Legionella and Legionnaires’ Disease in Southern Nevada
• What is *Legionella*?
• Where does it come from?
• How it causes infections
• Finding, investigating, reporting
• Preventive steps
• Case Study
Discovered in 1976 at an American Legion Convention in Philadelphia

Attendees became ill with pneumonia
221 Total Cases
2/3 Hospitalized
34 Deaths
Bacteria *Legionella pneumophila* were found to be the cause.
What is *Legionella*, and where does it come from?
Organism Characterization

Kingdom Bacteria, Genus *Legionella*

43 or more identified species of *Legionella*

Multiple **Serogroups**, with over 60 serogroups presently identified for the genus

Many of the species serogroups are further differentiated into numbers of **subtypes**
Legionella pneumophila, Serogroup 1
Other L. pneumophila serogroups
Other species of Legionella

70% 5-10% 20-30%
Ecology of *Legionella*

Grow best at 68 to 115° Fahrenheit

*(Water supply systems often kept at 77 to 108°F)*

Can be found in natural surface waters and in buildings

Infect/replicate in both protozoa and human white blood cells

The protozoa/blood cells infected with *Legionella* burst and release the bacteria into the water
**Legionella** enters the amoeba or white blood cell macrophage.

**Legionella** fuses with the cell’s endoplasmic reticulum-inside a membrane-bound vacuole and replicates.

**Legionella** releases from amoeba/white blood cell, exiting as the cell dies by forming a pore and exploding.
Growth curve

Like other bacteria, *Legionella sp.* have optimum growth temperatures
<20°C (68°F)
Predominantly dormant, but still viable
35-46°C (95-115°F)

*Legionella’s* optimal growth temperature
50°C (122°F)
90% Kill in 2 Hours
>70°C (158°F)
100% Rapid Kill
Oxygen

Standing Water

Wet Tubing

Warm Temps

Microorganisms

Bacteria

Legionella, germs, fungi

Food deposits

$CO_2$, Metal Ions, Nitrate, Ammonium, Sulfate
*Legionella* attaches to biofilm
Replication forms a microcolony
Colony reaches maturation
Some *Legionella* form new colonies
Others continue to end fixture
*Legionella* are found in the biofilms that accumulate in the built environment:
How *Legionella* causes human infections
The bacteria travel downstream to locations where it is aerosolized, such as:
Susceptible Individuals:
50+ Years of Age
Has Chronic Lung Disease
Has Weakened Immune System
Is a current or former smoker
Incubation Period

2 day - 14 day
High fever
Headache
Chills
Muscle pain
Dry Cough
Difficulty breathing
Symptoms are severe; the individual will usually visit a physician. Legionnaires’ disease may be diagnosed as common pneumonia.
Sputum culture or urine antigen test is used for positive identification.
8,000 to 18,000 Hospitalizations Annually
4,000 Deaths Annually
5–30% Mortality Rate
Legionnaires’ disease is under reported
...sometimes patients recover without medical assistance
...sometimes patients are not tested by the physician
...and sometimes patients receive a misdiagnosis.
Once diagnosed, the physician reports the diagnosis to the local health department.
More than 20% of cases are associated with travel.
CDC reports the case to the visited state or community.
If a case is associated with an SNHD-permitted facility, SNHD conducts an investigation.
Environmental Investigation
SNHD receives report of Legionnaires’ disease
SNHD informs facility of case (Visit/Letter)
Investigation

Environmental Assessment

INTERVIEW

- Building Schematics
- Water systems
- HVAC system
- Bodies of water and/or water systems

- Water management plans
- Recent sample results
- Water System Consultants
Investigation

Environmental Assessment

ONSITE SURVEY

Tour of water system

Collection of chlorine residuals and water temperatures

Collection of water and biofilm samples

All buildings

Guest rooms

Guest Rooms

Bodies of water

Bodies of water
SAMPLING EQUIPMENT

- Sterile plastic 1 L bottles
- Sodium Thiosulfate
- Pipettes and bulbs
- Chlorine analyzer
- Thermometer
- Labels
- Chain of Custody
- Dacron-tipped swabs
- Sterile Plastic screw top tubes
SAMPLING-PROCEDURE

- Pre-Flush sampling the Hot and Cold water
- Post-1 minute flush sampling the Hot and Cold water
- Swab samples of faucets / emitters
Types of rooms tested

– Case room
– Terminal end of loop
– One additional room
– Riser vs. System
– Other possible sources
Test Results: 10-14 Days

SNHD reviews results and sends to facility
Action will be taken if the results have identified the organism that caused the illness.

This is the target organism.
For example, in the case that had a positive urine antigen test, the target organism will be *L. pneumophila*, serogroup 1.
Results

If the target organism is identified in the results of room fixtures or hot water system, SNHD will require that the water system supplying the room water system be remediated based on the following results:

- Target organism in bulk water greater than 10 cfu/ml
- Environmental swabs from two different fixtures greater than 10 cfu/ml
- Water or environmental swabs from two different fixtures less than 10 cfu/ml
Results

If a single water sample or environmental swab returns with results less than 10 cfu/ml, but is the target organism, then the SNHD shall determine what type of remediation is required.
Results

If the results find other *Legionella* in the samples, SNHD will make a recommendation based on results.
Environmental samples collected from areas that are not guest room fixtures must meet the OSHA standards. If the samples do not meet OSHA standards, then remediation of the system will be required.
100 CFU
10 CFU
1 CFU
If SNHD testing verifies that the facility contains *Legionella*, the areas that were identified as containing *Legionella* must be remediated.
Remediation of *Legionella* is dependent upon where it is found.

Additional testing or remediation of the other water systems will be required.
Remediation
ASHRAE recommends two methods to remove *Legionella*: 
I: Hot Water Flush
(160 - 170°F)
2: System chlorination (min 2 ppm, 2 hours)
Legionella can come from any source upstream...
...So, if this site tests positive for *Legionella*,...
...it could have come all the way from the well pump, up the riser pipes, and into the faucet.
Follow-up testing of the water system is performed to ensure the remediation was effective.
After remediation, the facility must adhere to a strict monitoring sample schedule.
3
Biweekly
Monthly
Quarterly
Communication with Public during an Outbreak Investigation

During an outbreak investigation, SNHD will issue reports updating the public on the ongoing investigation and what has been found.

Timing of the reports will be dependent upon the activities of Environmental Health and the Office of Epidemiology.
Ongoing control is necessary to ensure that the facility does not pose an increased risk to occupants.
ASHRAE Standard

- Proposed New Standard 188, Prevention of Legionellosis Associated with Building Water Systems
- The goal of the document is to specify a Standard Practice for use by facility managers/owners to prevent legionellosis associated with building water systems
- Requires a Hazard Analysis Critical Control Point (HACCP) plan
Active Control Measures currently in use
Control can include raising the temperature of the water or adding secondary disinfection.
If secondary disinfection is used as a control, the facility may need to obtain public water system (PWS) permit.
Ongoing secondary control options that...

...may not require a PWS permit

- Heat-and-Flush (Heat Shock)
- Ultraviolet (UV) Radiation
- Ozonation
Ongoing secondary control options that...

...may require a PWS permit

- Chlorination
- Copper-Silver Ionization
- Chlorine Dioxide
- Monochloramine
Public Water System Requirements

Application to Nevada Department of Environmental Protection, Bureau of Safe Drinking Water

PWS Classification
  – Community
  – Non-Transient Non-Community
  – Transient Non-Community

Tri-annual sanitary survey
Public Water System Requirements

Water Quality Monitoring
- Chlorine Residuals
- Disinfection By-Products
  - Total Coliforms
  - Lead and Copper

Water Operator Certification
- Distribution operator
- Treatment operator

Public Notice Requirements/
Consumer Confidence Reports
Case Study
**CDC**
- Multiple cases different time periods
- Urine Antigen Positive
- Provided information on the facilities and rooms where the cases stayed

**SNHD**
- Informed Facility
- Performed Environmental Assessment
- Collected water and biofilm samples

**Facility**
- Assisted SNHD with all requests
The positive urine antigen tests indicated that the cases’ Legionellosis were caused by *Legionella pneumophila* serogroup 1. Environmental sample results indicated the presence of *Legionella pneumophila* serogroup 1 in the riser tested.
SNHD required remediation of the hot water system in addition to additional testing of the remaining hot water risers
The facility decided to remediate all of the risers beginning with the riser where the most recent case stayed.
The most recent case had a sputum isolate of *Legionella pneumophila* serogroup 1, the CDC requested cultures from the case and environmental isolates be sent to them for DNA sequencing.

The DNA sequencing found that all of the environmental isolates either matched the case isolate or varied by a single nucleotide mutation on one gene.
Follow-up post remediation testing did not detect *Legionella* in the hot water system.

The facility was then placed on the additional testing protocol discussed earlier.

To date, *Legionella pneumophila* serogroup 1 has not been identified in the facility.
Reports on the recent investigations can be found at

- www.snhd.info
- Click ‘Health Topics’
- Then click ‘Statistics, Surveillance and Reports’
Summary

Ultimate Goal is for us to work together in a proactive way
• Not working together in a proactive manner will result in:
  – Rolling the dice for the second case
• Two cases with no response will result in an OUTBREAK response from SNHD, including:
  – Need for SNHD to notify the public
  – SNHD requesting guest lists
  – Notification of new guests regarding the outbreak while investigation is ongoing
  – Potential/likely posting of outbreak locations by CDC on their website
  – MEDIA WILL BE VERY INVOLVED/INTERESTED
• Being proactive by looking at one reported case as a canary in a mine:
  – Facility has a proactive Water Management Plan
  – If SNHD gets report of a case, SNHD will work with you to review the Water Management Plan and take samples to identify potential sources
  – Implement disinfection and take corrective action before sample results are received
• By SNHD responding and investigating and the facility using the best practices/taking the appropriate corrective action:
  – Any second case reported prior to the disinfection requires no further action

• If the SNHD investigation does not identify the target organism, then the investigation is closed and potential outbreak can be ruled out

• If a case subsequently occurs, and the SNHD does not identify a source, there will be no outbreak identified

• Minimizes the need for public notification/media attention
Discussion

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