

Source of the bacteria

Legionella bacteria are ubiquitous, surviving and multiplying in water. It is widespread in natural fresh water including rivers, lakes, streams and ponds and may also be found in wet soil. Airborne dispersal may occur when water droplets are created. There is a strong likelihood of very low concentrations of the bacteria existing in all open water systems including those of building services.

The risk is related to the number and types of Legionella in the water at the point of use. Also a large factor in risk within our buildings is the **Hazards** that promote proliferation of legionella and **aerosolation** of legionella.

Ecology

The following conditions have been found to influence the colonisation and growth rate of Legionella:

1. Water temperature between 20°C and 50°C is the range in which Legionella will proliferate most rapidly. The optimum laboratory temperature for the growth of the organism is 37°C. Legionella are killed within a few minutes at temperatures above 60°C. The death curve is logarithmic with time for a given temperature.
2. Poor water flow and areas within the water system where water is either stagnant (dead-legs) or trapped in pipework that is permanently capped (dead-ends) or is becoming stagnant. This is because water temperature will rise or fall to within the optimum range for growth and the formation of biofilm is encouraged.
3. Biofilm plays an important role in harbouring and providing favourable conditions in which Legionella bacteria can grow by providing protection from the effects of heat and biocides, notably chlorine.
4. Legionella have been shown to colonise certain types of water fitting, pipework and material used in the construction of water systems. Water quality can deteriorate in mixing valves (TMV's), particularly when utilisation is low, because the mixed water can then become stagnant at a temperature favoured by pathogens such as Legionella, and further to this, the cold tap if separate on the outlet is likely not to be used.
5. The presence of sediment, sludge, scale and organic material provides a good nutrient source for Legionella. Evidence suggests that the presence of iron oxide (rust) also favours the growth of the organism.

6. Commonly-encountered organisms in water systems such as algae, amoebae and other bacteria serve as an additional nutrient source for Legionella bacteria. Algal slime provides a stable habitat for multiplication and survival. Whilst exposure to direct sunlight may inhibit the growth of Legionella bacteria, it does stimulate growth of algae and the formation of slimes. Legionella bacteria have also been shown to proliferate rapidly in association with some water-borne amoebae.
7. Stagnant water encourages colonisation.

Note on Biofilm

Biofilm forms when bacteria adhere to surfaces in aqueous environments and begin to secrete a slimy, glue-like substance that can anchor them to many materials such as metals and plastics. A biofilm can be formed by a single bacterial species, but more often biofilms consist of many species of bacteria as well as fungi, algae, protozoa, debris and corrosion products. Essentially, biofilm may form on any wetted surface exposed to bacteria. Biofilm develops where the temperature is right for growth and where there is a nutrient source. Nutrients can be scale, sediment, corrosion products, or trapped organic and inorganic molecules supplied by the flowing water.

Epidemiology

Legionella pneumophila serogroup 1 is the commonest cause of legionnaires' disease. *L. pneumophila* is also responsible for **Pontiac Fever**. Another species, **L. Misdadei**, is responsible for a similar illness called **Lochgoilhead Fever**. To date, over 50 species of Legionella have been identified. The bacterium can be found naturally in many freshwater sources and can survive a variety of environmental conditions. Virulence may be enhanced when the bacteria have been exposed to temperatures around 37°C which are most favourable to its growth.

The risk of legionellosis depends on a number of factors such as:

1. The presence of Legionella in sufficient numbers.
2. Conditions suitable for multiplication of the organisms (for example temperatures between 20°C and 50°C and stagnant water).
3. A source of nutrients (for example sludge, scale, rust, protozoa, algae and other organic matter)

4. A means of creating and disseminating respirable droplets (for example cooling towers, showers and most other water draw-offs that are capable of creating a spray or causing splashing)
5. The presence of people who may be exposed to contaminated aerosols, especially those who are vulnerable to *Legionella* infection (for example those with compromised immune or respiratory systems, and transplant patients). Many, if not all, of these factors are likely to be encountered in healthcare premises, public areas, sheltered housing and were the elderly population or frail individuals frequent.

Control measures

Original guidance on the control of Legionella in hot and cold water services relied on a temperature control regimen: that is, maintaining cold water below 20°C and hot water above 50°C. Because of the complexity of hot and cold water systems found in hospitals and larger complicated old buildings with susceptible populations and the responsibility of maintaining a temperature control regimen at all times, chemical and other water treatments that have been shown to be capable of controlling Legionella may need to be considered to supplement a temperature control regimen.

Residual biocidal techniques such as chlorine dioxide and silver/copper ionisation can inhibit free-floating and attached bacteria with varying degrees of efficiency.

Ozone and ultraviolet (UV) treatment are also options, however, they have a limited effect as UV is non-dispersive, and ozone rapidly degrades and therefore has only a short-term residual effect. Ozone and UV are not effective at removing biofilm from hot and cold water distribution systems.

Monitoring to ensure that any of the control measures remain effective is essential. Ionisation is pH-sensitive and there have been reports of a reaction between silver and calcium causing staining of sanitary ware. Control of water hardness will be necessary to avoid this, but softening should not be used for drinking water systems. In hot water systems, chlorine is rapidly lost, and maintaining temperature control of the calorifier/water heater and hot water circulating system is essential.

Route of infection

The principal route of infection is through inhalation of the bacteria into the lungs. The risk rises with increasing numbers of inhaled bacteria. Aspiration of contaminated drinking water into the airways has also been described as a mode of transmission of legionnaires' disease. For some persons with mobile units for medical reasons, there is the additional risk of Legionella infection from the use of nasogastric tubes.

Aerosol generation

Contaminated water presents a risk when dispersed into the air as an aerosol. This risk increases with reduced droplet size, as smaller droplets remain airborne for longer, and aerosols (5 μm diameter or less) penetrate deeply into the lungs (alveoli) and cannot easily be expelled. However, larger droplets can evaporate and still contain the initial number of organisms. Amoebic vacuoles, typically 3 μm , may contain many Legionella and potentially provide an infectious dose.

In both a cooling tower and evaporative condenser, water is actively re-circulated around these systems, which increases the opportunity for aerosols to be produced. Water services are also capable of generating aerosols from the impaction of water onto hand-wash basins, sinks, baths and showers. In whirlpools and spas, the agitation of the water is achieved by the combination of air jets and pulsating water flow. Splashing water and air bubbles bursting as they break through the water surface create an aerosol immediately above the water surface. The risk of Legionella infection increases with the number of infective particles in the aerosol generated, especially if the size of the aerosol is less than 5 μm .

Number of infectious bacteria

The number of organisms that cause infection has not been reliably determined and is likely to vary from person to person.

Two factors determine the number of bacteria deeply inhaled:

1. The concentration of bacteria in the air: (i) this is determined both by the concentration of bacteria in the water and by the amount of contaminated water dispersed into a given air volume. The concentration of live bacteria in the air falls rapidly with distance from the source. Where a cooling tower and the fresh-air inlet to a building are both at roof level, it may be possible for contamination from the tower to reach the air inlet and, hence, enter the building(ii) the quantity entering will depend primarily on the separation distance between the tower and the fresh-air inlet. Increasing this distance of separation and locating the air inlet upwind (prevailing wind) of the tower help to reduce the likelihood of water droplets containing Legionella entering the building.
2. The duration of exposure to the contaminated air: (i) exposure in a shower is usually limited to a few minutes, while exposure in a bath, particularly a spa, is much longer. Exposure to airborne Legionella distributed from a contaminated water-cooling system may take place whenever the tower is operating – this may be most of the day during the

summer; (ii) the risk increases with the number of Legionella in the air, the respiratory rate of the individual and the length of time the person is exposed. The chances of Legionella infections occurring increase with the number, and susceptibility, of people exposed.

Susceptibility of individuals

While previously healthy people may develop legionnaires' disease, there are a number of factors that increase susceptibility:

1. Increasing age, particularly above 50 years(children are rarely infected).
2. Sex: males are three times more likely to be infected than females (this may change with altered smoking habits) existing respiratory disease that makes the lungs more vulnerable to infection.
3. Illnesses and conditions such as cancer, diabetes, kidney disease or alcoholism, which weaken the natural defences.
4. Smoking, particularly heavy cigarette smoking, because of the probability of impaired lung function.
5. Patients on immunosuppressant drugs that inhibit the body's natural defences against infection. Even those on normal ant-biotics.

For more information consult L8 as this is the book used in a court of law.

What next? Contact Simon French on 07771 560980 or via Web site as stated below for a totally independent unbiased help in auditing, consultancy and first class training.

**Water is for life
Don't let it kill you**