Legionnaires' Disease – Controlling a Very Costly and Scary Hospital Acquired Infection

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Effective Engineering Solutions to Engineering System Pathogens

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Legionella
A Growing Problem
The issue is real.

Legionella and Legionnaires’ disease pose a real significant threat to the healthcare industry.

Because Legionella is typically a result of not having an effective plan to control waterborne pathogens the liability and litigation risk is very high.

For lawyers Legionella is the new asbestos.
National Incidence of Legionellosis, 1998-2012

Incidences per 100,000 pop.

Year

2014
CDC - Surveillance for Waterborne Disease Outbreaks Associated with Drinking Water – 2011-2012 pub date 2013

- *Legionella* was implicated in 66% outbreaks, 89% hospitalizations, and 100% deaths.
- Although the total number of drinking water-associated outbreaks has remained nearly constant, *Legionella* has caused increasing proportions of drinking water-associated outbreaks (33%, 60%, and 66% during each of these time periods, respectively). This pattern has been driven by the increasing proportion of *Legionella* outbreaks among those in community water systems (60%, 76%, and 84% during each of these time periods, respectively).
among 21 Legionella outbreaks in community water systems, 14 (67%) occurred in hospitals or health care facilities, illustrating the disproportionate disease burden among hospitalized persons, who are more likely to be older or have underlying conditions that increase their risk of developing Legionnaire’s disease.
2016 - EPA Commissions Study on Negative Impact of Water Use Reduction

8 years after Legionella becomes responsible for over 33% of DW outbreaks in ‘08, then over 50% in ‘09.
Southfield lawyer Geoffrey Fieger filed a $100-million lawsuit today against McLaren Flint Hospital and the State of Michigan, saying they did nothing to combat an outbreak of Legionnaires' disease that killed at least one person during the Flint water crisis.”

John Wisely and Jennifer Dixon, Detroit Free Press 7:08 p.m. EST February 2, 2016

(/story/news/local/michigan/flint-water-crisis/2016/01/22/legionnaires-expert-blames-spike-cases-flint-water/79203614/)
What has changed?

Why is this getting headlines?
1. Construction / Renovation
2. Healthcare Codes
3. Outdated Plumbing Codes
4. Water / Energy Saving Initiatives (LEED)
5. Population Changes
Strong Memorial Hospital has confirmed its sixth case of Legionnaires' disease — even though the hospital three months ago declared its water system free of the bacteria that cause the disease.

Strong officials said they do not know how the most recent patient caught the pneumonia-like illness.

They said they are beginning to suspect that the last two Legionnaires' patients might have acquired the disease before being admitted to the hospital for other health problems. Why?

Strong found low levels of Legionella in its water system in February after a patient tested positive for the disease. Three more patients tested positive, with one dying. Three of the four patients were already being treated at Strong for serious illnesses when they contracted the disease, according to Strong officials. The fourth had terminal cancer when the illness was contracted.
Al Evans said all his wife did was drink a glass of water and use the restroom while visiting a sick friend in early May 2006. He and Ruth Evans, his wife of 39 years, were visiting Susan Tripp, who was recovering from surgery in a new wing of the hospital.

“The same day we were in there, they came rushing in, took her (Tripp) out of there, said not a word to us and put her in the ICU,” Evans said. Tripp would be diagnosed with Legionnaires' disease within days, and a little more than a week later Ruth Evans went to the emergency room, gravely ill. She died May 22.

Rudy Martinez, who was caring for his hospitalized wife at the time, fell ill with the disease but survived, remaining in poor health, and so did John E. Swaney, who was visiting a friend at North Central Baptist.
Heat exchangers installed by hospitals to conserve energy can promote growth of *Legionella pneumophila* in their hot water systems, according to a study published in *Infection Control & Hospital Epidemiology*, the journal of the Society for Healthcare Epidemiology of America. For the study, researchers followed two cases of healthcare-associated *Legionella* infections at a 400-bed hospital in Canada. They identified the hot water system as the source of contamination.

The study found 27 of 34 water samples collected from taps showed high levels of the *Legionella* bacteria. Also, seven out of eight samples taken directly from the heat exchanger had high levels of the bacteria. The heat exchanger that was used to pre-heat the water "acted as a reservoir for *Legionella pneumophila* and contributed to the system wide contamination that led to the cases," the study authors noted.
“Leading plumbers fear many of Melbourne's new apartment buildings pose a legionella bacteria risk due to their energy-efficient ‘warm water’ systems.

The systems store water at lower temperatures than traditional units and have become popular in recent years as developers seek to achieve six-star energy efficiency ratings. They rely on solar-powered boosters to heat water on the way to residents' shower heads.

But the cooler temperature for storage of between 25 (77) to 40 (104) degrees can encourage the growth of legionella bacteria, while solar energy does not always achieve high enough temperatures to kill it off.

Mr Pewtress said residents at George - which won a national environmental award in 2012 - were still experiencing major problems with their water system more than a year after the VBA was first notified.”
Who is susceptible...

- Organ Transplant
- HIV
- Diabetes
- COPD
- Corticosteroids
- Cytotoxic Chemotherapy
- Radiation Therapy

- Age (over 50)
- Smoking
- Heavy Drinking
  - Gender (Male) slight increase in risk over female.
On January 1, 2001 over a decade and a half ago Joint Commission issued a standard of care, a code requirement, requiring all Joint Commission hospitals have a waterborne pathogen risk management plan effective 1/1/2001.

This Legionnaires’ disease issue is nothing new.
Introduction

“The Joint Commission's accreditation manuals for 2001 will include a new, standard that will appear in the Environment of Care - Utility Systems Management standards and require health care facilities to develop program that will reduce organization-acquired illness.”

“In an effort to offer a uniform strategy on the management of waterborne pathogens, ASHE and JCAHO staff have collaborated and drafted the following interim guidance and executive brief on Legionella.”

“Prepared by:
Dale Woodin, Advocacy Director, ASHE, Douglas Erickson, ASHE Consultant, DSE Consulting, Ltd., Susan McLaughlin, ASHE Consultant, SBM Consulting, Ltd., Dean Samet, Associate Director, JCAHO, George Stevens, Associate Director, JCAHO, Tim Keane, President, Legionella Risk Management, Inc.”
CMS codifies ASHRAE 188 with new policy dated 6/2/17

CMS memorandum titled: “Requirement to Reduce Legionella Risk in Healthcare Facility Water Systems to Prevent Cases and Outbreaks of Legionnaires’ Disease (LD)” states:

- “Facilities must develop and adhere to policies and procedures that inhibit microbial growth in building water systems that reduce the risk of growth and spread of legionella and other opportunistic pathogens in water.”
- “CMS expects Medicare certified healthcare facilities to have water management policies and procedures to reduce the risk of growth and spread of Legionella and other opportunistic pathogens in building water systems.”
The rate of reported cases of legionellosis has increased 286% in the US during 2000-2014

Approximately 9% of reported legionellosis cases are fatal.

Outbreaks generally are linked to environmental reservoirs in large or complex water systems.

19% of outbreaks were associated with long-term care facilities and 15% with hospitals.

Transmission from these water systems to humans requires aerosol generation, as can occur from showerheads, cooling towers, hot tubs, and decorative fountains.
**CMS also said...**

*Legionella* can grow in building water systems and devices can spread contaminated water droplets via aerosolization. Examples of these devices include:

- Hot and cold water storage tanks, Water heaters,
- Water-hammer arrestors, Pipes, valves, and fittings
- Expansion tanks, Water filters,
- Electronic and manual faucets, Aerators,
- Faucet flow restrictors, Showerheads and hoses
- Centrally-installed misters, atomizers, air washers, and humidifiers, Nonsteam aerosol-generating humidifiers, Eyewash stations, Ice machines, Hot tubs/saunas, Decorative fountains, Cooling towers
CMS requires - “Surveyors will review policies, procedures, and reports documenting water management implementation results to verify that facilities:”

1) 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.

2) Implement a water management program that considers the ASHRAE industry standard and the CDC toolkit, and includes control measures such as physical controls, temperature management, disinfectant level control, visual inspections, and environmental testing for pathogens.

3) Specify testing protocols and acceptable ranges for control measures, and document the results of testing and corrective actions taken when control limits are not maintained.
Who should be responsible for control of Legionnaires’ disease in a hospital?

a) Infection Control
b) Risk Management
c) Engineering
d) all of the above
e) a and c only
Who should be responsible for control of Legionnaires’ disease in a hospital?

a) Infection Control
b) Risk Management
c) Engineering
d) all of the above
e) a and c only
Who should be responsible for control of Legionella in a hospital water system?

a) Infection Control
b) Risk Management
c) Engineering
d) all of the above
e) a and c only
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2) Implement a water management program that considers the ASHRAE industry standard and the CDC toolkit, and includes **control measures such as physical controls, temperature management, disinfectant level control, visual inspections, and environmental testing for pathogens**.

3) Specify **testing protocols and acceptable ranges for control measures**, and document the results of testing and corrective actions taken when control limits are not maintained.
Who should be responsible for control of Legionella in a hospital water system?

a) Infection Control
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c) Engineering
d) all of the above
e) a and c only
Legionella & Litigation
Will ASHRAE 188
Increase or Reduce Liability Risk
By Jacob Batchelor

Law360, New York (February 24, 2015, 3:50 PM ET) -- Former guests of the Las Vegas Aria Resort & Casino can’t seek punitive damages in a case alleging they contracted Legionnaires' disease from the hotel's water system, because management took adequate water safety steps, a Nevada federal judge ruled Monday.

U.S. District Judge Andrew P. Gordon ruled on summary judgment that the hotel took numerous precautions to prevent the form of pneumonia in its water supply, including hiring an outside consultant, routine testing, and chlorination — all steps that show the hotel didn’t knowingly endanger the...
Negligence is caused by **not** delivering a ‘standard of care’.

‘Standard of care’ means implementation of appropriate laws and industry guidelines.
Duty of Care

Delivering a ‘standard of care’.

‘Standard of care’ means implementation of appropriate laws and industry guidelines.

Management by a knowledgeable, capable person

Is there someone responsible for control of legionella in your facility, in your design process?
Does that person understand the root environmental causes of the problem?
Does the person responsible for developing water system risk management plans adequately understand design, operation and maintenance of those systems and components in those systems?
Is that person familiar with industry, local, state and federal guidelines?
Considerations for litigation outcomes

- Severity of outcome
- Probability of outcome
- Sources of disease are well known
- Root causes are well established.
Legionella
The Bacteria and Disease
How Disease/Infection Occurs

- Interaction between agent, host, and environment
  - **Agent** - bacteria, fungi, viruses
    - Must be viable (living)
    - Must be present in adequate numbers and be virulent
  - **Host** - a person
    - Must be susceptible - influenced by age, nutritional status, underlying illness, vaccination status, immune status, exposure to procedures, etc.
  - **Environment** - the setting
    - Influences the spread of infection - temperature, humidity, season, hospital vs. community, construction/renovation, potable water, food preparation, etc.
Transmission of Infection

- The agent must be transferred from a reservoir to an acceptable entry site on a susceptible host in sufficient numbers (the infecting dose) for transmission to occur.

- **Direct** (Contagious person to person)
  - Direct contact (kissing, shaking hands, touching a wound)
  - Direct large droplet spread of secretions (coughing, sneezing - up to 20,000 particles into air)
Transmission

- **Indirect (Environmental - Not person to person)**
  - **Airborne**
    - (small particles, 1-5 um, suspend in air; breathed in)
  - **Vehicle-borne**
    - (contaminated water, food, blood)

  - Airborne transmission: size of particles determine where deposited in respiratory tract
    - 15-20 microns - nose, mouth, throat
    - 7-12 microns - upper airway
    - 4-6 microns - bronchioles
    - 1-5 microns - alveoli (deep in lungs)
Legionella

- **Infection:**
  - Pontiac fever - flu-like illness
  - Legionnaires' disease - pneumonia

- **Diagnosis:**
  - Difficult to culture and stain
  - Urinary antigen - only detects serotype 1
  - Bloodwork (serology, others)

- **Transmission:**
  - Environmental pathogen not contagious disease
    - Aerosolization and aspiration from environmental source into lungs
  - Not contagious - person to person
Legionella the germ

- Parasitic nature grows best inside hosts such as amoebae and lungs.
- Gram negative bacteria
- Intracellular parasite of amoeba
- Primarily found in freshwater environments
- Amplification and aerosolization needed to cause disease
- 48 species and 70 serogroups (22 species associated with human disease)
- *Legionella pneumophila* accounts for approximately 90% of all cases
Impact of ASHRAE Standard 188
ASHRAE / ANSI Standard 188-2015

- Publication Date
  June 26, 2015
- First International Legionella Standard

Standard committee members included personnel from following groups / associations:

- CDC
- ASHE
- ASPE
- APIC
- AWT
- GSA
- IAPMO
- NSF
- PMI and
- Major Equipment Manufacturers
- Large Corporations
- Consulting Engineers
## CONTENTS

**ANSI/ASHRAE Standard 188-2015**  
**Legionellosis: Risk Management for Building Water Systems**

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Chapter 2.1 This standard provides minimum Legionellosis risk management requirements for the design, construction, commissioning, operation, maintenance, repair, replacement and expansion of new and existing buildings and their associated (potable and non-potable) water systems and components.
2.2 This standard applies to human-occupied commercial, institutional, multiunit residential, and industrial buildings. This standard does not include single-family residential buildings. Only where specifically noted in this standard shall certain building water systems or part of building water systems be exempt.
Responsibility from the “source to tap” in any of these buildings means for an engineer designing the building water systems and/or the facility operator who is in charge of the water system - full responsibility from the water meter to the furthest fixture in the building.
4. COMPLIANCE
4.1 Building Designer Requirements
4.2 Building Owner Requirements
4.3 Health Care Facility Requirements
4.1.1 Survey each new building design and its water systems to determine if the design contains any of the devices or factors described in Section 5 that relate to Legionellosis. If the building and associated property has:

a. any of the building water systems in Section 5.1, then all of those building water systems shall comply with all applicable requirements of Section 8 of this standard.

b. any of the factors listed in Section 5.2, then the new building design shall comply with the requirements of Section 8 of this standard.
ASHRAE 188 Section 5.1

5.1 The building shall be surveyed to determine whether it has one or more:

a. open and closed-circuit cooling towers or evaporative condensers that provide cooling and/or refrigeration for the HVAC&R system or other systems or devices in the building.

b. whirlpools or spas either in the building or on site, or

c. ornamental fountains, misters, atomizers, air washes, humidifiers or other non-potable water systems or devices that release water aerosols in the building or on the site.
5.2 If the building has any of these factors:
   a. It includes multiple housing units with one or more centralized potable water-heater systems,
   b. It is more than 10 stories high (including any level below grade).
   c. It is a healthcare facility where patient stays exceed 24 hours,
   d. It is a building containing one or more areas for the purpose of housing or treating occupants receiving treatment for burns, chemotherapy for cancer, solid organ transplantation or bone marrow transplantation,
   f. It is a building ... housing occupants over age of 65
7.1.3 The program documents shall include procedures for:

a. inspections and the inspection schedule for water containing vessels and system components,
b. flushing or mixing of stagnant or low flow areas,
c. maintenance and monitoring procedures, based on equipment manufacturer’s recommendations for cleaning, disinfection, replacement of system components and other treatments necessary for the following:
8.1 General. When designing for new construction, renovation, refurbishment, replacement or repurposing a facility, the following shall be documented:

a. A system overview and intended mode of system operation.
b. Documentation and design compliance to address hazardous conditions for each of the following shall be provided:
   o schematic diagrams of water systems,
   o monitoring and control diagrams of water systems,
   o locations of access, fill, makeup, flush points, sampling points, temperature monitoring, and drain points,
### System Risk Factors
**Temperature**

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 72°F (22°C)</td>
<td>no growth</td>
</tr>
<tr>
<td>72°F (22°C) to 86°F (30°C)</td>
<td>slow growth</td>
</tr>
<tr>
<td>86°F (30°C) to 110°F (43°C)</td>
<td>rapid growth</td>
</tr>
<tr>
<td>110°F (43°C) to 122°F (50°C)</td>
<td>slow growth</td>
</tr>
<tr>
<td>&gt; 122°F (50°C)</td>
<td>no growth</td>
</tr>
<tr>
<td>&gt; 130°F (55°C)</td>
<td>die in hours</td>
</tr>
<tr>
<td>&gt; 140°F (60°C)</td>
<td>die in minutes</td>
</tr>
<tr>
<td>&gt; 160°F (71°C)</td>
<td>die in seconds</td>
</tr>
</tbody>
</table>
Water Temperature

The ANSI Z358.1-2004 requires tepid water and defines it as, “Moderately warm; lukewarm.” A good range to stay between is 60-95 degrees F. To assure tepid water, the equipment generally needs both hot and cold water, with a blending valve to mix the water. Consult the MSDS to determine if a chemical reaction is accelerated by the flushing fluid temperature. You may need to consult with a medical professional if this is the case.
A total of 705 ED visits for nonfatal scald burns were identified during the study period. No consistent temporal variation in the number of visits was observed across the 6 years,† or by hours of the day, days of the week, or seasons of the year. In 536 (76%) of the 705 visits, the nonfatal scald burn occurred at home, most commonly in the kitchen (60%), dining area (20%), and bathroom (11%). Hot food was involved in 42% of burns (rate = 9.9 per 100,000), hot water or steam in 30% (rate = 7.2), and contact with cookware in 9% (rate = 2.2); 8% (rate = 1.9) of nonfatal scald burns were related to home or kitchen appliances, including 3% with microwave ovens. Among the 705 visit narratives, 90% recorded the type of liquids associated with the burn, including hot (boiling) water (42%), hot oil (21%), coffee (15%), food (12%), steam (7%), and tea (3%).
“During the 6-year period, the estimated average annual number of initial ED visits for nonfatal scald-related burns in persons aged ≥65 years was 8,620.”

Of that number only 220 cases per year were related to potable hot water (sinks, showers and tubs)
## CDC Study - Nonfatal Scald-Related Burns

<table>
<thead>
<tr>
<th>Burn Source</th>
<th>Number</th>
</tr>
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<tbody>
<tr>
<td>Food</td>
<td>3,580</td>
</tr>
<tr>
<td>Water/steam</td>
<td>2,600</td>
</tr>
<tr>
<td>Cookware**</td>
<td>780</td>
</tr>
<tr>
<td>Home/kitchen appliances††</td>
<td>690</td>
</tr>
<tr>
<td>Bathroom products§§</td>
<td>220</td>
</tr>
<tr>
<td>Dining accessories¶¶</td>
<td>220</td>
</tr>
<tr>
<td>Other***</td>
<td>480</td>
</tr>
<tr>
<td>Unknown¶</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8,620</strong></td>
</tr>
</tbody>
</table>

§§ Includes bathtub, shower, and whirlpool.
Data from a Legionnaires’ disease outbreak in a healthcare facility demonstrated conclusively the impact of very low flow electronic faucets on Legionella colonization and resultant disease.

Water sample sets at time of outbreak included representative samples from electronic faucets (13), shower mixing valves (12) and manual sink faucets (14). Results were conclusive.
Figures from Hopkins Paper (2/28/12)

fig 1. Disassembled electronic-eye faucet. A, Aerator; B, solenoid valve; C, check valve; D, inline filter.

fig 2. Disassembled manual faucet. A, Aerator; B, hot water compression cartridge; C, cold water compression cartridge.
Contractor Awareness -

a) Insure not just your hospital operating team but also anyone hired for design, construction, renovation are knowledgeable in CMS requirements, ASHRAE Standard 118 and ASHRAE Guideline 12

b) Training - Contractors should have some documentation of training for compliance / competence in this area.
Plumbing Design Solution for Healthcare
Solution:

Avoiding stagnation by choosing a “series installation” or “loop installation”.

“series installation”

“loop installation”
Series innovation to reduce stagnation

Flow Through Fittings - Series

With a Series Installation, every time a fixture is operated, fresh water flows through the supply piping of every fixture upstream of the fixture used.

Whenever possible, the most frequently used fitting should be installed at the end of the series.
Private showers in hospitals are seldom used. Placing showers in series upstream of sinks insures every time sink is used shower is purged up to shower valve eliminating the need to manually flush shower saving in wasted water, energy and manpower.
Design Strategies

Thermostatic Recirc. Valve

Temperature pre-set

100 %

Volumetric Flow Rate (gpm)

134° F
Design Strategies

Internal Recirculation
Design Strategies

- Less Piping
- Smaller Circulator
- Saves Energy
- Saves Water
- Saves Material (Hangers, Fire Stops, Insulation)
- ProPress
- Fast Installation
- Less Material & Installation Cost compared to pipe system
- Innovative
The Eye Pod
Conclusions:

- Solutions that can be implemented by utilities
  - Maintaining higher chlorine residuals
  - Upgraded infrastructure
- Solutions that can be implemented by building owners / designers
  - Higher temperatures
  - In building disinfection
  - Flow velocity control
  - Heater type and operation
  - Water age
    - Less pipes
      - Rest room series flow
    - Pipe diameter based on flow (code change)
Questions?

Tim Keane
timke@verizon.net