LEGIONELLOSIS: KEY CONSIDERATIONS FOR CASE AND ENVIRONMENTAL EXPOSURE INVESTIGATION.

Presenters:
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Valerie Nguyen, Public Health Inspector, MLHU
Dru Sahai, Environmental Science Specialist, PHO
Agenda

• Epidemiology: The Ontario picture.
• Ecology of legionella species
• Transmission of legionella species
• Disease manifestation
• Case exposure investigation
• Environmental investigation
• Case study
Objectives

- Provide a glimpse of Ontario’s Legionellosis case incidence: 2010-current,
- Discuss significant manifestations of Legionella infections,
- Explore challenges faced by Legionnaires disease (LD) case investigators and
- Discuss key aspects of Legionellosis case exposure investigation using Public Health Ontario’s 2014 Case Report Form (CRF).
Epidemiology of Legionellosis in Ontario
Legionella case count by month and year: Ontario, 2010– Apr 2017

Sources: Ontario data – Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario. Ontario population – IntelliHEALTH Ontario, extracted by Public Health Ontario [2017/04/05].

PublicHealthOntario.ca
Legionella case count by year: Ontario, 2005–Apr 2017

Sources: Ontario data – Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario. Ontario population – IntelliHEALTH Ontario, extracted by Public Health Ontario [2017/04/05].
Legionella case counts by age-2010- Apr 2017

Sources: Ontario data – Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario. Ontario population – IntelliHEALTH Ontario, extracted by Public Health Ontario [2017/04/05].
Incidence of Legionellosis by age and sex: Ontario, 2010- Apr 2017

### Selected health units legionellosis case counts and rates 2012-May 2017

<table>
<thead>
<tr>
<th>Public Health Units</th>
<th>Year</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
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<td>6</td>
<td>1.5</td>
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<td>0</td>
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Sources: Ontario data – Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario Ontario population – IntelliHEALTH Ontario, extracted by Public Health Ontario [2017/04/05].
Overview

- Found in the natural environment including ground and surface water, moist soil (compost)
- Can exist in free floating form or within an amoeba host
- The amoeba (Acanthamoeba spp) provides nutrition and shelter
  - Protects *Legionella* from heat and disinfectants

Abdel-Nour et al. 2013
**Ecology: Overview (cont.)**

### Temperature

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Survival</th>
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</thead>
<tbody>
<tr>
<td>70 - 80°C</td>
<td>Dies very quickly</td>
</tr>
<tr>
<td>60°C</td>
<td>Survives several minutes</td>
</tr>
<tr>
<td>55°C</td>
<td>Survives several hours</td>
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<tr>
<td>&gt;50°C</td>
<td>Survives but inactive</td>
</tr>
<tr>
<td>20-50°C</td>
<td>(25 – 42°C optimal growth conditions)</td>
</tr>
<tr>
<td>&lt;20°C</td>
<td>Survives but inactive</td>
</tr>
</tbody>
</table>

### Biofilm

- Replication within protozoa
- Survive municipal water treatment
- Environment
  - Stagnation
  - Scaling
  - Corrosion
  - Reduced residual disinfectant
  - Reduced temperature (<50°C)
  - Water surges
  - off and on
  - vibration

Source: Abdel-Nour et al. 2013 with modifications
• Biofilms can be difficult to eliminate once established even after thermal or chemical disinfection

• Water pressure surges, turning the system off and on, and vibration as experienced during construction can dislodge biofilm
  • Leads to large amounts of legionella in the water system

• The number of Legionella organisms will be greater in biofilm than water
  • Swab in addition to taking a water sample
The risk of Legionella growth and transmission:

• A suitable temperature for multiplication (20°C and 50°C)
• A Lack of a biocide residual
• A source of nutrients
• A means of creating and disseminating aerosols that contain *Legionella*
Transmission

- Typically transmitted though inhalation of minute aerosolized water droplets that contains *legionella* (amoeba/*legionella*)
  - High humidity increases viability
- Can occur by aspiration/instillation of Legionella into the lungs
- Humans have traditionally been considered a dead-end host for *Legionella*
  - One probable case of person-to-person transmission has recently been reported (*N Engl J Med*. 2016;374;5:497-498).
Transmission

• Several infectious species (*Legionella pneumophila, Legionella longbeachae*) have been linked to exposures to soil, potting soil and compost
  • Mode of transmission?

• Typically acquired by a susceptible person
  • >50 years
  • Smoking/alcohol
  • Persons with underlying medical conditions
  • Immunosuppressed/immunocompetent

• LD has incubation period of 2 – 14 days (most commonly 2 – 10 days).
Manifestation

Pontiac Fever
- Milder self-limiting flu-like illness
- No pneumonia

Legionnaires’ Disease
- Severe and potentially fatal form of pneumonia
Case exposure investigation: PHO’s CRF

Maurice Coppin,
Communicable Disease Consultant, PHO
Case exposure investigation

Environmental investigation

Laboratory investigation
Case exposure investigation

Surveillance & reporting

Legionella surveillance package

- Reviewed and updated, as needed, annually.
- Released to PHU in the ESD and Monitored Situations notice
- 2017 surveillance for the Legionella period started the week of June 19

- Legionellosis Case Report Form
- Legionellosis Case Report Form instruction guide
- Legionellosis Questions and Answers

PHUs that are interested in having this data included in PHO’s supplementary analysis may choose to send completed CRFs as attachments to iPHIS referrals to MOHLTC-PHD(0) CDOMINTAKE. (Note: Files attached to iPHIS referrals must be under 5 MB in size per file).
Case Exposure Investigation

Case report form (CRF)

Objectives:

• To monitor legionellosis activity at the provincial level;

• To collect supplementary exposure data in a timely manner to:
  • Identifying clusters of cases based on potential common exposure locations.
  • Assessing the frequency of exposures reported among sporadic cases of legionellosis; and
  • Provide public health units (PHUs) with a tool to guide general data collection required for iPHIS entry.
Case Exposure Investigation

The CRF

- PHO encourages voluntary submission of CRFs via iPHIS referral from health units.
- Submission allows cases that are reported on or after the start of the annual legionella season to be included in the provincial analysis.
- PHO will collate CRF data (Sections 2, 7–10) for analysis of potential exposure location and sources.
- Enhanced Surveillance Directive (ESD) may be issued if incidence increases above expected.
Legionellosis CRF

• Health units may submit via iPHIS referral for all cases reported on or after June 1, 2017

• Only Sections 2 and 7–10 of the CRF will be analysed by PHO

Legionellosis Case Report Form

The purpose of this case report form (CRF) is to collect additional information about potential exposure sources and locations for cases of legionellosis in Ontario, as well as provide public health units (PHUs) with a tool to guide general data collection required for iPHIS entry during legionellosis case investigations. PHUs may use their own case report form if available. See the accompanying Instruction Guide for an explanation of Sections 2 and 7–10.

Public Health Ontario (PHO) will only use Sections 2 and 7–10 of this CRF for analyses of potential exposure sources and locations. If interested in being included in these analyses, PHUs may submit these sections to PHO via iPHIS referral as soon as possible when the information becomes available. These data will assist in the identification of frequently reported exposure locations and potential exposure sources among cases at the provincial level.

<table>
<thead>
<tr>
<th>Health unit:</th>
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<tbody>
<tr>
<td>Date form completed (yyyy/mm/dd): _______/<em><strong><strong>/</strong></strong></em>  □ New case report  □ Update</td>
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</table>

<table>
<thead>
<tr>
<th>Investigator information:</th>
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<tbody>
<tr>
<td>Name:____________________</td>
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<tr>
<td>Designation:______________</td>
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<tr>
<td>Manager advised:___________</td>
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</table>
1. CASE DETAILS

**Health unit:**

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<tr>
<th>Date form completed (yyyy/mm/dd):</th>
<th>New case report</th>
<th>Update</th>
</tr>
</thead>
</table>

**Investigator information:**

<table>
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<th>Name:</th>
<th>Phone Number:</th>
<th>Designation:</th>
<th>Date of investigation (yyyy/mm/dd):</th>
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<tr>
<th>Manager advised:</th>
<th>Date advised (yyyy/mm/dd):</th>
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</thead>
</table>

**Aetiological agent:**

| ☐ L. pneumophila | ☐ Legionella, species unspecified |
| ☐ Other Legionella species (specify): | ☐ Unknown |

**SeroGroup:**

| ☐ Unknown |

**Classification:**

| ☐ Confirmed | ☐ Probable | ☐ Person under investigation | ☐ Does not meet |

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<thead>
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<th>Classification date (yyyy/mm/dd):</th>
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PublicHealthOntario.ca
2. CLIENT DEMOGRAPHICS

Initials: _______________________________ Gender: □ Male □ Female □ Transgender □ Other □ Unknown

Date of Birth (yyyy/mm/dd): _______/_____/______ Age: _______(years) □ Unknown

Primary residence: □ Home □ LTCH □ Retirement home □ Acute care hospital □ Homeless □ Other (specify):

Address: __________________________________________________________ APT #: __________________

City: _________________________ Postal code: ____________ Phone (Home/Cell): (____) ____________

If applicable, name of facility: _____________________________________________

Admission date (yyyy/mm/dd): _____ / ____ / ____ Discharge date (yyyy/mm/dd): _____ / ____ / ____

Work: □ Employed □ Unemployed □ Retired □ Not specified □ Other (specify): ______________________

Occupation: __________________________________________________________

Place of employment: __________________________________________________

Address: ___________________________________________________________ Suite #: __________________

City: _________________________ Postal code: ____________ Phone (Work): (____) ____________

If applicable, type of facility: □ LTCH □ Acute care hospital □ Retirement home

If applicable, please indicate last day at work (yyyy/mm/dd): _______/_____/____

Did the client visit a LTCH, acute care hospital or retirement home during the incubation period? □ Yes □ No □ Unknown

If yes, type of facility: □ LTCH □ Acute care hospital □ Retirement home □ Other (specify):

Name of facility: _______________________________________________________

Address: __________________________________________________________________ Suite #: __________________

City: _________________________ Postal code: ____________ Phone (Work): (____) ____________

Most recent visit date (yyyy/mm/dd): _____ / ____ / ____ Frequency of visits (e.g., weekly, daily, etc.): ____________
### 3. SYMPTOMS

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<th>No</th>
<th>Don’t know</th>
<th>Not asked</th>
<th>Refused</th>
<th>USE AS ONSET (X only one)</th>
<th>Onset date/time (yyyy/mm/dd)</th>
<th>Recovery date/time (yyyy/mm/dd)</th>
<th>Duration (in days)</th>
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<td>Cough, non-productive (dry)</td>
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<td>Fever (Specify ___ °C)</td>
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<td>Malaise (feeling unwell)</td>
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<td>Other, specify below:</td>
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## 4. CLINICAL INFORMATION

<table>
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<th>Chest X-ray performed:</th>
<th>Yes</th>
<th>No</th>
<th>Don't know</th>
<th>If yes, date (yyyy/mm/dd):</th>
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<td>Chest X-ray results:</td>
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</tbody>
</table>

If case had pneumonia, indicate how the diagnosis was determined:

- [ ] Radiological evidence
- [ ] Clinical diagnosis
- [ ] Pathological evidence (upon autopsy)

**Was case hospitalized?**

- [ ] Yes
- [ ] No
- [ ] Unknown

If yes, name of hospital: ____________________________ City: ____________________________

Admission diagnosis: ____________________________

Admission date (yyyy/mm/dd): _____/___/____

Discharge date (yyyy/mm/dd): _____/___/____

ER Visit Only

- [ ] Yes
- [ ] No
- [ ] Unknown

Date: (yyyy/mm/dd): _____/___/____

Admitted to ICU

- [ ] Yes
- [ ] No
- [ ] Unknown

Date: (yyyy/mm/dd): _____/___/____

On Ventilator

- [ ] Yes
- [ ] No
- [ ] Unknown

Date: (yyyy/mm/dd): _____/___/____

## 5. RISK FACTORS

Check all that apply:

- [ ] Chronic illness/underlying medical condition (specify): ____________________________
- [ ] Immunocompromised (specify): ____________________________
- [ ] Diabetes
- [ ] Use of respiratory therapy equipment
- [ ] Alcohol abuse
- [ ] Smoker
- [ ] Other (specify): ____________________________
6. OUTCOME

<table>
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<tr>
<th>Recovered</th>
<th>Yes</th>
<th>No</th>
<th>Unknown</th>
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<tbody>
<tr>
<td>Death</td>
<td>Yes</td>
<td>No</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

If yes, discharge date (yyyy/mm/dd): ______/_____/_____
If yes, date of death (yyyy/mm/dd): ______/_____/_____

If death occurred, was legionellosis the:
- Underlying cause
- Contributing factor
- Unrelated
- Cause of death is unknown

7. ENVIRONMENTAL SAMPLING

Were environmental samples collected?  
- Yes  
- No  
- Unknown

If yes, indicate sample collection location(s):
- Home  
- Health care facility  
- Community
8. TRAVEL WITHIN INCUBATION PERIOD

Provide the details specified below if the case travelled outside the health unit jurisdiction in the 14 days before the onset of symptoms of legionellosis. This includes single day trips.

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<thead>
<tr>
<th>City</th>
<th>Province</th>
<th>Country</th>
<th>Accommodation/destination*</th>
<th>Dates of visit/stay (yyyy/mm/dd)</th>
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<tr>
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<td>From</td>
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<td><em><strong><strong><strong>/_____/</strong></strong>   _______/</strong></em>__/____</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><em><strong><strong><strong>/_____/</strong></strong>   _______/</strong></em>__/____</td>
</tr>
</tbody>
</table>

If suspected that the case was exposed during travel, are any other confirmed or probable cases linked to the same location?

☐ Yes  ☐ No  ☐ Unknown

If yes, how many cases: __

*Accommodation/destination may include, for example: Hotel/motel, bed and breakfast, resort, hostel, lodge, cruise ship residence.
### 9. EXPOSURE HISTORY

Please report all relevant exposures that occurred during the **14-day period prior to symptom onset**. Refer to the Legionella CRF Instruction Guide for definitions of exposures provided in the table below; however, please also report additional exposures to aerosolized water that may be associated with the acquisition of Legionella infection.

**14-day period covers (yyyy/mm/dd):** ______/_____/______ to ______/_____/______

**In the 14 days before the onset of symptoms of legionellosis, did/was the case:**

<table>
<thead>
<tr>
<th>Exposure type</th>
<th>Yes</th>
<th>No</th>
<th>Unable to assess</th>
<th>Date(s) (yyyy/mm/dd)</th>
<th>Location(s) of exposure (include address if available)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed to a whirlpool spa/hot tub</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Take a shower outside the home</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed to vegetable/fruit mister machine (e.g., in grocery store)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed to respiratory therapy equipment that uses water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visit the dentist for a check-up or treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed to decorative/ornamental fountains or other water displays</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed to water storage systems, not otherwise specified here</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PublicHealthOntario.ca
10. MOST FREQUENT POTENTIAL EXPOSURE LOCATIONS

This section is intended to capture the locations where the case spent the most time during the incubation period for Legionella (i.e., 14 days before symptom onset). Any location identified in the Exposure history section must be captured here; these locations are inclusive of home, work, shopping centers and hotels. Please provide a Postal code for all reported potential exposure locations.

14-day incubation period covers (yyyy/mm/dd): _____/____/____ to _____/____/____

PLEASE REPORT LOCATIONS IN DECREASING ORDER, BASED ON AMOUNT OF TIME AT THE LOCATION.

Location 1 – MANDATORY (Place where the case spent the most time)

- Home  □ Work  □ LTCH  □ Retirement home  □ Acute care hospital  □ Other (specify): ______________

Location name: ____________________________________________
Address: ____________________________________________ Postal code: __________________

Exposure date range (yyyy/mm/dd): FROM _____/____/____ TO _____/____/____ (only enter TO date if applicable)

Location 2

- Home  □ Work  □ LTCH  □ Retirement home  □ Acute care hospital  □ Other (specify): ______________

Location name: ____________________________________________
Address: ____________________________________________ Postal code: __________________

Exposure date range (yyyy/mm/dd): FROM _____/____/____ TO _____/____/____ (only enter TO date if applicable)

Location 3

- Home  □ Work  □ LTCH  □ Retirement home  □ Acute care hospital  □ Other (specify): ______________

Location name: ____________________________________________
Address: ____________________________________________ Postal code: __________________

Exposure date range (yyyy/mm/dd): FROM _____/____/____ TO _____/____/____ (only enter TO date if applicable)
Legionellosis CRF Instruction Guide

- Developed to assist investigators in completing the legionellosis CRF
- Provides direction for completing sections of the CRF that PHO will use for analyses
- Provides definitions for many of the exposure types
New developments and next steps

• Currently using a detection algorithms to detect case threshold signaling:
  • The start of the season, and
  • Abnormal increases within the season.

• Testing the use of a spatial cluster surveillance detection tool
  • use of postal codes to identified common potential exposure location/s for possible case cluster:
    • All addresses and associated postal codes linked to a case during the incubation period should be entered into iPHIS.
    • HU within an identified defined potential exposure location will be notified.
Case exposure investigation: Case interview

Valerie Nguyen, Public Health Inspector
MLHU
Case exposure investigation

Introduction
Case exposure investigation

Typical process

• Case presents to acute care facility.

• Case reported to HU in accordance with HPPA, R.S.O 1990, c, H.7. Specification of Infectious Diseases, O. Reg 558-559/91.

• Investigator consults: Appendix A and Appendix B of ID protocol.

• Investigation initiated by public health nurse (PHN) or public health inspector (PHI).

• Case interview done by phone (may be done in person if needed)

• A standardize questionnaire is used to collect risk factors and potential exposure locations and sources.
Case exposure investigation

Surveillance & reporting

Case classification
- Confirm
- Probable

Surveillance

Case-by-case

Provincial reporting
- Confirmed
- Probable
Types of outbreaks/clusters:

**Institutional**
- Health care and correctional facilities

**Travel related**
- Hotels and cruise ships

**Community**
- Workplaces and sporadic

- Outbreaks (cluster) account for only 4% of cases
- LD is substantially underdiagnosed and under-reported
- Seasonal (June to November), peak - July
- Overall case fatality rate 5-30% (9% on average)
- US (2011-2013) 98% of cases hospitalized; 44% in IC

- **Important that all potential sources of Legionella are rendered safe ASAP especially in healthcare settings.**
- **Workplace exposure should be reported to the Ministry of Labour.**
Case exposure investigation

Case Interviews

Legionellosis Case Report Form (CRF)

• Available from PHO – to assist in collecting additional information about potential exposure sources and locations for cases in Ontario.
• May be used as a tool to guide general data collection required for iPHIS entry
• PHUs may use their own case report form
Case exposure investigation

Challenges

• Time between onset of symptoms and confirmation of diagnosis.

•Severity of the disease process.

•Case inability to recall potential locations and sources of exposure.

•One effect of the disease process is short term memory loss.

•Individuals who live alone.

•Distraught family members.
Exposure & Probable Source

Visit any hospitals...
- as a patient
- for a medical appointment/procedure
- as a visitor
- as an employee

Hospitals: LHSC UH

Visit any clinics...
- as a patient
- for a medical appointment/procedure
- as a visitor
- as an employee

Clinics:

Any dental work done?

Office:

Visit nursing/retirement homes?

Name:

Any overnight travel?

Go swimming?
- Where
- Any fountains when you went swimming?
- Take a shower away from home?

Use a humidifier at home?
- Type

Use city water?
- Use well water?

Work on any plumbing projects?
- Details

Shopping trips to malls/dept stores?
- Name

Shop for groceries?
- Name

Shop in produce area of these stores?

Recall being near fountains?
Environmental Sampling
### Initial Contact With Physician or Health Care Worker

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Time</th>
<th>Result</th>
<th>PN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Date</td>
<td>Time</td>
<td>Result</td>
<td>PN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Telephone Calls to Client

<table>
<thead>
<tr>
<th>Attempt</th>
<th>Date</th>
<th>Time</th>
<th>Result</th>
<th>PN</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Mar 13, 2012</td>
<td>9:15 AM</td>
<td>Message left to return call</td>
<td>PN</td>
</tr>
<tr>
<td>#2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date Letter Sent to Client

Respondent interviewed

---

Record Added By: NGUYEN  | Date: Feb 29, 2012
Record Modified By: NGUYEN | Date: May 11, 2017

Records: 6560
### Signs & Symptoms

#### Clients

**Select Client**: Legionella, Lenny

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Response</th>
<th>Date of Onset</th>
<th>Use as Onset?</th>
<th>Date of Recovery</th>
<th>Duration (Days)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chills</td>
<td></td>
<td>Mar 9, 2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cough, productive</td>
<td></td>
<td>Mar 9, 2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Set blank to No**

**Add All Symptoms** | **Add Many Symptoms** | **Add One Symptom** | **Delete Symptom** | **Delete Changes** | **Add All Changes** | **Cancel** | **Back**

**Record Added By**: NGBUENV | **Record Modified By**: NGBUENV

---

**5000 records**
### Risk Factors

#### Medical Risk

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Response</th>
<th>Start Date</th>
<th>End Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immuno-compromised (specify)</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Set blank to No

#### Social/Behavioural Risk

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Response</th>
<th>Start Date</th>
<th>End Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Set blank to No
### Discharge

**Select Client:** Legionella, Lenny

<table>
<thead>
<tr>
<th><strong>Client Status</strong></th>
<th><strong>Comments</strong></th>
<th><strong>Disp. Date</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed</td>
<td></td>
<td>Mar 13, 2012</td>
</tr>
</tbody>
</table>

**Evaluation Summary**

- **Index Case Treated:** Yes
- **Index Case Survived:**
- **If no. Date of Death:**
  - **Accurate Date:**
  - **Cause of Death:**
  - **Type of Death:**
  - **Source of Info:**
  - **Disposition Type:**
  - **Facility Name:**

**Date Investigation Ended:**
- Date closed/given to PA to close in PHIS
- Closed in PHIS by

**Record Added By:** NGUYENV
- **Record Modified By:** NGUYENV
- **Date Added/Modified:** Feb 25, 2012 / May 11, 2017

**Reports:**
- All diseases
- All investigators
- All cases
- Cases and contacts
- All dates

**Filter:**
- Disease
- Investigator
- Active cases only
- Cases only
- Contacts only
- Past week
- Past month
- Past 6 months
- Past year
Nine-day old female admitted to hospital with fever, poor feeding and irritability.

Query suspect meningitis.

Given antibiotics.

Continued to worsen.

Further clinical workup included: CSF culture, respiratory culture.

At 4-weeks old, legionella spp. was detected in a tracheal aspirate sample, along with pseudomonas spp, and a non-fermenting gram negative rod.
Case Review continued

• Home water birth using a private hot tub
• Hot tub was cleaned and disinfected, refilled with water from a garden hose, held at 104F for 3-4 days, then turned down to 98F for birthing process
• Birthing process in the water was 30 minutes
• Attempted environmental sampling, however, due to unforeseen circumstances, sampling was not conducted
• After legionella was detected, appropriate antibiotic therapy was started and the infant improved
Environmental outbreak investigation of Legionnaires’ disease

Dru Sahai, Environmental Science Specialist
PHO
The **case exposure investigation** collects clinical history and exposure details to identify a location.

The **environmental investigation** aims to identify potential sampling sites by conducting an environmental assessment. Helps to identify the source through environmental sampling (ES).

The **laboratory investigation** conducts environmental and clinical testing. Seeks evidence linking the two.

The **remediation** process helps to prevent future outbreaks by addressing the identified source.
Potential sources of contamination

Main sources

• Cooling towers

• Potable water systems
  • Water heaters, hot water storage tanks, heat exchangers, water-hammer arrestors, expansion tanks, water filters, flow restrictors, aerators, pipes, electronic and manual faucets, showerheads and hoses

• Spas

• Decorative fountains
Potential sources of contamination

Other potential sources

- Aerosol producing humidifiers
- Misting devices (grocery and cooling)
- Wastewater treatment plants
- Air scrubbers
- Birthing baths (aspiration)
- Vehicle washers
- Powered dental equipment
- Garden hoses

- Non-disposable medical equipment
  - nebulisers, ventilators and other respiratory therapy equipment that uses water for filling or cleaning
- Soil (usually potting) - *L. longbeachae*
  - Mode of transmission?
- Ice machines
  - aspiration
Potential sources of contamination

Cooling towers
Potential sources of contamination

Evaporative cooling equipment (open system)
Spas

- Water temperature (39-40°C) is ideal for legionella (and other organisms) growth
- Disinfectant is rapidly lost because of high temperature and high bather load
- Equipped with jet and air blowers which can generate aerosols
- Persons using the spa are at most risk but a passerby also can be exposed

Decorative Fountains

- Lack disinfectant
- Lack maintenance protocol
- Underwater heating source (lighting)
Other potential sources

Grocery mister
Environmental investigations

Case exposure information focuses the investigation

• Cluster within a section of an institution
  • Rehab department, Neonatal, Transplant unit
• May be that cases visited a specific community location
  • Supermarket, hotel, restaurant
Environmental investigations (cont.)

Involves more than taking samples!

- Environmental risk assessment
  - Identify potential sources and to prioritize sampling locations
  - Generally concerned about aerosol-generating devices
- Developing a sample plan
  - Sampling
  - Health and safety
- Confirming the source
- Remediation

Health Department staff needed
- PHI (X2)

PHO/L (available for consultation)
Environmental Assessment

CDC: Legionella Environmental Assessment Form
Institutional environmental assessment

BEFORE ARRIVING ON SITE

• PHI should:
  • Contact the Public Health Ontario Lab (PHOL) at the beginning of the Legionella investigation to:
    • Make them aware of the case/outbreak
    • Obtain testing materials (e.g., water bottles, swabs, requisition forms)
  • Request meeting with the building manager (or other contractors)
  • Instruct facility to temporarily discontinue the use of aerosol-generating items as a precautionary action pending sampling

  *But advise them not to super chlorinate, clean, drain or change/disturb any of the filter systems*
Institutional environmental assessment (cont.)

AFTER ARRIVING ON-SITE

• Review the building water schematic
  • Generally concerned about aerosol generating devices

• Collecting information about any:
  • Building water systems (BWS) that are infrequently used (low occupancy)
  • Recent construction, renovation, maintenance work
  • Note any changes to potable water quality (for example, taste, odour, flavour and appearance)

• Review any onsite maintenance logs (disinfectant residual, microbiological results)

• Ask about previous outbreaks or cases
  • High chance of reoccurrence

• May have an outside contractor (BWS, cooling towers, pool)
Inquire about any shock dosing or thermal disinfection that may have been done to the water prior to sampling.
Community Outbreak

• Case interviews may identify a link in time and location for further assessment of aerosol-generating sources
  • e.g., all visited a retail with spa display or restaurant/hotel with a decorative fountain, supermarket, car wash, public fountain

• If the case investigation data does not reveal an association with a single building or other common source of Legionella exposure:
  • Suspect a cooling tower (CT) if there is a high attack rate in a small area
    • How to locate all the CT?
    • With dozens of potential sources best to start within 0.5 KM of the middle of the cluster and work outwards
    • Meteorological condition may help to identify source/cases
Attack ratio analysis using postcode geography using data received 22/6/2012 (attack ratio per 10,000 population)
Sampling plan

• The purpose for sampling is to identify the source of transmission
  • Matching clinical and environmental strains

• Sampling points should be prioritized based on the case investigation data and the environmental assessment

• It is not a haphazard process!

• Types of sample that can be collected:
  • Water: Pre-flush – preferred sampling for outbreaks
  • Swab of biofilm
  • Bulk sample - soil, sludge, filter material (backwash sample)
Sampling plan (cont.)

• Aerosol sources that the case(s) may have been exposed to should be sampled first
  • Case patient room
    • Pre-flush sample from sink and showers, (instantaneous water tank)
    • Ask facilities to remove showerhead and aerators from faucets; swab hoses, inside of the pipe, faucet aerator, shower head,
  • Common exposure sources (humidifiers, fountains (indoor and outdoor), CT, misting machines, ice machines, spas)
  • Followed by other high-risk sources (i.e., sites that potentially contain the highest numbers of Legionella bacteria e.g. hot water tank, storage tanks, heat exchanger, expansion vessels)
Sampling plan (cont.)

Useful to sample

- At the point of entry to the building
- The re-circulating hot water returning to the heater
- Rooms at the distal end of the water distribution system
- Randomly selected rooms from residents who were not sick
- Sampling points should be continually reassessed as the investigation progresses and as more results and information become available to locate the source of the Legionella
Sampling plan (cont.)

• Taking samples from cold water for Legionella culture is not generally done, but
  • Cold water can be contaminated with Legionella if it gets warm enough to support its growth (hot summer)
    • Poor insulation of tanks and pipes
    • Ice machines can get warm
    • Measuring temperature is useful in deciding whether to sample

• Temperature and disinfectant residual and pH testing of the hot water systems should be conducted when sampling
### Possible sampling site

#### Spas

<table>
<thead>
<tr>
<th>Sample Site</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water in the pool/balance tank</td>
<td>W</td>
</tr>
<tr>
<td>Biofilm above the water line</td>
<td>S</td>
</tr>
<tr>
<td>Water jets</td>
<td>S</td>
</tr>
<tr>
<td>Back wash from filter</td>
<td>W</td>
</tr>
</tbody>
</table>

#### Decorative Fountain

<table>
<thead>
<tr>
<th>Sample Site</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fountain reservoir</td>
<td>W</td>
</tr>
<tr>
<td>Fountain trough</td>
<td>S</td>
</tr>
<tr>
<td>Material such as foam in the fountain</td>
<td>S,B</td>
</tr>
</tbody>
</table>

#### Cooling tower

<table>
<thead>
<tr>
<th>Sample Site</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection basin (area below the tower for collection of cooled water)</td>
<td>W,S</td>
</tr>
<tr>
<td>Sump (section of the basin from which water is pumped back). Silt and sludge may also be collected here</td>
<td>W,S,B</td>
</tr>
<tr>
<td>Drift eliminator</td>
<td>S</td>
</tr>
</tbody>
</table>

Types: 
- **W**: Water
- **S**: Swab
- **B**: Bulk
Health and safety

• Take appropriate precautions during sampling to minimize aerosols.
  • Taps should be turned on and run gently
  • Susceptible staff should not be involved in sampling
  • Respiratory protection (NIOSH, fit-tested, N-95), safety glasses, hard hat and safety shoes, impermeable gloves (nitrile), and high visibility vests

• PHIs should be accompanied by a health and safety committee member/facilities manager
  • This person can provide access to restricted area and remove fixtures
Environmental Sampling


• Allana Murphy, Senior Laboratory Lead for the Environmental Microbiology Section at Public Health Ontario Laboratory (PHOL)

• Anna Majury, Clinical Microbiologist
Reasons for no match

- Lag time between exposure to *legionella* contaminated water and time of sampling—conditions may have changed
- Didn't locate the source
- Shock disinfection before sampling occurred
- Not culturally viable
- Overloaded
More than one match

- Sequence based typing involves identifying only seven genes; possible to get more than one match
- New test - whole genome sequencing
- Involves reading the entire DNA sequence of the bacteria
- If WGS not available then go with epi info

Source: Weiss et al., Public Health Reports, 2017
Remediation and Emergency Control Measures

• Once the environmental source has been identified
  • Implement a remediation action plan

• May wish to hire an environmental consultant

• The most common methods
  • Thermal disinfection and/or
  • Chemical disinfection
Remediation and Emergency Control Measures

• Thermal Disinfection

  • Maintain water heater temperatures at 71—77 degrees C while progressively flushing each outlet for up to 30 minutes at 65 degrees C

  • Thermal disinfection will not disinfect downstream of TMV

  • Some researchers recommended that thermal disinfection be followed with chemical disinfection of the water system
Remediation and Emergency Control Measures

• Chemical Disinfection
  
  • The most common chemical used for chemical disinfection is chlorine (shock chlorination).
  
  • The level of chlorine should be dosed at 50 mg/L for an hour.
  
  • After disinfection is complete, the outlet should be flushed.
  
  • The plumbing components should be able to withstand this level of chlorination.
Remediation and Emergency Control Measures

Point-of-use Filters

• Commercially available membrane filters fitted to water outlets
  • Effective in preventing *Legionella* from being released at the point of use
  • Filters can be installed immediately and may be a better alternative than restricting showering and providing bottled water.
  • Does not eliminate *Legionella* from the potable water system
  • Follow the manufactures instructions on change out schedule
Post-Remediation Sampling

• After remediation, all previously contaminated sources should be resampled, to ensure that the re-colonization of *Legionella* has not occurred

• Biofilms can be difficult to remove even with thermal and chemical disinfection and they may serve as a reservoir for persistent *Legionella* contamination
Long term Prevention

• Most effective strategy for reducing the risk of Legionnaires’ disease is
  • Supplemental disinfection
  • Eliminating stagnant water conditions
  • Proper water temperature management

• *Legionella* water safety plan
  • ANSI/ASHRAE Standard 188-2015
  Legionellosis: Risk Management for Building Water Systems
  *Best practices document which focuses on identifying hazardous conditions and applying control measures to interrupt Legionella growth and transmission.*
Questions/Comments

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Valerie.Nguyen@mlhu.on.ca