>Bulk water and biofilm</td>
<td>At least once biofilm swab of moist surface</td>
</tr>
</tbody>
</table>
Water samples vs swabs

> Swabs should be taken in conjunction with water samples from cooling tower sumps, potable water faucets, hoses, showerheads, and whirlpool spa filters

> However, water cultures are better at detecting *Legionella* compared with swab cultures
Clinical surveillance

> Test clinically compatible patients by both urine antigen test and respiratory specimen culture as early as possible

> Urinary antigen test
  • Does not rule out Legionellosis
  • Only detected *Legionella pneumophila* Serogroup 1
  • PCR recommended if UAT results are negative but LD is still suspected
    • Identifies *Legionella pneumophila* and detects all *Legionella* species

> Lower respiratory specimens
  • Outbreak investigations and management require more precise characterization of the bacteria in order to identify the outbreak source
  • Genetic matching of lower respiratory specimens (e.g. sputum, bronchoalveolar lavage) and positive environmental samples can identify the area of exposure
Finding Common Environmental Sources

> Although serotyping can be conducted through culture testing, levels of *Legionella* can fluctuate over time. The time difference between an outbreak becoming evident and samples taken may make it difficult to interpret results.

> Other challenges:
  * *Legionella* can hide within protozoa and culture methods can produce false negative results
  * High levels of other microorganisms
  * Viable not not-culturable (VBNC) states
  * Missing the source during the investigation
  * Samples taken from a source that was just disinfected
Following up with the facility

> It is not necessary to await the results of sampling before undertaking control measures, particularly if inadequacies have been found in the management of potable water systems, medical equipment, or cooling towers

> Prompt implementation of control measures and monitoring of their effectiveness should be confirmed

> Ongoing control measures and remedial actions should be documented and a sampling schedule is in place to monitor water quality parameters
Conclusion of Investigation

> No new cases of Legionellosis for at least 6 months from last associated case
> Remediation has been conducted, if any, and proper follow-up testing is complete without additional positive results
> A water management program has been implemented and/or updated, and it has been submitted for public health approval
Outbreak Investigation Exercises
Scenario 1: Large hospital in New York

> The state health department was notified by a local health department about two confirmed cases of Legionnaires’ disease in a major hospital in Buffalo, New York.

> A 65-year old male patient was admitted to cardiology, who received aerosolized treatment with a nebulizer during hospitalization. Initial improvement was followed by labored breathing and severe chest pain.

> Chest x-ray was performed. Urinary antigen test was positive for *Legionella pneumophila* serogroup 1.

> A second LD case was identified in the same hospital 1 week later. The patient was admitted to the cardiology ward for 10 days. He also received oxygen through a nebulizer.
Scenario 1: Large hospital in New York

> The hospital is 11-floors, 650-bed capacity with a five cell cooling tower. Occupancy ranges from 60-90%. The hospital recently underwent renovations for ambiance and water conservation.

> The hospital uses a number of medical devices including humidifiers, hemodialysis devices, and nebulizers.
Scenario 1: Large hospital in New York

- The hospital is 11-floors, 650-bed capacity with a five cell cooling tower. Occupancy ranges from 60-90%. The hospital recently underwent renovations for ambiance and water conservation.

- The hospital uses a number of medical devices including humidifiers, hemodialysis devices, and nebulizers.
Scenario 1: Large hospital in New York

> Should an environmental investigation be performed?
> Yes, CDC recommends a full investigation for the source of Legionella in a facility upon identification of ≥ 1 case of definite healthcare-associated Legionnaires’ disease at any time
Who Needs to Be Included on the Environmental Investigation?

> Building Manager/Administrator
> Building Engineer/Maintenance
> Biomedical/clinical engineering
> Infection Prevention
> Nursing
> Water Treatment Professional
> Others
Scenario 1: Large hospital in New York

> Staff from the local health department meet with the hospital IP to review medical records and interview patients.

> What questions should be asked of the case?
  
  • Date of symptoms onset
  • Travel history
  • History of exposure to high risk sources
  • Risk factors
  • Exposure dates
  • Occupation
  • Place of residence of attendance at a facility or institution
Outbreak Investigation Exercises

**Process Flow Diagram**

What water systems are missing?
Critical Control Points

> Receiving
  - Water Service Disruption
    - Water main breaks are infrequent
  - Incoming Chemical Residual
    - Disinfectant – Chlorine
    - Level – 0.2 mg/L in all samples measured
  - Fire Suppression
    - Backflow device – 10’ from main
  - Policy for filling nebulizers with sterile water

Mechanical room temp ≥ 30°C/86°F
Cold Water Distribution

- Ice Machines
  - Ice machines used in patient care units
  - Ice chips given to patients
  - All have carbon-block filters to remove chlorine

- Sinks
  - Policy states that “ALL sink faucets shall be flushed at least weekly”

- Long stagnant line in the cardiology wing

- Showers with hand-held wands
  - Low-flow for water savings
  - Corrosion and scale on the showerheads

- Hydrotherapy tubs
  - Intermittently used
**Heating**

- **Water Heaters (1st floor, 11th floor)**
  - Gas fired
  - Temperature set at 49°C/120°F
  - Recirculation return temperature ≤ 40°C/104°F

- **Hot Water Storage**
  - Sized for maximum occupancy

- Instantaneous water heaters on floors 4, 6, and 2nd floor kitchen
Hot water distribution

> Showers
  • Some 2nd floor showers register ≥ 57°C/135°F
  • Floors 4, 6 stating temperatures not hot enough

> Sinks (Floor 6)
  • Only used during high occupancy
  • Recent renovations have been implemented
Review of records

> Corrective actions

> Verification
  - Flushing records
    - No records to confirm flushing is performed
  - Disinfection reports
  - Chemical dosing records
  - Vendor service records
  - Sterile water filling records – not uniformly applied
    - Nursing confirms tap water used to fill nebulizer in cardiology wing

> Validation
  - Microbial testing
  - Re-evaluation
Potential remediation

> Infection prevention should reinforce the policy of using sterile water for nebulizers
> Provide guidance on the disinfection of nebulizers between treatments on the same patient and between different patients including cleaning, disinfection with chlorine at 50 mg/L for one hour, rinsing with sterile water and drying
> Removal of dead legs or disinfection of areas in cardiology wing
Scenario 2: Long term care center

> The health department was contacted regarding a single confirmed case of nosocomial Legionnaires’ disease at a long term care center, and two suspected cases of nosocomial LD

> The first patient was a 75 year old man. The two suspected cases were maintenance staff members

> The facility has a water management plan which was written by a senior director of the organization that owns the facility.

> A 200-ton cooling tower is located on the north side of the facility
Scenario 2: Long term care center

- The facility has 1 floor, 100-bed capacity. Occupancy is nearly 100%.
- Medical devices include hydrotherapy tubs and humidifiers
- The patient resided in the north wing which was recently re-opened
- Water restrictions were put in place by the facility after the initial case
Sample signage

STOP

WATER RESTRICTIONS IN PLACE

Do NOT:

• Drinking water from taps or drinking fountains
  • Use tap water when brushing teeth
  • Consume ice from ice machines
  • Use showers
Hot water distribution

> Records indicated showerheads are inspected monthly; however, some showerheads had significant biofilm accumulation on the no
Scenario 2: Skilled nursing home

What questions should be asked of the facility?

- When did each case start showing symptoms?
- Is the water management plan able to be viewed?
- Have any water samples been taken?
- What water systems are included in the north wing?
- What water systems did patients come in contact with?
- Are any procedures documented?
- Are procedures recorded in a log book?
A water management plan was developed. How can you make a sufficiency determination?

<table>
<thead>
<tr>
<th>Control Measure</th>
<th>Oxidizing Biocide Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>Daily, or every three days</td>
</tr>
</tbody>
</table>

**Steps**

1. Prior to performing any step of the procedure, refer to the manufacturer's requirements for inspection instructions.
2. Oxidizing biocides with active ingredients bromine or chlorine should be used for microbial control. Only biocides products registered by the EPA under FIFRA and the corresponding AHI should be used. Registered biocide products should have a label that states the product is for use with cooling tower systems.
3. Criteria that should be considered in specifying the treatment chemical include:
   a. compatibility with other treatment chemicals
   b. potential effects on the efficacy of the biocide(s) used for microbial control
   c. federal, state, and local regulations pertaining to chemical usage and discharge
   d. general safety concerns
   e. compatibility with the materials of construction of the cooling tower system
   f. site-specific water chemistry characteristics

4. Document the following information for all chemicals used to treat the cooling tower system:
   a. brand name
   b. active ingredient(s)
   c. manufacturer
   d. recommended storage time
   e. AHI approved label
   f. safety data sheet(s) (SDS)

5. Oxidizing biocides should be added at least three days per week, up to 7 days/week, either continuously or semi-continuously (e.g. slug fed 1-3 times per day).
   a. If a non-stabilized oxidizing biocide is used, it should be added to the cooling tower water in an amount sufficient to achieve an average daily free residual oxidant (FRO) level within the range set on the product label.
   b. If a stabilized oxidizing biocide is used, it should be added to the cooling tower water in an amount sufficient to achieve average daily total halogen and FRO levels, within the ranges set forth on the product label.

**NOTE** – Some oxidizing biocides are stabilized with additives such as sulfamic acid and require special handling. If stabilized biocides are fed at amounts exceeding the manufacturer specified levels, the biocide can become over stabilized, decreasing anti-microbial efficacy.

3. Sample the water from a sampling point just prior to chemical injection for free available halogen. Sample the water at least 1 hr after dosing.
### Outbreak Investigation Exercises

**Circulation of Condenser Water System**

<table>
<thead>
<tr>
<th>Control Measure</th>
<th>Circulation of Condenser Water System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>Weekly</td>
</tr>
</tbody>
</table>
| **Steps**       | 1. Prior to performing any step of the procedure, refer to the manufacturer's requirements for inspection instructions.  
  2. During times of known off-peak periods (i.e., <65°F), the condenser water circulation pumps should be manually turned out to circulate the entire system at a minimum when the oxidizing biocide feed is initiated and at least 1 hour following completion of oxidizing biocide feed.  
  3. Circulation pumps may then be manually turned off and set back to automatic for next use. |

**Cleaning and Disinfection**

<table>
<thead>
<tr>
<th>Control Measure</th>
<th>Cleaning and Disinfection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>Semi-annually (twice per year), As Needed</td>
</tr>
</tbody>
</table>
| **Steps**       | 1. Prior to performing any step of the procedure, refer to the manufacturer's requirements for sampling instructions.  
  2. Personnel performing cleaning and disinfection must be trained and certified to do so. Personnel must wear proper PPE such as an N95 respirator.  
  3. Perform a visual inspection of all wetted components of the cooling tower system that can be safely seen during operation of the system.  
  4. Lower the conductivity of bulk water in the tower as quickly as possible by blowdown.  
  5. Refer to the following procedures for disinfection:  
    a. Increase the concentration of FRO of the oxidizing biocide to 5 ppm (± 1 ppm)  
    b. Acid organic dispersant as necessary  
    c. Add oxidizing biocide as needed to maintain the 5 ppm average residual of free residual oxidant (FRO) over the 1 hr treatment period  
    d. Measure the FRO every 30 min, and adjust the feed to maintain a 5 ppm (± 1 ppm)  
    e. Measure pH every 30 min and adjust as necessary to maintain the level for efficacy of the oxidizing biocide  
    f. After at least one hour, blowdown the system as rapidly as possible, continue to flush the system until the FRO is 1.0 ppm or less and the water is clear, and immediately re-passivate all metals by restoring controls to routine treatment levels.  
  6. Disinfection should be performed with a non-oxidizing biocide. |
What documentation do we need to see to validate the water management plan for the cooling tower?

What is missing from the water management plan procedures for the cooling system?

<table>
<thead>
<tr>
<th>Control Measure</th>
<th>Corrosion and Scale Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>Daily</td>
</tr>
</tbody>
</table>
| Steps           | 1. Prior to performing any step of the procedure, refer to the manufacturer’s requirements for sampling instructions.  
2. Corrosion and scale control should be controlled using chemical inhibitors:  
   a. Scale control should be through the use of inhibitors containing phosphates and polymers.  
   b. Corrosion control should be through the use of inhibitors containing phosphates, azoles, molybdenum, and zinc.  
3. Continuously monitor the corrosion rate in the system and the concentration of the corrosion and scale inhibitors.  
   NOTE – Use of surfactants may assist in the effectiveness of other chemicals by removing biofilms.  
4. Document all corrosion and scale control measures including the date and time of dosing as well as the person responsible. |

<table>
<thead>
<tr>
<th>Control Measure</th>
<th>Conductivity Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>Daily (Continuous)</td>
</tr>
</tbody>
</table>
| Steps           | 1. Prior to performing any step of the procedure, refer to the manufacturer’s requirements for sampling instructions.  
2. Identify a target number of cycles of concentration and associated conductivity set point  
3. Continuously monitor the conductivity of the blowdown water and the make-up water.  
4. Continuously monitor the conductivity set-point at which blowdown is initiated.  
5. Document all conductivity measurements including the date and time of monitoring and the person responsible. |
Outbreak Investigation Exercises

Records from 2016 were found when the water management plan was first developed that use the verification sheet. Records look as if the person responsible filled in all data at the same time.

What additional verification data should be collected?

What about validation data?

• Policies state that on-line remedial disinfection should be implemented when cultures confirm *Legionella* presence > 20 cfu/mL.
• One lab report showed concentrations at 20.1 cfu/mL
Conclusions
The time to act is now

> Our goal is not to completely eliminate *Legionella* bacteria, but to control it

> Outbreak investigations of healthcare facilities should be performed with adequate understanding of utility and medical water systems

> A water management plan is nothing without defensible verification and validation records. Verification and validation records are nothing without a water management plan.
Communicating Risk

Sample staff/resident notification letter

<Date>

Dear Staff and Patients,

This letter serves to inform you that the <County Health Department> and the <State> Department of Health are investigating a case of Legionnaires’ disease possibly associated with our facility. Legionnaires’ disease is a serious form of pneumonia that persons may acquire after being exposed to water containing Legionella bacteria. While it has not been definitely determined where this individual was exposed to the bacteria, the health and safety of our patients is our top priority and we are fully cooperating with the health department’s investigation, and working with experts to <Insert Actions Taken/Planned>.

Legionella bacteria are spread by the release of small droplets of contaminated water into the air. People who have Legionnaires’ disease are infected by breathing in these droplets of water, NOT through contact with a sick person. Therefore, to limit the risk of becoming ill, the <Health Department> recommends the following:

> No showering
> No oral consumption of tap water
> No brushing of teeth with tap water
> No flushing of nasogastric tubes or preparation of medications with tap water
> No oral consumption of ice from the ice machines

There are commonly available antibiotics to treat Legionnaires’ disease. Attached to this letter is a Legionnaires’ disease Fact Sheet with additional information.

If you experience symptoms of pneumonia, such as fever, cough, or shortness of breath, please contact <Insert Contacts and Phone Numbers>.

If you have any questions or concerns, please contact <County Health Department> during normal business hours at <Insert Phone Number>.

We will provide additional details regarding specific treatments and water interruptions as the information becomes available. Thank you for your patience and cooperation.