



**Legionella is a bacteria that can cause lung infections including Legionnaires' disease, a serious type of pneumonia.**

## Legionella and Legionellosis

*Legionella* is a bacteria that can cause lung infections including Legionnaires' disease, a serious type of pneumonia. It can also cause Pontiac fever, a milder infection. Collectively, these diseases are known as legionellosis. People can get either disease when they breathe in small droplets of water in the air that contain *Legionella*.

### History

*Legionella* was discovered in 1976 after 182 attendees of an American Legion convention fell ill at the Bellevue-Stratford Hotel in Philadelphia. Of the reported cases, 29 died. Those affected suffered from a type of pneumonia that doctors were unable to pinpoint the cause of. After several months of research, the responsible pathogen was eventually identified in January 1977. The disease became known as Legionnaires' disease and the previously unknown bacteria was eventually named after the

disease. Following the discovery of Legionnaires' disease, unexplained outbreaks of severe respiratory diseases that occurred in the 1950s were attributed to *Legionella*.

The first cases of Pontiac Fever occurred in 1968 among people who worked and visited the city of Pontiac, Michigan's health department. However, it wasn't discovered until after the 1976 Legionnaire's outbreak in Philadelphia that the *Legionella* bacteria causes both diseases.

### Legionellosis symptoms and treatment

Legionnaires' disease is a severe form of pneumonia that often requires hospitalization. Symptoms can include acute onset of lower respiratory illness with fever, cough, shortness of breath, chills, muscle aches, and headaches. Nausea, vomiting, and diarrhea may also occur. The incubation period is typically 2 to 14 days after exposure (5-6 days is most common). It is estimated that Legionnaires' disease is the cause of 2 - 9% of pneumonia cases that are acquired outside of a hospital.

An x-ray or physical exam is used to check for pneumonia. A doctor may also order a urine antigen test and

sputum culture to determine if the infection is caused by *Legionella*.

There is currently no vaccine available for Legionnaires' disease but it is treatable with antibiotics. Most people who get sick need hospital care but make a full recovery. Possible complications of Legionnaires' disease include lung failure and death. About 10% of healthy people who get Legionnaires' disease will die from complications from their illness. The fatality rate is around 25% for those with underlying health conditions and for those who get Legionnaires' during a hospital stay.

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Most healthy people who are exposed to *Legionella* do not get sick. In outbreak settings, less than 5% of people exposed to the source of the outbreak develop Legionnaires' disease. Factors that may increase the risk of getting sick include:

- Age 50 years or older.
  - Greater than 60% of cases involve males.
  - Smoking (current and former).
  - Chronic lung diseases such as obstructive pulmonary disease or emphysema.
  - Compromised or weakened immune systems due to disease or medication.
  - Underlying diseases such as diabetes, kidney failure, liver failure, or cancer.
  - Recent travel with overnight stay. Travel is a risk factor because hotels, resorts, and cruise ships often have large, complex water systems with aerosol generating devices.
- More than 20% of Legionnaires' disease cases are among individuals who have traveled within 2-10 days of when symptoms begin.
- Recent care at a hospital or healthcare facility. Seven percent of Legionnaires' disease cases are among individuals who have stayed overnight in a healthcare facility.
  - Exposure to hot tubs.
  - The rate of reported Legionnaires' disease cases is higher in the Mid-Atlantic and Northeastern Central regions compared to the South and West.

In contrast, Pontiac fever is a milder, self-limiting illness without pneumonia. Symptoms may include fever, chills, myalgia, malaise, headaches, fatigue, and nausea. The incubation period may be as low as a few hours to 3 days after exposure. Up to 95% of people exposed during outbreaks of Pontiac fever can develop symptoms of the disease. Pontiac fever generally resolves on its own – hospitalization is uncommon and the fatality rate is extremely low.

*Legionella* can also cause disease outside of the lungs (extrapulmonary legionellosis). Examples include endocarditis, wound infection, joint infections, and graft infections.

## Transmission

*Legionella* is most commonly transmitted via inhalation of aerosolized (mist) contaminated water or soil. In the lung, human immune cells called alveolar macrophages (a type of white blood cell) look very similar to *Legionella* protozoa. When *Legionella* bacteria enter human lungs, it invades and grows within alveolar macrophages, mistaking them for their natural host. Inside the macrophages, the *Legionella* bacteria multiply, causing death of the

macrophage. Once the macrophage dies, the bacteria are released from the dead cell and infect other macrophages.

It is possible, but less common for people to get sick by aspiration of drinking water containing *Legionella*. In general, Legionnaires' disease is not contagious. People do not spread Legionnaires' disease and Pontiac fever to other people.

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## Sources of *Legionella*

There are at least 60 different species of *Legionella* bacteria. Although most are capable of causing disease, about 80% of disease is caused by the *Legionella pneumophila* species. Other species frequently associated with Legionellosis cases include *L. micdadei*, *L. longbeachae*, *L. bozemanii*, and *L. dumoffii*.

*Legionella* bacteria are found in nature in fresh water, such as lakes and streams, and in manmade water sources and supplies. In nature, *Legionella* grow in the thin fresh-water biofilm layer (i.e., slime) on the surface of rivers, lakes, and streams, but rarely cause illness. *Legionella* can also be found in most building water systems (e.g., heating, ventilation, and air conditioning; domestic and industrial potable water). However, the levels of *Legionella* are not usually present in sufficient quantity to cause disease. *Legionella* can also be present in soil.

In water, *Legionella* grows and multiplies in a symbiotic relationship within protozoa, which are small one-celled organisms. *Legionella* bacteria survive in water as intracellular parasites of protozoa, such as amoeba. The protozoa provide nutrients for replicating and growing *Legionella* and also provide protection from environmental conditions such as extreme temperatures and chlorine. Amoeba are often part of biofilms and once *Legionella* and the infected amoeba are protected within a biofilm, they are difficult to destroy.

*Legionella* bacteria grow best in warm temperatures and thrive at water temperatures between 77 and 113°F. The optimum temperature for *Legionella* growth is between 95° and 115°F. Temperatures above 140°F kill the bacteria.

Under specific conditions, *Legionella* bacteria can become a health concern when they grow and spread rapidly in building water systems and are transmitted to hosts via aerosolization.

Low and non-detectable levels of *Legionella* can exist in a water source without resulting in Legionellosis cases. However, under specific conditions, *Legionella* bacteria can become a health concern when they grow and spread rapidly in building water systems and are transmitted to hosts via aerosolization. *Legionella* grows best in warm water that is not moving or that does not have enough disinfectant to kill germs. According to the CDC, the most common places for getting Legionnaires' disease include hotels, long-term care facilities, and hospitals. Cruise ships are also another place where outbreaks can occur. In these buildings, the sources for aerosolizing and spreading water droplets contaminated with *Legionella* include:

- Showers and faucets. *Legionella* can grow in and spread through showerheads if the building's water has low disinfectant rates.
- Hoses, pipes, valves, and fittings.
- Cooling towers, evaporative condensers, and fluid coolers used in large, centralized air conditioning systems in office buildings, hotels, hospitals, and industrial processes. When disinfectant levels are low, cooling tower fans can spray contaminated water droplets, sometime far beyond the property boundaries.
- Evaporative coolers.
- Hot and cold-water storage tanks.
- Water heaters.
- Water hammer arrestors.
- Expansion tanks.
- Industrial processes that create aerosolized water (e.g., cooling spray or tanks and water-based fluids used as coolants during cutting and fabrication processes).
- Spa, whirlpools, and hot tubs. If hot tubs are not well maintained, the warm temperatures support growth of *Legionella*, which can spread through water jets.
- Decorative fountains and water features. *Legionella* can grow in warm areas of a fountain and splashing can spread the contaminated water.
- Windshield washers.
- Room-air humidifiers
- Ice-making machines.
- Centrally installed misters, atomizers, air washers, and humidifiers.
- Cooling misters including grocery produce misters.
- Respiratory-care devices such as humidifiers and nebulizers used with contaminated tap water.
- Medical equipment such as CPAP machines, hydrotherapy equipment, and bronchoscopes.
- Infrequently used equipment such as eyewash stations.
- Dissemination of aerosolized *Legionella* in an air handling system from an external or internal contaminated source.

*Legionella* can also be present in soil, potting mix, and compost. Note that home and automobile air conditioning units do not use water to cool the air, and therefore are not a risk for *Legionella* growth.



## Legionella growth in water systems

Internal and external factors that can lead to *Legionella* growth in a building water system include:

- Construction.
- Water main breaks.
- Changes in the municipal water quality.
- Water temperature fluctuations.
- pH fluctuations.
- Inadequate levels of disinfectant.
- Changes in water pressure.
- Presence of biofilms: Slimy biofilms of bacteria and other microorganisms can provide a source of nutrients for *Legionella*. Conditions which can lead to the presence of biofilms include:
  - Scale: Biofilms can develop when mineral deposits buildup on surfaces inside water lines and containers.
  - Sediment: Organic particles suspended in water provide a source of nutrients for *Legionella*.
  - Water stagnation. When water ceases to flow, biofilms can more easily develop.
- Presence of other microorganisms: Algae, amoeba, and protozoa provide a source of nutrients.

## Trends

In the United States, there are about 10–15 cases detected per million populations. An estimated 8,000 to 18,000 cases a year in the United States require hospitalization. However, Legionnaires' disease is believed to be under diagnosed and the true number of Legionnaires' disease cases may be 1.8 to 2.7 times higher. About 90% of Legionnaires' disease are likely missed due to misdiagnosis.

After *Legionella* was discovered, cases of Legionnaires' disease reported to the CDC increased from 235 in 1976 to 1,370 in 1990. Reported cases in the U.S. remained relatively stable from 1990–2002. Reported Legionnaires' disease cases began increasing in the U.S. in 2003. The number of reported cases in the U.S. has increased by nearly nine times between 2000 and 2018. The average incidence was 0.48 cases/100,000 population during 1992–2002 compared with 2.71 cases/100,000 population in 2018. It is not known if the increase is due to increased awareness and testing, increased susceptibility of the population, or increased levels of *Legionella* in the environment.

The reason that Legionnaires' disease rates are increasing is not known, but likely to do a variety of factors such as:

- Modern buildings with efforts to conserve water and energy.
- Aging municipal infrastructure.
- An aging U.S. population.
- Increasing summer precipitation and fall mean temperatures.
- Improved surveillance and reporting.

## Legionnaires' outbreaks

An outbreak is defined as two or more cases where the onsite of the illness is closely linked in time and space, where a suspicion or evidence exists of a common source of infection. Although outbreaks of Legionnaires' disease often receive significant media attention, the disease usually occurs in single, isolated cases that are not associated with an outbreak. Outbreaks of the disease account for a minority of the total cases. Legionnaires' disease outbreaks are also difficult to detect because symptoms take one to two weeks to develop and not everyone who is exposed develops the disease.

There are at least 20 outbreaks (aka clusters) of Legionnaires' disease reported each year in the United States. Most outbreaks occur in buildings with large water systems. While it can occur any time of the year, it is more common in the summer and fall.

The CDC has determined the following are common causes of Legionnaires' disease outbreaks:

- 65% are due to process failures, such as not having and water management program.
- 52% are due to human error, such as not cleaning or replacing hot tub filters per the manufacture recommendations.
- 35% are due to equipment, such a disinfection equipment, not working.
- 35% are due to changes in water quality due to reasons external to the building (e.g., nearby construction projects). Events that interrupt the delivery of municipal water supply to a building allow dirt to enter the water system and use up disinfectant.
- 48% are due to more than one of the above causes.

## Prevention

Most Legionnaires' outbreaks occur in buildings with larger water systems, such as hotels, long-term care facilities, and hospitals. *Legionella* grows best in building water systems that are not well maintained. The key to help prevent Legionnaires' disease is maintenance of water systems. The CDC has shown that 9 in 10 outbreaks are caused by problems that are preventable with more effective water management. This requires a comprehensive water management program to prevent its growth and spread.

A water management program identifies hazardous conditions and takes steps to minimize the growth of *Legionella* and other waterborne pathogens in building water systems. The key elements of a water management system include:

- Establishing a water management program team.
- Describing the building water systems using text and flow diagrams.
- Identifying areas where *Legionella* could grow and spread.
- Deciding where control measures should be applied and how to monitor them.
- Establishing ways to intervene when control limits are not met.
- Making sure the program is running as designed (verification) and is effective (validation).
- Documenting and communicating all the activities.



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Specific elements of a water management plan may include:

- Keep water temperature either above or below the 68–122°F range in which the *Legionella* bacterium thrives.
- Prevent stagnation by removing from a network of pipes any sections that have no outlet (“dead legs”), infrequently used faucet, expansion tanks, hammer arrestors, by-pass lines, and backflow prevention devices.
- Where stagnation is unavoidable, as when a building is unoccupied or wing of a hotel is closed for the off-season, systems must be thoroughly disinfected just prior to resuming normal operation.
- Help prevent the buildup of biofilm by not using (or by replacing) construction materials that encourage its development.
- Reducing the quantity of nutrients for bacterial growth that enter the system.
- Periodically disinfecting the system by high heat, chemical biocide, or chlorination. Treatment of water with copper-silver ionization or ultraviolet light may also be effective.
- Reducing the production of aerosols and reduce human exposure to them, by directing them well away from building air intakes.
- Hot tubs and spas should be operated with proper disinfectant residual levels and pH. Free chlorine levels should be 3 – 10 parts per million (ppm), bromine levels should be 4 – 8 ppm, and pH should be 7.2 – 7.8.

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