Legionellosis

Outbreak Investigation and Environmental Sampling

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Legionnaire’s Disease was first identified after a large outbreak in July of 1976 related to an American Legion convention.

- Convention attendees with unexplained pneumonia:
  - 221 cases
  - 2/3 cases hospitalized
  - 34 deaths

- *Legionella pneumophila* identified
Legionella

- Bacteria: gram-negative rods
- Serogroups and subtypes
  - *Legionella pneumophila*, serogroup 1 accounts for ~70% of cases
- Waterborne
  - Surface waters
  - Building water systems
    - Biofilms!
- Grows at 77-108°F
- Replicates in human white blood cells and protozoa
**Clinical Presentation**

**Legionnaires’ Disease**
- Pneumonia, fever, cough
- Hospitalization common
- Treated with antibiotics
- 2-10 day incubation
- Fatality rate: 10%
- Risk groups: age 50+, smokers, COPD sufferers, diabetics, the immunosuppressed

**Pontiac Fever**
- Flu-like illness (fever, chills, cough) without pneumonia
- Hospitalization uncommon
- Symptoms resolve themselves
- 1-3 day incubation
- Fatality rate: 0%
- No special risk groups
Legionellosis

- Human infections via aerosolization of contaminated water from things like:
  - Showers and faucets
  - Cooling towers
  - Hot Tubs
  - Decorative Fountains
Legionellosis

- Between 8,000 and 18,000 annual hospitalizations estimated
- About 4,000 annual deaths estimated
- Diagnosed most often via sputum culture or urine antigen test
- Underreported
  - Patients recover without medical assistance
  - Patients are not tested
  - Patients misdiagnosed
- 20% of cases travel associated
- 96% of cases “sporadic” (not associated with a known outbreak)
General Epidemiology

**Legionnaires' Disease Is On The Rise 2000–2015**

*Incidence (cases/100,000 population)*

Year

*National Notifiable Diseases Surveillance System*
General Epidemiology

- Why the increase in incidence?
  - More testing
  - Better surveillance
  - Aging population
  - Aging infrastructure
  - Warmer temperatures
Cases with a laboratory diagnosis are reportable to the North Dakota Department of Health.

North Dakota State-wide Legionellosis Incidence Rate by Year, 2006-2016

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</thead>
<tbody>
<tr>
<td>Cases</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>5</td>
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North Dakota Case Investigation

- All cases are investigated by NDDoH field epidemiologists
  - Travel info
  - Possible water exposures
  - Possible healthcare exposures
  - Clinical data
  - EH personnel are alerted if possible exposure location identified

- Because of the potential for outbreaks, including outbreaks in other states, Legionellosis is considered first priority, meaning case investigation is initiated within 24 hours

- Data are sent within five days to the Centers for Disease Control and Prevention
Travel-Associated Cases

- The NDDoH receives a notification if an out-of-state (or out-of-country) case traveled to North Dakota during their incubation period.
  - NOT included in North Dakota case count
  - Notification includes:
    - Limited non-identifiable demographic data
    - Location of stay
    - Dates of stay
  - Investigation prompted when more than one notification is received for a North Dakota building within a year (or less)
Legionella and the Built Environment

- Fresh water is reservoir for *Legionella*
- In nature, *Legionella* generally exists in insufficient quantities to cause disease
- Buildings can provide a more ideal environment for *Legionella*
  - Better environment for growth
  - Opportunities for contaminated water to be aerosolized
Legionella and the Built Environment

How do Legionella (and other pathogens) get into a building’s water system?

- Certain activities can introduce dirt and other materials into the system:
  - Construction (new and renovation)
  - Water main breaks
  - Changes to municipal water quality

- These activities can help by either introducing Legionella or by introducing other materials that can use up available disinfectant.

What factors promote growth of Legionella once inside a water system?

- The presence of biofilm, scale, and sediment
- Fluctuations in water temperature and/or pH
- Inadequate levels of disinfectant
- Changes in water pressure
- Water stagnation
Legionella and the Built Environment

Where can *Legionella* grow, spread, and aerosolize? Many places!

- Hot and cold water storage tanks
- Water heaters
- Expansion tanks
- Water filters
- Electronic and manual faucets
- Aerators
- Faucet flow restrictors
- Showerheads and hoses
- Pipes, valves, and fittings
- Centrally installed misters, atomizers, air washers, and humidifiers
- Nonstream aerosol-generating humidifiers
- Infrequently used equipment, including eyewash stations
- Ice machines
- Hot tubs
- Decorative Fountains
- Cooling towers
- Medical equipment
  - CPAP machines
  - Hydrotherapy equipment
  - Bronchoscopes
  - Nebulizers
## Water Temperatures

<table>
<thead>
<tr>
<th>Temperature °C/°F</th>
<th>State of Legionella</th>
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<tr>
<td>&lt;20 &lt;68</td>
<td>Dormant but viable</td>
</tr>
<tr>
<td>35-46 95-115</td>
<td>Optimal growth</td>
</tr>
<tr>
<td>50 122</td>
<td>90% Kill in two hours</td>
</tr>
<tr>
<td>60 140</td>
<td>90% Kill in two minutes</td>
</tr>
<tr>
<td>&gt;70 &gt;158</td>
<td>100% Rapid kill</td>
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Biofilms

- Building water systems offer a warm, enclosed space with regular access to air and water—great for *Legionella* and other aerobic organisms!
- Biofilms can be difficult to remove
- How *Legionella* can contaminate your water system:

  - attaches to biofilm →
  - replicates to form a microcolony →
  - colony matures →
  - bacteria break of colony to form new colonies on biofilm →
  - some bacteria break of colony and continue in water system to end fixture
Outbreak Investigation

- When the NDDoH discovers a building is a shared risk factor for two or more unrelated cases of Legionellosis, and outbreak investigation is prompted.
- A full investigation will include personnel from Disease Control, the Division of Microbiology Lab Services, and local environmental health personnel.
Outbreak Investigation

- Additional **case information** is obtained, including information about accommodations and visits to surrounding attractions.

- An **environmental assessment** is conducted at the facility.

- Samples as collected from various locations within the facility for **laboratory testing**.
Following an outbreak, the investigation team will view the facility and speak with building maintenance personnel; investigations include:

- Review of building water system, including building schematics, water management plants, routine sampling results, and recent consultations
- Tour of all buildings on the premises
- Sample collection

The NDDoH utilizes the CDC outbreak toolkit for outbreak investigation, which provides a comprehensive form for guiding the environmental investigation (see Resources slide)
Environmental Assessment: Sample Collection

- During sample collection, the following is measured or obtained:
  1. Chlorine residual levels
  2. Water temperature
  3. Water pH
  4. Water samples
  5. Biofilm samples (swab)

- It is important to make sure the right equipment and sufficient supplies are on hand to conduct an environmental assessment.
Environmental Assessment: Sample Collection

- Important equipment for samples collection can include:
  - **Sterile** plastic 1 L bottles (at least one for every location that must be sampled)
  - Sodium thiosulfate
  - Pipettes and bulbs
  - Chlorine analyzer
  - Thermometer
  - Labels
  - Chain of custody documentation
  - Dacron-tipped swabs
  - Sterile plastic screw top tubes
  - Coolers or other equipment needed for transport
Environmental Assessment: Sample Collection

- Common locations where samples are collected can include:
  - Sinks and showers
  - Pools and hot tubs (including filters)
  - Hot water heaters
  - Water softening equipment
  - Municipal point of entry
  - Medical equipment that utilizes and holds water
  - Decorative water features
  - Any kind of water storage tank or device that is part of the water system

- The CDC provides excellent training videos on how to collect and transport samples. These techniques can be used for both outbreak and routine sample collection (see Resources slide)
After an Environmental Assessment

- Collected samples will be analyzed for the presence of *Legionella* (results can take 10-14 days)
- The outbreak team will work with the CDC to create recommendations for remediation or future action
- Results and recommendations are provided to the facility
  - Recommendations will be provided in writing; information for immediate action will also be provided verbally
  - Failure to isolate *Legionella* in collected samples is **does not** indicate the facility is free from *Legionella*
After an Environmental Assessment: Remediation

- ASHRAE recommends two methods to remove *Legionella*:
  1. Hot water flush (160-170°F)
  2. System chlorination (min 2 ppm, 2 hours)

- **Remember**: *Legionella* identified at one point can could have come from anywhere upstream in the water system!
- Follow-up testing and system monitoring will occur after remediation
- May choose to engage a *Legionella* consultant
Avoiding Outbreaks through Water Management

- Ongoing control is important in reducing the burden of Legionellosis
  - Document, document, document!
- In response, the CDC has developed a toolkit to help building owners:
  - Evaluate their water system
  - Develop a water management plan if one is needed
  - Create a water management team
New CMS Rule

- New regulation effective June 2017 to reduce *Legionella* (and other waterborne pathogen) risk in:
  - Hospitals
  - Skilled nursing facilities
  - Critical access hospitals
- A response to outbreaks identified in hospitals and nursing homes
  - High-risk populations
  - Large, complex water systems
- Requires facilities to create and follow a water management plan
New CMS Rule

- Survey and Certification Memo 17-30 came out on June 2, 2017
- Revised the memo on June 9, 2017 to clarify what facility types must comply. Hospitals- CAHs – Skilled Nursing Homes
- Link to CDC water system management tool kit
  - [https://www.cdc.gov/legionella/maintenance/wmp-toolkit.html](https://www.cdc.gov/legionella/maintenance/wmp-toolkit.html)
- Healthcare facilities are expected to comply with CMS requirements to protect the health and safety of its patients.

Those facilities unable to demonstrate measures to minimize the risk of LD are at risk of citation for non-compliance with the CMS Conditions of Participation.

Accrediting organizations will be surveying healthcare facilities deemed to participate in Medicare for compliance with the requirements listed in this memorandum, as well, and will cite non-compliance accordingly.
What About Routine Testing?

- **Question:** Is routine testing for *Legionella* recommended?
  - **Answer:** Sometimes!

- Why test for the presence of *Legionella*?
  - Following an outbreak or identified facility-related case—Yes!
  - Validation of efficacy of water management program—Maybe! (or, perform surveillance for *Legionella* infections)

- Regular monitoring of water quality parameters (i.e. disinfectant levels, temperature) is recommended as part of a water management program
  - Document, document, document!
Specific decisions about sample frequency, location, and methodology should be made by the building’s water management team as part of a comprehensive water management program.

Sampling plans should be based on a variety of factors including:

- Environmental assessments and baseline *Legionella* data
- Performance of water management program and trend analysis of *Legionella* test and water quality parameter results
  - Correlation of environmental testing results with clinical surveillance data
- Building characteristics (age, complexity, populations served)
- Sites of possible exposure to aerosolized water
- Available resources to support testing.
Where can Validation Samples be Sent?

- A private lab
- Soon, the NDDoH Division of Microbiology
  - Will be fee-for-service
Thank you!

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Questions?


• CDC environmental investigation videos: https://www.cdc.gov/legionella/videos.html

• CMS *Legionella* and Other Waterborne Pathogens Surveyor Training Video: https://surveyortraining.cms.hhs.gov/pubs/VideoInformation.aspx?id=134&cid=0CMSLEGWEB-Archived