Nosocomial Legionnaires' Disease: An Engineering and Integrated Approach Solutions for Prevention-Associated with Building Water Systems; By: Homi R. Mullan / e-mail: mullan.hts@gmail.com; Cell:+91-9820811308

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Nosocomial *Legionnaires' Disease* (LD): An Engineering and Integrated Approach Solutions for Prevention- Associated with Building Water Systems

Background:

During my professional work in dealing with the specialised field of Industrial Heating Systems for Hot Water utility, I came across a process of hot water heating application dealing with control of *Legionellosis* in Hot Water piping system. The application was to minimise risk of the multiplication of bacteria such as *legionella* in hot water piping system by maintaining the system at a temperature above and at a temperature below at which such a bacteria can multiply. A reference to this effect was made to U.K. Health and safety Executive document (HS (G) 70. Considering my extensive involvement and experience since 1993 dealing with infectious hospital waste management systems which overlaps with nosocomial infection control practices, I made further document research into the subject. Control of Legionnaires' Disease (LD) is an evolving subject that has gained momentum in the early 1990's resulting in establishing of new engineering and construction work standards and guidelines in the US, UK, Europe and Australia. A co-ordinated integrated approach is required by Management, Engineering, Microbiology and Physicians & Surgeons, Environmentalists and Health Administrators to prevent outbreaks of Nosocomial Legionnaires' Disease (LD). This outbreak of LD is not confined only to Hospital and Healthcare facilities. The LD outbreaks also concerns Hotels, Community Recreation and Health Centres (Spas, swimming pools), Old people homes, Jails, Buildings housing immunosuppressed people (Smokers, Alcoholics, people with: AIDS, diabetes mellitus, patient receiving systemic steroids, ≥65 years age, congestive heart failures and chronic obstructive lung disease). It also covers the industry using water for its processes for example Pharmaceutical industry and Engineering industry using cooling water during metal machining process.

Legionnaires' Disease is a severe, progressive form of pneumonia, which is fatal in up to 15 percent of cases.

This paper deals with various aspects of LD associated with building water systems. It provides broad overview of areas for prevention of LD outbreaks. Each aspect in itself is a specialised subject, requiring separate study. This would include but not limited to aspects of: i) Hot Water Systems; ii) Cold Water Systems; iii) Temperature Measurements for hot and cold water services; iv) Cooling Water Towers; v) Water Treatment; vi) Biocides; vii) Plant Soil; viii) Decorative Fountains.

Legionnaires' disease is a form of pneumonia, which particularly affects those who are susceptible due to their age, illness, immunosuppression, smoking or a combination of these. Inhaling airborne droplets or particles containing viable legionella small enough to travel deep into the lungs and be deposited in the alveoli causes infection. Other types of disease associated with the legionella bacteria have also been identified. These are Pontiac and Lochgoilhead fever. The generic term used to describe these diseases is Legionellosis.

Out of over 37 different species of legionella bacteria and 14 different Serogroups that are recognised to date, ***L.Pneumophila Serogroup 1*** being most commonly associated with cases of legionnaires' disease in the UK. Widespread in small quantities within natural water sources the bacteria present few problems until man made devices such as cooling towers and hot and cold water services provide the right conditions for multiplication and dissemination.

Engineering, Plant operation and maintenance staff play a supportive role on the Hospital Acquired Infection control committee at few progressive hospitals and Municipal Corporation. Now dealing with nosocomial LD prevention, the engineering staff at the hospital will be playing a leading role. Imagine the engineering staff disinfecting the water system and sterilising pipefittings after the hot water system has been opened for maintenance. Likewise the role of Microbiologist extends beyond the hospital laboratories to assist the Hotels, Buildings, Community housing and Home construction, and the Industries.

Like any other evolving subject, the aspect of preventing nosocomial Legionnaires' disease outbreak, it has to be led and supported by the management team right at the top of an organisation.

Although the dose of legionella required to infecting man is still not known, the conditions necessary to minimise the risk of this disease are well understood.

Summary
Legionell spp. is commonly found in a variety of natural and man-made aquatic environments and may enter hospital water systems in a low or undetectable numbers. Cooling towers, evaporative condensers, heated potable water distribution systems within hospitals and locally produced distilled water can provide a suitable environment for legionellae to multiply. Factors known to enhance colonisation and amplification of legionellae in man-made water environments include Temperatures of 25-40°C, Stagnation, Scale and Sediment, and the presence of certain free-living aquatic amoebae that are

capable of supporting intracellular growth of legionellae. This paper addresses solution of temperature maintenance of Hot Water system, which is one of the conditions of minimising the LD risk.

Guidance aimed at reducing the risk of Legionellosis in the UK was introduced by the Government in the early 1990s in the form of two documents:

- The Health and Safety Commission: The prevention or Control of Legionellosis (including legionnaires' disease): Approved Code of practice (ACOP), (came into effect 15th January 1992).

- The Health and Safety Executive: The control of Legionellosis including legionnaires disease: Health and Safety Series Booklet, [HS (G) 70]

HS (G) includes many design and operation and maintenance criteria to help minimize the risk of Legionellosis from building water systems included amongst these are:

i) 'Avoid temperatures in the range 20°C to 45°C for potable water systems.
ii) 'Avoid deadlegs' in distribution systems.
iii) Install destratification pumps' for water heaters.
iv) 'Routine cleaning' and 'chlorination' every six months for evaporative cooling systems.
v) Routine cleaning and chlorination every month for shower heads
vi) Routine cleaning and chlorination every six months for water heaters and hot water distribution systems.
vii) Maintaining cooling systems in a clean condition with the application of routine water treatment programs.
viii) Install high efficiency drift eliminators.
ix) Avoid construction materials, which harbour Legionella or support its growth.
x) Design and Construct systems to allow ease of access for cleaning and chlorination works and to enable systems to be taken out of service for such cleaning as required.

For the control of Legionella on health care premises the UK guidelines issued in 1989, the summary of which is presented below.

1.1.0 Water tanks and Storage Systems

1.2.0 Health Technical Memorandum (HTM) 27 recommends 24 hours total on-site storage capacity at roof level. There should be minimum heat gain

(BS 6700, section 2). The tank should be well insulated and have a properly fitted cover. The temperature of 20°C or lower should be maintained. All pipes should be tested at regular intervals.

1.3.0 Hot and cold water systems should be flushed with a calculated chlorine concentration of 50 ± 10 mg/litre (or p.p.m.) and left for 1 hour, after which time the chlorine concentration should be over 30 mg/litre. The process should be repeated if this concentration is not achieved.

1.4.0 Cold water should be distributed in such a way as to minimize heat gain.

1.5.0 Cold tanks should feed hot water systems, the water should then be heated to 60°C and the circulating temperature should be 50°C. The end water temperature should be no less than 50°C and the outlet should be clearly labelled DANGER! HOT WATER.

1.6.0 Hot and cold water pipes should be separated or thermally insulated to minimize heat gain.

1.7.0 Cold water should be less than 20°C after running the water for 2 minutes or less.

1.8.0 Pipes should be taken from as close to the water draw-off point as possible. For new installations, this should not be more than 300 mm.

1.9.0 Plastic washers should replace rubber ones.

1.10.0 Showerheads should be cleaned regularly.

2.1.0 Pools and Baths

2.2.0 Hydrotherapy pools, etc. pose no danger of Legionella contamination.

3.1.0 Ward closure (If a ward has to be closed for any length of time:)

3.2.0 All taps should be run for 3 minutes;

3.3.0 The cisterns should be flushed;

3.4.0 The water system should be disinfected prior to reopening.

3.5.0 Continuous chlorination and routine sampling for Legionella pneumophila are not recommended.

4.1.0 Air conditioning systems.

4.2.0 Stagnant or recycled water from the drip tray should not be in the vicinity of air generation.

4.3.0 There should be no deadlegs or pools of water.

4.4.0 The circulation pump flow should be able to overcome the resistance of the distribution system and the refrigerated machine condenser.

5.1.0 Disinfectant.

5.2.0 Hypochlorite is recommended as a biocide.

5.3.0 Protective clothing should be worn when handling Hypochlorite.
5.4.0 Sodium thiosulphate or sulphur dioxide (50 g/500 litre water) is used to dechlorinate the water system.

For the Stake Holders, Managers, Administrators, Medical and Engineering Fraternity and all of whom are involved in managing Environment and Health, the below listed questions and answers will briefly enlighten them on the subject of 'Legionellosis' and some of the measures for prevention of its outbreak on an epidemical scale.

Where are Legionella found?
Legionella bacteria are widely distributed in the environment. They can be found in creeks, ponds, **hot and cold water taps**, **hot water tanks**, **air conditioning cooling towers** and soil.

What can be done to prevent Legionellosis?
Improved design and maintenance of cooling towers, plumbing systems, and heating and cooling ventilation systems is the foundation of Legionellosis prevention. Properly designed and maintained systems limit the opportunity for growth of Legionella organisms.

How common is Legionellosis in the United States?
An estimated 10, 000 to 15, 000 persons get Legionnaires' disease in the United States each year. An additional unknown number are infected with the Legionella bacterium and have mild symptoms or no illness at all.
Outbreaks of Legionnaires' disease have received the most media attention; however, most often the disease occurs as single, isolated cases not associated with any recognized outbreak. Outbreaks are usually recognized in the summer and early fall, but cases may occur year-round. **About 5% to 15% of known cases of Legionnaires' disease have been fatal.**

Who gets Legionellosis?
People of any age may get Legionnaires' disease, but the illness most often affects middle-aged and older persons, particularly those who smoke cigarettes or have chronic lung disease. Also at increased risk are persons whose immune system is suppressed by diseases such as cancer, kidney failure requiring dialysis, diabetes, or AIDS. Those that take drugs that suppress the immune system are also at higher risk.
Pontiac fever most commonly occurs in persons who are otherwise healthy.

How is Legionellosis spread?

Outbreaks of Legionellosis have occurred after persons have inhaled aerosols that come from a water source (e.g., air conditioning cooling towers, whirlpool spas, showers) contaminated with Legionella bacteria. Persons may be exposed to these aerosols in homes, workplaces, hospitals, or public places. Infection cannot be acquired from another person with Legionellosis, and there is no evidence of persons becoming infected from auto air conditioners or household window air-conditioning units.

Where is the Legionella bacterium found?
Legionella organisms can be found in many types of water systems. However, the bacteria reproduce to high numbers in warm, stagnant water (95-115^{o}F), such as that found in certain plumbing systems and hot water tanks, cooling towers and evaporative condensers of large air-conditioning systems, and whirlpool spas. Cases of Legionellosis have been identified throughout the United States and in several foreign countries. The disease likely occurs worldwide.

What is being done to prevent Legionellosis?
Improved design and maintenance of cooling towers and plumbing systems to limit the growth and aerosolization of Legionella organisms are the foundations of Legionellosis prevention.
During outbreaks, CDC and health department investigators seek to identify the source of disease transmission and recommend appropriate prevention and control measures, such as decontamination of the water source. Current research will likely identify additional prevention strategies.

How Do You Get Legionnaires' disease?
Infection is known to be acquired through breathing in aerosols (very fine droplets of water), which contain the bacteria. It is not passed from person to person nor is it acquired through drinking Legionella contaminated water.

Where Do You Find Legionella Bacteria?
The bacteria are widely distributed in the environment and have been found in lakes, rivers, creeks and other bodies of water and soils. Certain man-made systems such as cooling towers (including evaporative condenser) can provide conditions in which bacteria can multiply to large numbers.

Why Are Cooling Towers a Problem?
During the normal operation of a cooling tower, aerosols are formed which will be carried into the environment through the tower exhaust. If Legionella are present in the tower water, breathing the aerosols can result in infection. Poorly

maintained cooling towers have been implicated in outbreaks of Legionnaires' disease overseas and Australia.

What are My Responsibilities As a Cooling Tower Owner or Manager?
Your responsibilities are defined in the Health (Infectious Diseases) Regulations 1990, which state:
25.(1) The owner or the person who has management or control of any cooling tower or evaporative condenser which services an air conditioning system or industrial process must maintain that cooling tower or condenser and its associated equipment in a manner set out in the Guidelines for the Control of Legionnaires' Disease 1989.

What Are the Major Aspects of Cooling Tower Maintenance?
The necessary maintenance requirements for cooling towers are contained in the Guidelines and include:
- At least monthly inspection of cooling towers.
- Regular water treatment.
- At least monthly microbiological testing of tower water for total bacteria.
- Complete cleaning and disinfection of the tower every three to six months in accordance with the Guidelines.

Note - Cleaning and disinfection of the tower should be undertaken prior to start up, whenever the tower has been idle for four weeks or more. Cooling tower owners and managers will need copies of the Health (Infectious Diseases) Regulations 1990 and the Guidelines for the Control of Legionnaires Disease 1989 to be fully aware of their maintenance and legal responsibilities.

Who can Perform This Maintenance?
It is strongly recommended that a specialist water treatment company be engaged to conduct the cleaning, chemical treatment and analyses, and to arrange bacteriological monitoring. These companies are aware of the requirements of the legislation.

Do I Have to Keep Records?
Yes - All records of bacteriological monitoring, water treatment and testing, and cooling tower cleaning and disinfection must be maintained in an orderly manner, and be available on site for inspection by officers authorised under the Health Act 1958. Authorised officers include municipal council environmental health officers.
The Health (Infectious Diseases) Regulations 1990 state:
25.(3) In accordance with the Guidelines for the Control of Legionnaires Disease 1989 a person who is required to maintain a system under this Regulation must provide evidence of regular maintenance and testing of the system to an officer

of the Department authorised to do so on request of that officer.

What Happens If I Fail To Comply?

There are statutory penalties for failing to comply with the requirements of the legislation. If your tower is implicated as the source of infection in a case of Legionnaires' disease and it has not been in a case of Legionnaires' disease and it has not been maintained in accordance with the legislation, you may also be liable under occupational health and safety legislation. You may also be liable for common law damages claims by person infected or their dependants, on the grounds of negligence.

Other Sources of Legionella Bacteria:

- Warm (tepid) water systems in health care buildings, institutions and commercial buildings.
- Spa pools.
- Potting mixes used in horticulture by home gardeners.
- Ornamental fountains
- Humidifiers

Suitable water treatment practices should be used where appropriate. Personal measures to ensure personal protection should be applied in high-risk situations

Conclusion

Experiences of Westernised Countries like U.K., USA, Australia, and Europe have established that Legionellosis cannot be eradicated; it is everywhere within our surrounding environment and does reach an outbreak proportion which could be fatal for upto 5% to15% of detected cases. Accordingly Health and Safety Acts are already in place and are enforced in order to prevent its occurrence in damaging proportion to the mankind. It is intended that this article will enable Environment and Health authorities to begin to consider recognising the health hazard due to Legionellosis and starting to assess this environmental health hazard, to spread its awareness and to take preventive measures.

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