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Essential expertise for improving chlorine biocontrol performance.

Breaking The Causative Chain Of Legionellosis

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BACKGROUND

What is Legionellosis?

Legionnaires' disease first garnered public attention in 1976. After attending an American Legion convention at a Philadelphia hotel, 221 people became ill, with 34 dying of a mysterious illness. The U.S. Centers for Disease Control and Prevention (CDC) launched a major investigation, and in 1977 identified the responsible bacterium, naming it *Legionella*.
Infections caused by *Legionella* are called Legionellosis and have mild to severe effects. Two diseases caused by Legionella are Legionnaires' disease and Pontiac Fever. Legionnaires' disease is a potentially fatal pneumonia, whereas Pontiac Fever is more like a mild flu. While the disease and its cause are well known, the CDC reports that cases of Legionnaires' disease in the United States have grown by nearly 450 percent since 2000. This may be partly due to more infections, but also to aging population, increased awareness and testing, and other factors.

Symptoms for Pontiac Fever begin a few hours to three days after exposure and last about a week. Legionnaire's disease symptoms begin 2 to 10 daysfrom exposure. They may include cough, shortness of breath, fever, chills, headaches, muscle aches, and gastrointestinal illness. Patients often require hospitalization. Fatality rate varies, but the overall ratein Europe is 12 percent according to the World Health Organization (WHO).
Inhaling contaminated, aerosolized water droplets less than five microns in diameter is the most commonroute of exposure. Showerheads and faucets, hot tubs, cooling towers, HVAC systems, water fountains, and other water systems create aerosols that transmitthe bacteria. Those most at risk are people over 50 years old, current or former smokers, people with existing lung disease, and those with compromised immune system.

Legionella Bacteria

Legionellae are common throughout the worldwide environment in water and moist soil. While there are numerous species and subspecies of *Legionella*, only a few cause infections, with the majority resulting from exposure to *L. pneumophila*.

Legionella prefers warm water for growth, over 20º C , but below 50º C. The optimum temperature is 37º C , which is body temperature and the temperature most hot tubs are set at. It multiplies in stagnant water, making facilities with intermittent flows attractive. Cruise ships, hotels, campsites, and schools are highly susceptible for this reason.

In nature, *Legionella* does not exist in quantities to cause disease. However, small amounts can enter the water distribution system. It can then multiply in the complex water systems of large buildings and other facilities to become infectious. In addition to those noted above, common locations for infection include hospitals, large office complexes, areas around cooling towers, and fountains.

The Importance of Biofilm

Microorganisms, including *Legionellae* can adhere to natural and man-made surfaces. As they colonizethey form a biofilm, which helps protect them from temperature extremes or biocides.

Biofilms are extremely complex ecosystems and may consist of bacteria, algae, and grazing protozoa. Areasof slow water flow and stagnation encourage biofilm formation.

Water flowing past the biofilm provides nutrients and gas exchange, allowing *Legionella* to multiply. The biofilm provides stability, making it more difficult to physically remove *Legionella* and other pathogens, especially on surfaces with scale or corrosion. About 90 percent of the *Legionella* bacteria are in the biofilmversus the water stream.

Legionellae grown in biofilm are more resistant than those grown in the liquid phase. Research at the Montana State University Center for Biofilm Engineering has also found that as biofilms collect sediment or scale they become brittle and can break off in fragments. When these fragments are inhaled, they are more difficult for the body to clear than single bacteria.

As biofilm grows, protozoans can live within it. Protozoans are single celled animals, and include flagellates, ciliates, and amoebae. *Legionella* can infect an amoeba, a protozoan species, using the amoeba's internal materials as nutrients while gaining protection from the outside environment. *Legionellae* replicate within the amoebae, ultimately exploding and infecting other amoebae, then continuing to multiply.

To make things worse, *Legionella* that has grown within an amoeba may be protected from adverse conditions. Per a May 2013 article in the journal Virulence, "Cellular microbiology and molecular ecology of *Legionella*–amoeba interaction," when environmental conditions are unfavorable, amoeba can form into a cyst, protecting Legionella. The article also notes that "bacteria grown in amoeba have in biochemistry, physiology, and virulence potential" including better antibiotic and chemical resistance.

CHALLENGES

Industries and companies are responsible for minimizing risks posed by the growth of *Legionella* in their water systems thus preventing Legionellosis.

Regulatory Landscape

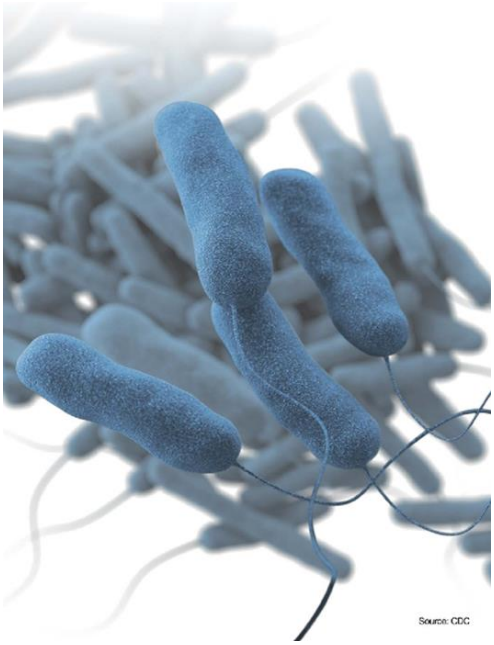
Regulations for preventing Legionellosis are difficult to encapsulate. The United Kingdom was a leader in this respect, implementing a stringent Code of Conduct after a major outbreak in the 1980's. *The European Technical Guidelines for the Prevention, Control and Investigation of Infections Caused by Legionella Species* is used as referral document throughout Europe. While individual countries may have different specific requirements, each has required methods to minimize risk, control *Legionella* growth, and document actions taken.

Guidelines in the United States (U.S.) are issued by the CDC, but there are currently no regulations. Some states or cities have adopted sections of the guidelines as law. Affected industries have implemented standards supported by the CDC, which offers a toolkit called *Developing a Water Management Program to Reduce Legionella Growth and Spread in Buildings: A Practical Guide to Implementing Industry Standards*. Other countries, like Indonesia, are now considering regulations for the control and prevention of Legionellosis.

Water Safety Plans

The guidelines above include development of a written Water Safety Plan (WSP) or water management program for each affected facility. Companies must perform a survey and risk assessment, looking at every link in the causative chain for Legionellosis. Once the risk assessment is complete they must address all the applicable issues. Other items in the WSP include training requirements for employees, documentation, and procedures to follow if an outbreak occurs. Each WSP is unique to its facility.

Items required in the WSP may include maintaining cold water taps below 15º C and above 50º C flushing stagnant lines, adding disinfectants,and preventing corrosion and biofilm buildup.



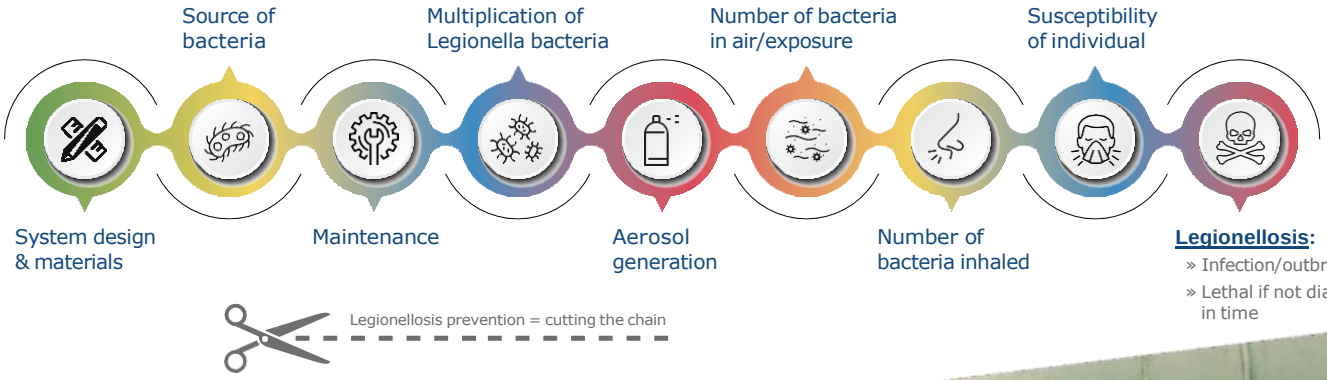
Breaking the Causative Chain

While regulations, standards, and guidelines for preventing Legionellosis have been in effect for over 30 years outbreaks are still possible and prevention is a major concern for water using companies

Clearly, the challenge of preventing this deadly disease is still ongoing. Each link in the causative chain must be addressed. Companies must find and cut the chain at its weakest link.

LEGIONELLOSIS

The Causative Chain



SOLUTION

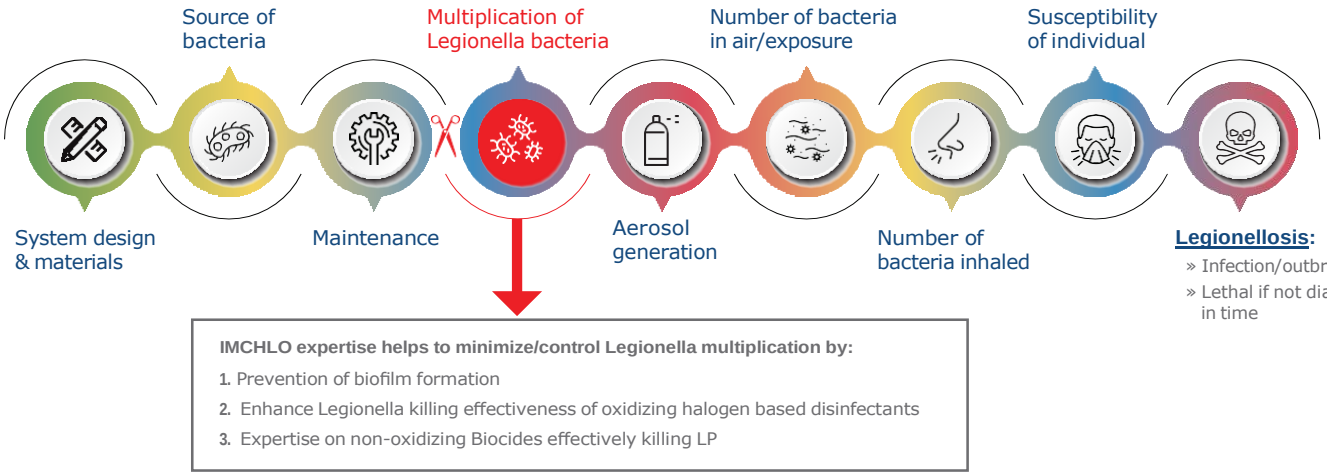
In order to cause infection, *Legionella* must be allowed to multiply and gain sufficient numbers. By controlling and minimizing Legionella proliferation, facility owners greatly reduce the risk of an outbreak.

Biofilm hosts the clear majority of *Legionella* in a water system–about 90 percent as noted previously. Also, *Legionella* grown in biofilm is more resistant to control methods. Heavy biofilm growth also supports amoebae, in which Legionella can strengthen and grow to the point of great multiplication and explosion.

By controlling the formation of biofilm, the causative chain of Legionellosis can be broken.

LEGIONELLOSIS

Breaking the Causative Chain



Biofilm prevention and removal should be part of a general microbial control program. Stopping the multiplication of *Legionella* does the same for other pathogens. For example, Naegleria fowleri, the “brain-eating amoeba,” or *Salmonella*, which causes many gastrointestinal illnesses.

Biofilms are very complex, dynamic systems. Preventing and removing them requires a high level of expertise. Many of our employees have worked in the industrial water industry and understand the systems where *Legionella* growth occur.

Reducing the Risk of Legionellosis

Reduceµing the potential for Legionellosis, with a three-pronged approach:

1. **Prevent biofilm formation**. This is the key to breaking the causative chain of Legionellosis. IMCHLO Stab-15 Stabilizer allows chlorine to penetrate the established biofilm. This technology allows the disinfectant to bypass the protective shield typically providedby the biofilm.

2. **Enhance the Legionella-inhibiting effectiveness of oxidizing halogen-based disinfectants**. IMCHLO Stab-15 technology provides astabilization and controlled-release mechanism that assures free halogen at more places then bleach alone.

3. **Use Non-Oxidizing biocides for Legionella control**. In emergency cases, there are 19 active biocidal compounds with proven effectiveness against *Legionella pneumophila*. Amongts them are BNPD (2-bromo-2-nitropropane-1, 3-diol), glutaraldehyde, dithiocarbamates, isothiazolin, DBNPA (di-bromo-nitrilo-propionamide), and some quaternary ammonium compounds. These products were tested using the Europeanmethod EN13623. (This method may not be recognized in all countries). If the first two stepsare utilized, this third method of control may not be needed.

Engage Technical Expertise

Using the help of technical experts saves companies time and money while helping to prevent a tragic Legionellosis outbreak. IMCHLO has the knowledge and experience to help companies break the chain and reduce the risk of Legionellosis.

Essential expertise for improving chlorine biocontrol performance.

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