Identifying Buildings at Increased Risk

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Objectives

- Identify structural and plumbing factors that put a building at risk
- Understand frequently used terminology

Outline

- Building Characteristics
- Patient Characteristics
- Devices present
- Cooling Towers
- Decorative fountains
- Hot & Cold water distribution systems
- Biofilm

Scenario 1:

- You are the Medical Director of Infection Prevention at a 450 bed hospital
- It was built in 2014 with a planned expansion to be completed in 2 years
- Some of the patients in your hospital are severely immunocompromised with organ transplants and an advanced oncology service.
- There will be anticipated disruption of plumbing as well as parts of the existing building as the construction is underway.
- The C-suite asks you to “do what needs to be done to make sure our patients aren’t exposed to anything.”

“YES, SIR”

Concerns

- Numerous construction related outbreaks reported
- Air-related
  - Aspergillus or other pathogenic molds
  - Spores can survive for long periods of time
  - during demolition or accessing walls/ceilings
  - airborne or tracked thru facility by workers
- Waterborne
  - Pseudomonas, Legionella, &/or mycobacteria
  - plumbing disruption → stagnation, inadequate disinfection→ organisms
  - Biofilms disrupted with changes in water pressure → more bacteria released

Action:

- Infection control risk assessments (ICRA)
- Infection Control risk mitigation recommendations (ICRMRs) for prevention of airborne and waterborne pathogens during construction and installation of features (HVAC, ice machines)

Scenario 2

- The hospital is beautiful.
- There's a donor who would like to donate money towards a decorative fountain in the Cancer Center.
- The administration thinks this would bring much enjoyment to the sick patients in the hospital.
- At a recent Infection Prevention social gathering, you overhear someone from another hospital talk about how their decorative fountain had to be removed because of a few cases of Legionella.
- The CMO of your hospital wants to know what to do and what to tell the donor about the fountain.

The answer:

“I will look into it and let you know”

How do I know?

How do we know if our building is safe?

What does safe mean?

Don’t all buildings have issues?

How do I get started?

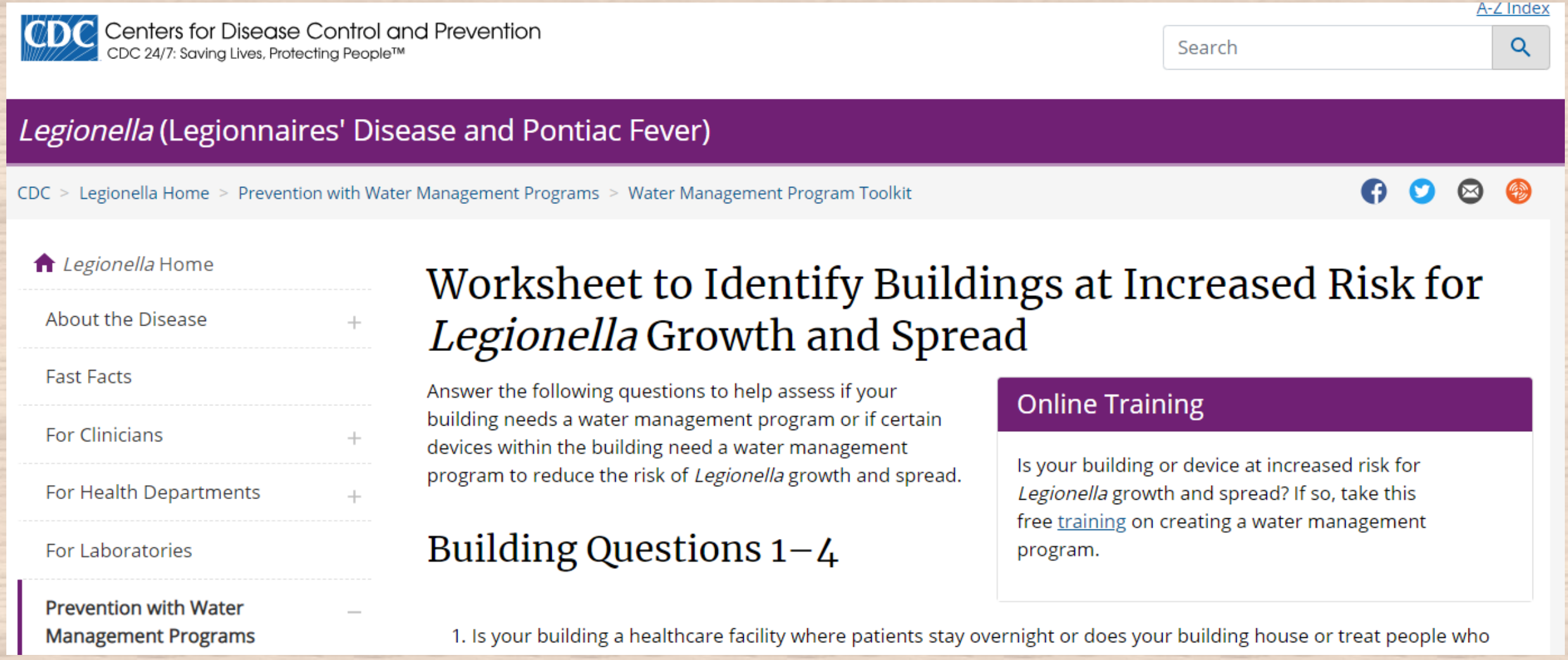
- I don’t know anything about construction or plumbing.
- I don’t know anything about water disinfection and biocides..

Where’s the cooling tower?

Decorative fountains?

Biofilms?

CDC Legionella home page



Toolkit: Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings

A Practical Guide to Implementing Industry Standards

Many buildings need a water management program to reduce the risk for *Legionella* growing and spreading within their water system and devices. This toolkit is designed to help people understand which buildings and devices need a *Legionella* water management program to reduce the risk for Legionnaires' disease, what makes a good program, and how to develop it.

Download the Toolkit

Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings: A Practical Guide to Implementing Industry

Consideration 1: Building characteristics

- Structure and size
- Age
- Location and surrounding conditions (geographic)
- Unique areas of risk for *Legionella* growth and spread
- Multiple housing units
- Centralized hot water system
- More than 10 stories

Consideration 2: Patient characteristics

- People over 65 (some say 50)
- Smoking: past or present
- Acute or Chronic medical problems:
  - Burns
  - kidney disease
  - Liver failure
  - Chronic Lung Disease
  - Diabetes
- Weakened immune systems:
  - Cancer
  - transplant

Consideration 3: Devices present

- Cooling tower
- Hot tub/spa
- Decorative fountain
- Centrally installed mister, atomizer, air washer or humidifier

Hyperbolic shaped cooling tower

Building Questions 1-4

1. Is your building a healthcare facility where patients stay overnight or does your building house or treat people who have chronic and acute medical problems† or weakened immune systems?
   - Yes
   - No
2. Does your building primarily house people older than 65 years (like a retirement home or assisted-living facility)?
   - Yes
   - No
3. Does your building have multiple housing units and a centralized hot water system (like a hotel or high-rise apartment complex)?
   - Yes
   - No
4. Does your building have more than 10 stories (including basement levels)?
   - Yes
   - No

Device questions 5-8

Devices in buildings that can spread contaminated water droplets should have a water management program even if the building itself does not.

5. Does your building have a cooling tower ?
   - Yes
   - No
6. Does your building have a hot tub (also known as a spa) that is not drained between each use?
   - Yes
   - No
7. Does your building have a decorative fountain?
   - Yes
   - No
8. Does your building have a centrally-installed mister, atomizer, air washer, or humidifier?
   - Yes
   - No

If you answer yes to any of the above, then

- You need a water management program for your building's
  - ✓ hot and cold water distribution system
  - ✓ cooling tower
  - ✓ hot tub
  - ✓ decorative fountain
  - ✓ centrally-installed mister, atomizer, air washer, or humidifier

- Multi-building campus: prioritize buildings that treat people at increased risk of contracting Legionella
- Single family or small multi-family homes are exempt

What is it about these features that puts buildings at risk*?

- Not just for Legionella but for other waterborne pathogens as well

Legionella can grow and spread in many areas of a building.

Effective water management programs can **REDUCE** the risk of Legionnaires' disease.

Legionella **can make people sick** when the germs grow in water and spread in droplets small enough for people to breathe in.

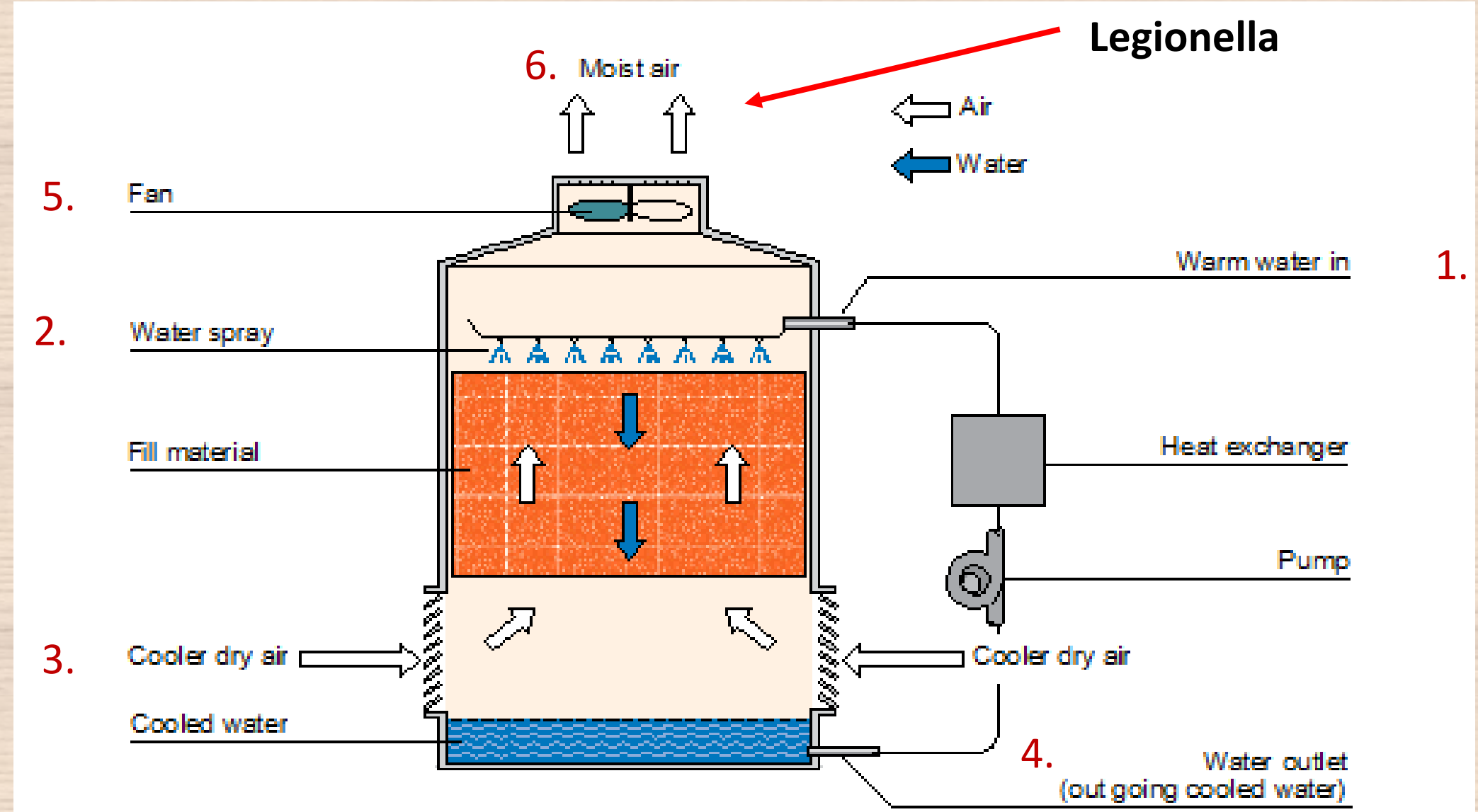
Legionella **grows best** in warm water that is not moving or that does not have enough disinfectant to kill germs.

SOURCE: Vital Signs, June 2016

What is a Cooling tower?

- Remove heat from a building
- Provide cooled water for large scale air-conditioning, manufacturing
- Works by spraying water down thru the tower to exchange heat resulting in warm moist air flowing out in a fine mist. Cooled water is then collected.
- July-Sept 2016: 196 cooling towers sampled in 9 regions of the Continental US.
  - 84% PCR positive for Legionella
    - 47% were culture positive, majority being *Legionella pneumophila*

https://doi.org/10.1371/journal.pone.0189937



Schematic of cooling tower

www2.health.vic.gov.au

Large tanks of warm water for Legionella to thrive

PLUS

Circulation of air with contaminated water droplets

AND/OR

Poor disinfection/maintenance

HIGH RISK OF TRANSMISSION TO PATIENTS

Decorative Fountains

- 2010 outbreak Wisconsin
- 8 people (not patients) passing thru the lobby
- Fountain was source
- More than 4000 people notified of possible exposure

A 2010 outbreak of Legionnaires' disease in Wisconsin has been linked to a decorative fountain in a hospital lobby.

Credit: Image courtesy of Society for Healthcare Epidemiology of America

Hot & Cold Water distribution systems

- pH (6.5-8.5)
- Effectiveness of disinfectant
  - Charcoal filters
- Water Temperature fluctuations
  - Legionella: 77-108F
- Plumbing:
  - Biofilm
  - Pipe corrosion
  - Scale & Sediment
- Water pressure changes→ disrupt biofilm
- Water stagnation—”dead legs” or infrequently used fixtures
  - Eyewash stations

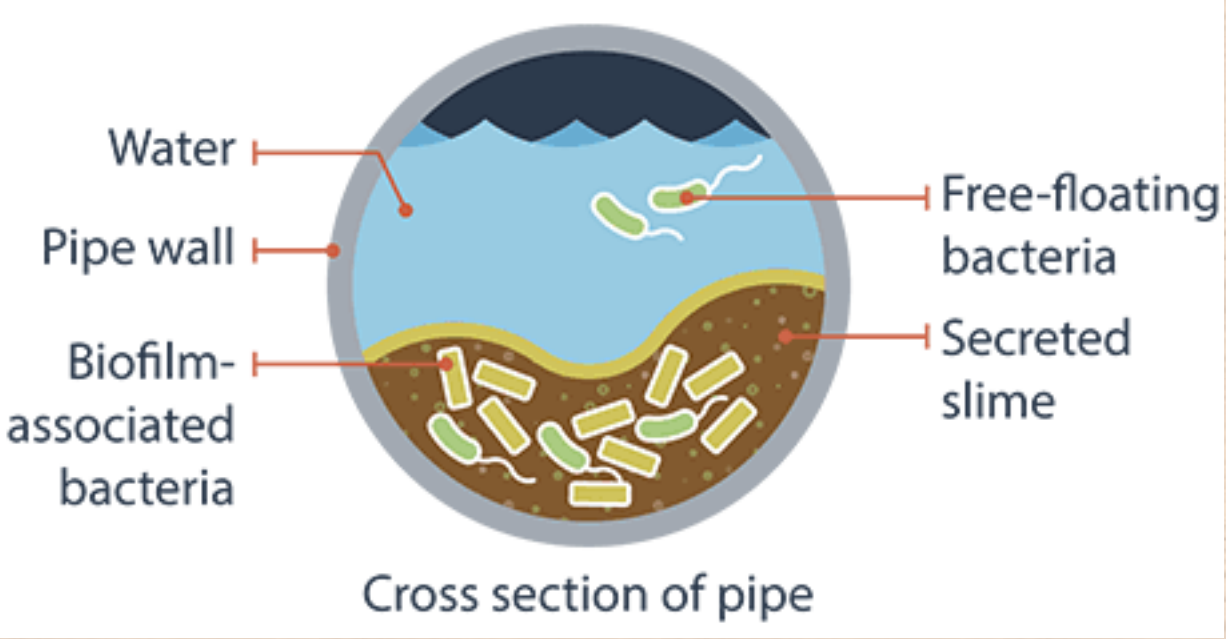
Scale in a pipe

Corrosion in a pipe

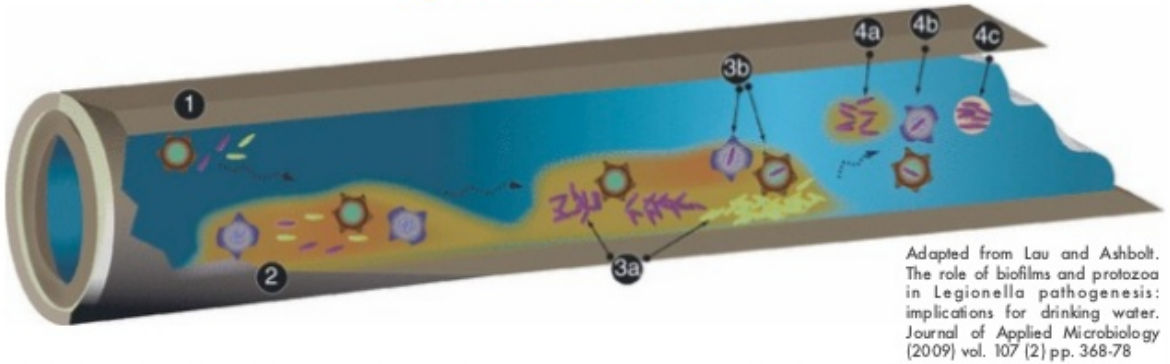
External Factors

- Construction → dislodge biofilm → release Legionella into the water
- Water main breaks → Changes in water pressure → dislodge biofilm
- Changes in municipal water quality:
  - Sediment
  - Lowering of disinfectant levels
  - Alter pH to be outside recommended ranges

Biofilm



Legionella infections can be traced to multi-species biofilms

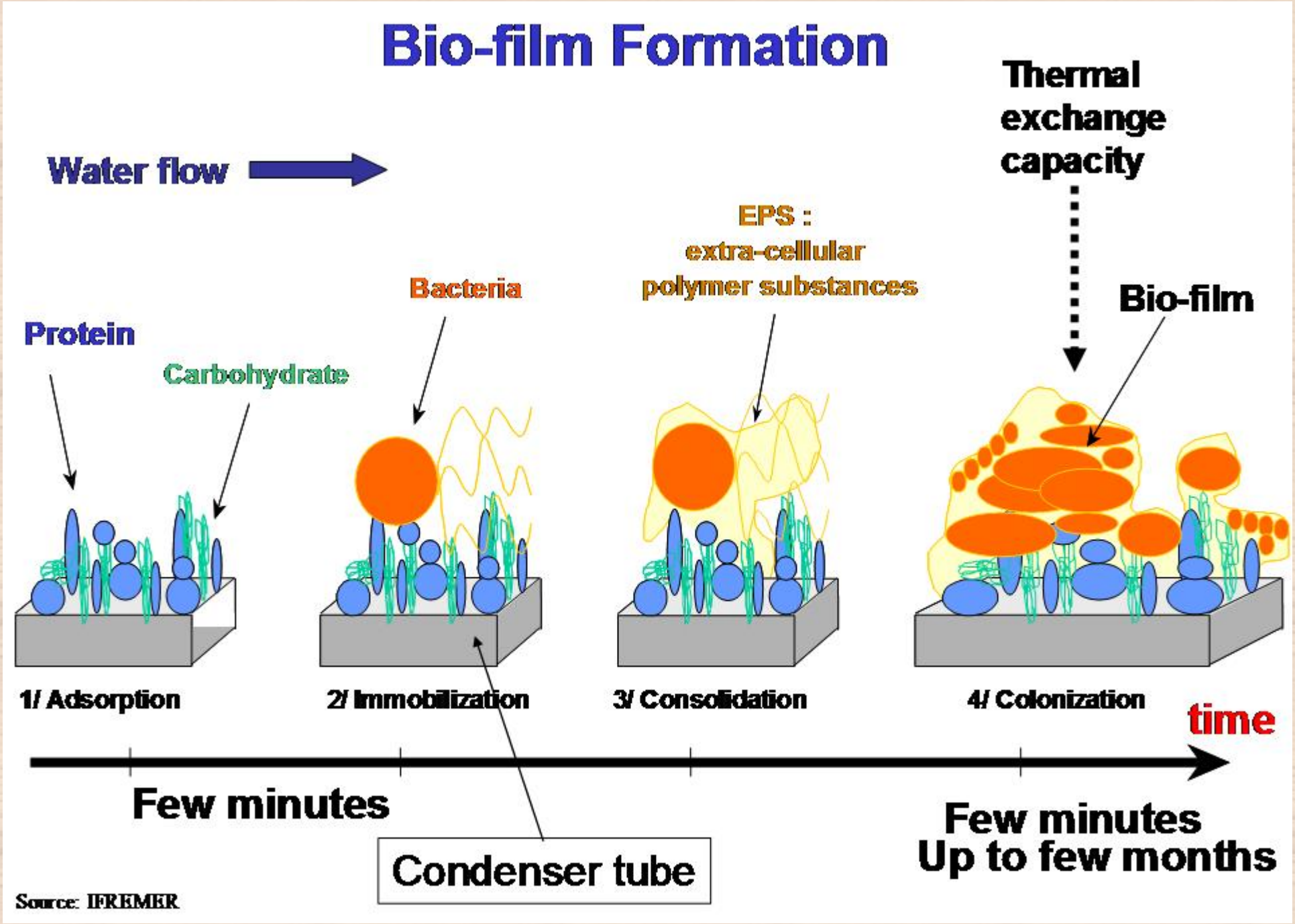


Adapted from Lau and Ashbolt. The role of biofilms and protozoa in Legionella pathogenesis: implications for drinking water. Journal of Applied Microbiology (2009) vol. 107 (2) pp. 368-78

1. Legionella along with various protozoa species (and different bacterial species) enter drinking water systems.
2. Absorption into biofilms.
3. Legionella either colonize (3a) or are ingested by grazing protozoa (3b), where they are multiply.
4. Legionella are then released from the biofilm and can enter into the drinking water or recolonize biofilms downstream.

www.cdc.gov

Journal of Applied Microbiology (2009) vol. 107 (2) pp. 368-781.


Bio-film Formation
Thermal exchange capacity
Water flow
EPS : extra-cellular polymer substances
Bacteria
Bio-film
Protein
Carbohydrate
1/ Adsorption
2/ Immobilization
3/ Consolidation
4/ Colonization
time
Few minutes
Few minutes
Up to few months
Condenser tube
Source: IFREMER

What lives inside biofilms?

- 95% of bacteria in water are in biofilms
- Organisms:
  - Protozoa (acanthamoeba)
  - Fungi (aspergillus spp, fusarium spp)
- Pathogenic bacteria
  - Legionella pneumophila and other spp
  - Pseudomonas aeruginosa
  - NTMs
  - Stenotrophomonas maltophilia
  - Acinetobacter baumanii
  - Sphingomonas sppp
  - Aeromonas hydrophila

Hot tub

- Adequate residual
- pH
- Removal of slime
- Routine testing of pH, residual
- Changing water
- Filters
- Biocide shock treatment
- Cover hot tubs

https://www.cdc.gov/healthywater/pdf/swimming/resources/operating-public-hot-tubs-factsheet.pdf
https://www.cdc.gov/legionella/downloads/hot-tub-disinfection.pdf

Scenario 2 (cont’d)

You tell your CMO that putting a decorative fountain in the lobby of the Cancer Center is NOT a good idea as there have been multiple reports of outbreaks and infection relating to Legionella and other waterborne pathogens associated with fountains.

Do we have any issues?

- Your IP director, reassures you that there have been no known cases of **Legionella** in your facility.
- However, she did notice that there's been a higher than usual number of cultures returning with **non-tuberculous mycobacteria**, specifically **M. avium intracellulare**.
- You both decide to look into this further..

Thank You

- Dr. Trish Perl
- Dr. Dan Diekema
- Dr. Matt Zahn
- Dr. Michael Klompas
- Dr. James Luby, former Medical Director of IP at UTSW
- Doramarie Arocha, Director of IP at UTSW
- Patrick Conley, Industrial Hygienist
- Steve Smith, Manager for facilities
- Chris Henderson, CIC

To be continued…

Thank you!

Questions?

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