Waterborne Pathogens & *Legionella*: Reducing Legionellosis Risk *Through Prevention*
Overview

► Legionella 101
► Economic /Legal Impact
► Guidelines & Regulations
► Being Proactive
► Disinfection Modalities
The **No. 1 IEQ Contaminant Likely to Result in** Mortality
Brought to attention in workplace environment

Also community health issue
Legionella bacterium 101

- 34 deaths
- > 200 illnesses

- CDC identified the cause as *Legionella pneumophila*. 
## Cases of Legionella Outbreak

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th># Infected</th>
<th># of Deaths</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christianburgh, VA</td>
<td>1995</td>
<td>23</td>
<td>3</td>
<td>Spa</td>
</tr>
<tr>
<td>Madrid, Spain</td>
<td>1995</td>
<td>230</td>
<td>16</td>
<td>Tower</td>
</tr>
<tr>
<td>Lo Que Pas, AZ</td>
<td>1995-1997</td>
<td>7</td>
<td>1</td>
<td>Potable</td>
</tr>
<tr>
<td>Woodbridge, NJ</td>
<td>1995 (1997)</td>
<td>3 (2)</td>
<td>1 (1)</td>
<td>Potable</td>
</tr>
<tr>
<td>Culver City, CA</td>
<td>1999</td>
<td>11</td>
<td>1</td>
<td>Tower</td>
</tr>
<tr>
<td>Bovenkarspel, Holland</td>
<td>1999</td>
<td>233</td>
<td>22</td>
<td>Spa</td>
</tr>
<tr>
<td>Melbourne, Australia</td>
<td>2000</td>
<td>104</td>
<td>4</td>
<td>Tower</td>
</tr>
<tr>
<td>Muracia, Spain</td>
<td>2001</td>
<td>638</td>
<td>2</td>
<td>Tower</td>
</tr>
<tr>
<td>Cleveland, OH</td>
<td>2001</td>
<td>4 (8)</td>
<td>2</td>
<td>Unknown</td>
</tr>
<tr>
<td>Barrow-in-Furnace, UK</td>
<td>Unknown</td>
<td>123</td>
<td>3</td>
<td>Tower</td>
</tr>
<tr>
<td>Toronto, Canada</td>
<td>2005</td>
<td>120</td>
<td>23</td>
<td>Potable</td>
</tr>
</tbody>
</table>
Legionella 101 - Legionnaire’s Disease

- Pneumonia.
- Incubation period of 2 to 10 days.
- Lasts for weeks.
- Frequently missed in diagnosis.
- Severity ranges from mild cough and low fever to rapidly progressive pneumonia, coma, and DEATH.

- Pontiac Fever

Outbreak in 1968 in Pontiac, MI
Legionella 101 - At Risk Populations

► Immuno-suppressed
  • Health care industry

► Smokers or others with chronic problems.

► Elderly

► Very young / neonatal

► Aging Workforce
Legionella 101 – CDC Facts

► 8,000 and 18,000 people are hospitalized with Legionnaires' disease in the U.S. annually.

► Estimated 25,000 to 75,000 cases annually (many infections are not diagnosed or reported)

► More illness is usually found in the summer and early fall, but it can happen any time of year.

► 5% to 30% of cases result in death.

► Most cases can be treated successfully with antibiotics, and healthy people usually recover from infection.
Legionella 101

► Reducing the mortality rate:
  ● Early diagnosis and testing.
  ● Correct antibiotics
Legionella 101

Upon exposure to *Legionella* several factors determine whether or not infection will occur:

- **Pathogen concentration**
- **The virulence** of the pathogen
- **The immune condition** of the patient
Legionella 101 - Exposure Routes

- **Inhalation of Water Vapor:**
  - Aerosols of water droplets

- **Ingestion of Water:**
  - Drinking
  - Ice
  - Showers

- **Aspiration**
  - Of water and drawing bacteria into the airways
Legionella 101 - Drinking Water Supply Chain

► Present at low, usually undetectable concentrations in the municipal water supply.

► Survive the municipal water treatment process due to relative resistance to low levels of chlorine.
Legionella 101 - Drinking Water Supply Chain

Source → Water Plant → City Pipes → End User
Legionella are Found in Both Cold and Warm Water
Legionella 101 - Major Growth Factor

- Warm water temperatures from 68 to 122° F

- Sediment, scale, deposits

- Certain amoebae and other protozoa that harbor Legionella – allowing it to thrive and amplify by resisting biocides.
Biofilm
Legionella 101 - Biofilm Shedding

- Intermittent Bio-film Shedding
Legionella 101 Biofilm Resistance

- Biofilm is difficult to eradicate. Biofilm is resistant against systemic disinfection such as:
  - Heat (Hot Water Flush $>70^\circ C$)
  - Chemicals (Chlorine)
Reconstruction measures may result in dead ends.
Cold Water Pipes are also a Risk

Warm and cold water pipes are frequently installed in the same duct
Legionella 101

► As a result, *Legionella* are found in man-made habitats.

- Legionnaires' disease has been linked to exposure to contaminated water supplies in:
  - Residences.
  - Commercial office buildings.
  - Hospitals.
  - Nursing homes.
  - Industrial facilities.
  - Hotels.
  - Cruise Ships.
Legionella 101

- Estimated to colonize 50-70% of all large water distribution systems.
Legionella 101

The predominant water systems associated with Legionnaire’s Disease are:

- Domestic hot water distribution systems.
- Cooling Towers.
- Spas and whirlpools.
- Industrial water supplies / systems.
- Humidifiers.
- Supermarket reservoir misters.
- Respiratory therapy equipment.
Legionella 101

The predominant water systems (continued):

- Decorative Water fountains
- Dental hygiene equipment
- Cold water systems (ice machines, storage tanks)
- Fire suppression systems
- Eyewash - Emergency Shower Systems
- Ice Machines
Non-Potable Sources

- Cooling towers
- Swamp coolers
- Spas/Whirlpools
- Supermarket misters
- Decorative Fountains
Legionella 101

Cooling Towers

- Evaporative cooling systems

- Atmospheric air cools warm water, with direct contact between water and the air.

- The smaller the water droplet (large surface-to-volume ratio), the more efficient the cooling.
Легионелла 101

- Вентиляторы (продолжение)

- Обычные температуры воды меняются от 85°F до 95°F.

- Органическое вещество и мусор (питательные вещества) накапливаются на поверхности.

- Вентиляционные башни могут передавать бактерии Legionella на расстояние до 2 миль под оптимальными условиями.

- Большинство инцидентов имеют расстояния передачи от 550 до 1100 ярдов.
Guidelines and Regulations
Guidelines and Regulations

- NO REGULATION IN THE UNITED STATES

- VA - Directive
- NY - Guideline
- TX - Guideline
- MD – Guideline
- CDC - Guideline
- OSHA - Guideline
- ASHRAE – Guideline (Consensus Standard in ????)
- Joint Commission – Accreditation Standard for Hospitals
Guidelines and Regulations

► Regulation and codes have legislative enforcement

- 20 Countries
  - Austria
  - England
  - France
  - Germany
  - Ireland
  - Italy
  - The Netherlands
  - Sweden
  - Turkey
Guidelines and Regulations

► ASHRAE Position Document Legionellosis


- Design and good operations, maintenance, and housekeeping procedures that prevent amplification and dissemination of *Legionella.*

- Not all recommendations are evidence based.

For example

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In high-risk applications, monthly removal of shower heads and tap aerators to clean out sediment and scale and to clean them in a chlorine bleach solution is recommended.
Guidelines and Regulations

► Depending on jurisdiction, public health agencies may have the authority to:

- Enter premises, undertake inspections, review Water management plans, require specific remedial action.

► Such governmental agencies can include:

- Departments of Health
- Environmental Health Departments
Departments of health often not familiar with Legionella get involved / react excessively.

May dictate unnecessary steps that are costly and not practical.

- Close facility
- Evacuation ordered.
- Bottled water.
- Excessive use of Super Heat / Hyper Chlorination,
Guidelines and Regulations

► OSHA offers guidelines to use when interpreting *Legionella* concentrations in cooling tower and potable water systems.
These guidelines are based on limited data and are subject to change.

**Action 1: Prompt** cleaning and/or biocide treatment of system when testing indicates:

**Action 2: Immediate** cleaning and/or biocide treatment of system when testing indicates:

- 100 / 1000 colony forming units (CFU) of *Legionella* per ml of water in a sample from a cooling tower.
- 10 / 100 CFU/ml in a sample of domestic hot water.

“Immediate” and “prompt” are not further defined in the guidelines.
ASHRAE Draft Standard

► Standard 188

► Risk Management Standard

► Go through the process of a formal risk assessment and develop a written prevention plan.

► Apply to owners/managers of most commercial, industrial and institutional buildings.
Be Proactive

► Conduct annual risk assessments.
► Develop a written Waterborne Pathogens Plan.
► Verify effectiveness.
► Review and update Annually.
Risk is a function of a particular feature, weighted by the population exposed to the risk.

The weighing factors are generally the type and number of:

- People exposed (e.g., healthcare setting, very high traffic, elderly, etc.).
- Water systems and their state of maintenance and care.
- Pathways for exposure.
Proactive - Evidence Based Risk Assessment

- Healthcare & Assisted Living
  - Highest Risk
- Travel Related Facilities
  - Higher Risk
- Workplace
  - Variable Risk
    - Smokers
    - Pre-existing medical
    - Aging workforce
- Residential
  - Lower Risk?
Assess the level of risk for contracting Legionnaires.

- Is there *Legionella* bacteria present?
  - You don’t know unless you look.
  - Remember 50-70% of all buildings colonized.

- Negative results do not mean no *Legionella* is present.
Proactive - Evidence Based Risk Assessment

- Are conditions suitable for multiplication of the organisms?
  - Temperature (68° F–113° F).
  - Source of nutrients (e.g., sludge, scale, rust, algae, biofilm and other organic matter).
Is there a means of creating and disseminating breathable droplets?

- Aerosol generated by a cooling tower, shower, decorative features, etc.
Proactive - Evidence Based Risk Assessment

- Is there the presence (and numbers) of people who may be exposed, especially in premises where occupants are particularly vulnerable.
  
  • Healthcare
  • Nursing Home
  • Workplace
  • Office
  • Cruise Ship
  • Hospitality
Location - Outdoor Air Intakes

Figure 5-L—Outdoor Air Intake Locations
Proactive - Evidence Based Risk Assessment
Disinfection Modalities
• POU Filters

• Short Course Treatment vs. Long Term Treatment

• Chlorine dioxide vs. Copper/Silver

• Conduct a risk assessment & a Waterborne Pathogens Management Plan.
Proactive - Disinfection Modalities

► System design features can influence the growth and dissemination of *Legionella*.

► Biocide dosing systems in water systems have proven effective.
Proactive - Disinfection Modalities

 ► The available disinfection methods to control Legionella in water distribution systems include short-term and long-term control measures.

 ► Two Approaches

  ● Point of Use

  ● Systemic Disinfection

  ● (3rd = Respirator Use unusual workplace situation)

 ► There is no one “best method” and each approach has advantages and disadvantages (Lin-98, Kim).

  ● Therefore analyzing water from systems is an essential component of a successful water treatment program.
Proactive - Disinfection Modalities

► Short-term methods
  ● Short-lived (weeks to months).
  ● Generally implemented in an emergency or intermittently.

► Hot water temperatures flushing outlets.

► Hyperchlorination (2-4 ppm free chlorine).
Proactive - Disinfection Modalities

► Superheat & Flush

► “Thermal Eradication” “Super Heat and Flush.”

► Flush every fixture with 65°C (150°F) hot water for 30 minutes.
  - Contrary to CDC that claims 5 min.
Proactive - Disinfection Modalities

- Long-term methods include:
  - Permanent temperature change
  - Copper or silver ionization
  - Chlorine dioxide
  - Filters
The following general maintenance activities are not necessarily evidence based:

- Clean and disinfect water heaters once a year.
- Flushing
- Keep shower heads and taps clean and free from scale.
- Draining hot water heaters periodically.
Proactive - Disinfection Modalities

► Cooling Towers – Manage & Treat to minimize:

- Microbial Growth
- Scale / Corrosion
- Sediment
- Biofilms
Proactive - Disinfection Modalities

- Biocides
  - Oxidizing / Non-oxidizing
- Scale & Corrosion Inhibitors
- Biocides must be EPA Approved.
- Water chemistry & microbiology
- System Management PMR
  - System cleaning
Proactive – Management Systems

► Waterborne Pathogens Plan
  ● Domestic Water
  ● Utility Systems
  ● Misc Water Features

- Hot water tanks = 4
- Cold water tanks = 2
- Showers = 1
- Faucets = 8
- Recirc. pumps = 2
- Cooling towers = 1
- Humidifier = 1
Proactive - Management Systems

- Temperature
- Disinfection
- Periodic Testing
- Maintenance and Cleaning
  - Cooling Tower System Shutdown and Start-up
  - Water storage tanks
  - Ice Machine
Proactive Prevention Strategies

► Run for your life…….
COMPLACENCY
I think we can relax now.
Questions?