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For Estate and Facilities Managers

Legionella control

Royal London Hospital overcomes health fears at the Dental Institute

Legionnaires' Disease: establishing the facts

What exactly is Legionnaires' disease? What causes it? Can it be effectively controlled?

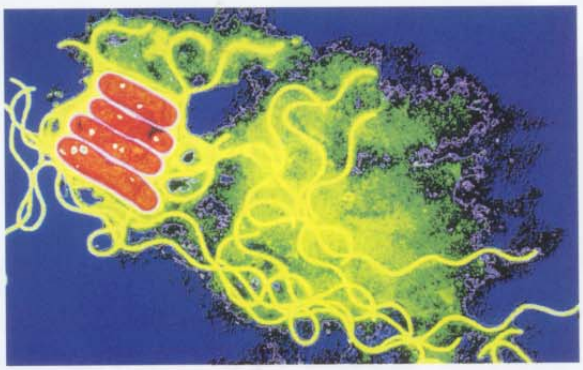
Dr Noel Christopher, Aquazur's water hygiene manager, establishes the facts about this challenging problem.

Following the publication of the revised ACoP (Legionnaires' Disease: The Control of Legionella Bacteria in Water Systems) by the HSE on 8th January 2001, legionella is the source of much written and verbal comment. It is therefore important to review the whole subject of Legionnaires' disease and understand how effective control is possible.

Legionnaires' disease is caused by the bacterium Legionella pneumophila which is widely distributed in the environment (occasionally the disease is caused by other species of the Legionella group). The bacterium can cause a pneumonia-like infection in people that is fatal in around 12% of all reported cases but can be significantly higher among at risk groups. And where it is not fatal, many of the victims suffer varying degrees of disablement.

The bacterium first hit the headlines in 1976 following an outbreak at the American Legion Convention in Philadelphia where 182 people suffered an acute respiratory disease, 29 of whom died. Subsequent investigations identified the legionella bacterium which was at that time new to science.

A review of stored pathology samples revealed that undiagnosed cases had occurred at least as far back as 1947. UK-based outbreaks of the disease were identified at Kingston in 1980 and Glasgow in 1984. But it was the Stafford hospital outbreak in 1985, followed by the BBC outbreak in 1988 and the Corby outbreak of 1996 that really raised the profile of the disease.



Guidelines introduced

Although water treatment companies had produced their own guidance prior to 1984, there were no HSE or HSC guidelines with respect to Legionella control. However, EH48 "Legionnaires' Disease" appeared in 1987, followed by the ACoP L8 and guidance HS(G) 70 in 1991 and the new L8 / HS (G) 70 revision this year. Outbreaks of the disease in Madrid, near Amsterdam, Paris, and Melbourne have also led to regulations in other countries.

Information from the Public Health Laboratory indicates that there have been about 200-250 individual cases of the disease reported annually in the UK since 1980 (around half of which have actually been acquired overseas. Also, since 1980 there have been 51 'outbreaks' of which 45% have been associated with cooling systems and 44% with hot and cold water systems.

The route of infection is always via the inhalation of an infective dose of the bacteria as an aerosol into the alveoli of the lungs. There is no current agreement as to what number of bacteria constitutes an infective dose and there is evidence to suggest that the association of the bacteria with protozoans host also plays a role.

The risk of death from Legionnaire's Disease increases significantly with the age of patient and if they have a pre-existing illness which lowers the natural immune system of the body. Men and smokers are more likely to contract the disease than women. Immuno-compromised patients are at particular risk.

Legionella beater: *an installation of Aquazur's Envirox system.*

How it works

The disease is caused by a Gram-negative bacterium, about 6-micron in length with one or more flagella allowing it to swim freely in water and attach itself to biofilms. When it infects humans, the organism has an incubation period of 2-10 days. The bacterium is also known to prefer environments with reduced oxygen levels (eg stagnant areas).

Studies show that the organism favours temperatures between 20-45°C for growth, with optimum growth being achieved at 35°C. The Legionella group contains approximately 40 separate species and the species can be further subdivided into serogroups. Legionella pneumophila has at least 16 sero groups of which serogroup 1 is the most significant and is predominantly associated with UK outbreaks of Legionnaires' disease. Pontiac fever is a non fatal form of legionellosis with an incubation period of 2-3 days.

The bacterium has been found in water temperatures ranging from 6-60°C, but does not proliferate below 20 0° and dies above 60°C. Legionella bacteria held at 37°C show greater virulence than the same bacteria held at 25°C. Water systems at particular risk are therefore those that store or use water at 20-45°C and produce an aerosol. This can include a wide variety of industrial and clinical equipment, including cooling towers, showers, taps, wash basins, horticultural misting systems, dental drills and the humble car wash. Legionella is an organism that has found a particular ecological niche in engineered water systems.

Chain of events

Legionella infection is caused by a chain of events, ie: The presence of the bacterium; conditions that encourage the proliferation of the organism and enhance its virulence; a means of dissemination (usually an aerosol; and finally susceptible members of the population to inhale it.

Effective control of the organism and prevention of infection can be achieved by breaking this chain of events at the highest point possible. Relatively simple control measures are needed, with a proactive management and monitoring programme.

Revised ACOP

A sound framework for Legionella control can be found in the revised ACOP, although healthcare premises are still covered by HTM 2027 which insists that temperature is the primary method of control. However, not all sites are able to strictly adhere to this regime, in which case alternative control methods may now be considered, in addition to temperature, using the new ACOP guidelines.

Clean conditions within water systems are required to limit the availability of nutrients derived from other bacteria and organic debris. This is achieved by regular cleans and disinfections.

The avoidance of low oxygen level areas, eg in deadlegs, and the bacteria's preferred temperature range of 20-45°C are also important. If this is not possible, for example in cooling towers or hot water systems that cannot maintain the recommended temperatures, the use of a good biocide regime, as part of a comprehensive water treatment programme will inhibit growth of or actively kill the organism. Effective management arrangements, a comprehensive monitoring programme and regular reviews (2 years maximum) must support this.

Biocides such as chlorine dioxide, which have proven efficacy against biofilms, are particularly important as they have a good environmental profile. However, chlorine dioxide is not something that can be taken to site in a drum. It needs to be generated on site, making it potentially hazardous to the handler. And as such there have always been objections to using it, particularly relating to COSHH issues. So to provide a safe and effective alternative for administering chlorine dioxide, Aquazur launched a new system in the UK called Envirox, just over a year ago.

Envirox has all the benefits of chlorine dioxide, without any of the downsides - in particular, it has none of the health and safety issues previously associated with the generation of chlorine dioxide.

A good monitoring programme is also important, including legionella tests at the recommended frequency, to ensure that control is achieved and being maintained. One important feature of the new guidance is that it has defined a legionella threshold of 100 colony forming units (cfu) per litre. At or below this level the system is deemed to be in control and has also defined an action level of 1000 cfu/L above which corrective actions are required. Between these levels operational review is recommended.

Royal London Hospital overcomes health fears at the Dental Institute

Legionella is a major issue for anyone who works in healthcare and estates management and where there are hot and cold water systems in place.

The Royal London Hospital, part of Barts and The London NHS Trust, is a general and teaching hospital dating back to the Victorian era. The Dental Institute, where aspiring dentists learn their trade, is also based at the hospital.

In 1998 Bob Jones, senior estates officer and co-ordinator of the legionella policy at The Royal London Hospital, identified the dental area as having "a potential risk for spreading Legionnaires' disease". Here Mr Jones explains the problems faced in combating the problem and the solution now in place, reflecting the issues with legionella control whatever the area of healthcare you are involved in.

September 2000 saw much coverage in the media surrounding the health hazards that can be associated with the water spray equipment used in dental institutes. The New Scientist and The Times both ran articles covering this emotive subject.

The articles told of research carried out showing levels of pathogens had exceeded EU drinking water safety limits in 52 out of 55 water samples taken from 21 dental surgeries in the south-west of England. Of the pathogens found, species of mycobacterium and legionella were identified which can cause tuberculosis and Legionnaires' disease respectively.

Risk Assessment

Prior to these headlines hitting the news stands, work had been carried out by water treatment specialist Aquazur, together with the Royal London Hospital, to provide protection for patients from the risk of bacterial infection from dental sprays. The particular area of concern was legionella.

Throughout the dental institute, spread over five floors, there are numerous dental chairs each with an oral water spray gun. Due to the sheer number of chairs (123 in total) the possibility of infection from opportunistic pathogens such as legionella was deemed to be a potential risk and one that could not be ignored.

Open wide: drinking a toast to the Aquazur installation (left to right), John Devenny, senior engineer for Aquazur, with Bob Jones, senior estates officer and co-ordinator of legionella policy at The Royal London Hospital.

When the Dental Institute was assessed we found no uniformity of water quality to the dental booths. Originally, the dental chairs were fed from numerous different water supplies. Some chairs were fed direct from the water mains while others were supplied by cold water storage tanks. In some areas we also had problems with discoloured water and the high bacterial activity which was found in these outlets.

The first stage for our team at the Royal London Hospital Facilities Directorate was to take corrective action, ensuring the dental chair booths were all fed from the same water supply.

Initially, work was carried out to the dental chairs so they were all fed directly from the mains via a pressurised pump booster set. This did away with the stored water supply to the chairs which was prone to water stagnation and bacterial growth.

The problems of discolouration were now removed but we still had concerns that there was a legionella risk in the oral water spray guns because of their ability to produce an aerosol.

A programme was put in place to clean and disinfect the system on an annual basis using chlorine dioxide (ClO_2). This was considered to be a short-term solution as it did not provide continual 24-hour protection. A decision was made that the objective should be continual protection against pathogens at all times.

Research began into finding a biocide regime that would provide the necessary 24-hour protection. At the time, two possible options were recommended by the legislation MISC 150 [now incorporated into the new Approved Code of Practice (L8)]. They were ClO_2 and silver/copper ionisation.

To begin with we rejected chlorine dioxide continual treatment because of the health and safety implications. There were serious COSHH concerns with both chemical handling and exposure to hydrochloric acid fumes.

However, it was acknowledged that chlorine dioxide offered the most effective solution owing to its ability to remove biofilm.

Decision Time

The decision was made, albeit reluctantly, to opt for a silver/copper ionisation unit to treat the dental water system. It was not considered to be the most effective solution as the efficiency of silver/copper ionisation is reduced in hard water and where the pH of the water to be treated is above 7.6. In the case of the Royal London Hospital the water to be dosed is hard and has a pH of 8.0. Also, existing pipe material could potentially be corroded through electrolysis, so these are not ideal conditions for effective control using ionisation.

Legionella beater: the Aquazur unit.

It was during this time that Aquazur contacted the Royal London Hospital with news of

their patented Envirox chlorine dioxide generator. Unlike previous generation methods, Envirox produces chlorine dioxide electrochemically from a single non-hazardous precursor. It also has the enormous advantage that no acid is required.

The Royal London Hospital's preferred choice of biocide could now be used without any of the previous health and safety implications and as a result the plans to install a silver/copper ionisation system were scrapped.

Following discussions with Aquazur, the Envirox unit was installed along with a water break tank, necessary to comply with current water regulations, and positioned prior to the booster set that supplies the dental chairs.

The objective of this dosing

arrangement was to maintain a reserve of 0.5mg/l of total oxidants in the break tank at all times, ensuring that the correct level of ClO_2 is in the water system and in so doing controlling the levels of bacteria.

Consistent results

In March 2000, the Envirox unit was installed and by the second week of operation ClO_2 levels were found in the furthest outlets.

The need for water of a sterile nature is very important for dental applications and the installation of the Envirox machine has helped us achieve just that.

John Devenny, senior engineer for Aquazur takes up the story

Dipslide results fell from a count of 10^3 colonies/ml to less than 10 within the initial two week period and have remained at this level ever since. The water is now sterile and suitable for dental purposes.

But these aren't the only benefits of Envirox in such systems. Chlorine dioxide has a definite benefit for teeth and gums. It is used as an active ingredient in many mouthwashes because of its ability to oxidise bacteria such as p.gingivalis which causes gum disease. It also destroys harmful oral pathogens such as methionine and cysteine, precursors to the volatile sulphur compounds (VSC's) hydrogen sulphide and methyl mercaptan, the cause of halitosis.

The success of this Envirox unit at the Royal London Hospital has led to a further unit being installed at its sister hospital, St Bartholomew's. In this case chlorine dioxide is being used to treat a water feature that dates back to the 1800's and it is providing excellent protection against legionella as well as removing the unsightly algae that blight such fountains.

This highlights just some of the applications for Envirox. It has a broad spectrum of uses from legionella control in the wide range of hot and cold 'domestic' water systems, to cooling tower treatment, through to food and beverage production. The possibilities seem endless!

North Cambridgeshire Hospital - a case study

Suffering persistent problems with the blockage of the hospital mixer valve strainer filters, in March of 1999 the estates engineering manager at the North Cambridgeshire Hospital, David Davies, approached Aquazur for help. Following an on-site inspection it became clear the problem was due to an accumulation of biofilm in the strainer filters, and in the hot water systems.

Gary Sewell, Envirox senior engineer for Aquazur says: "Bearing in mind this was prior to the launch of Envirox in the UK, the first option we looked at was pasteurisation of the system. However we knew this would have no effect in actually removing the sessile bacteria (Biofilm). Chlorinating the system was another option, but again we felt that chlorine would have little or no effect in removing the sessile bacteria."

Most suitable

The third option, a multiple precursor Chlorine Dioxide system seemed to be the most suitable, as Chlorine Dioxide is effective in removing biofilm. However, David Davies had previously used this system at another hospital in the group where he is also engineering manager. "Unfortunately, we had to stop using it there because the precursor was an acid," says Davies. "Because of this, both its storage and use caused major implications under COSHH.

"However, I heard that Aquazur was just about to launch its Envirox system which I understood was non-hazardous. And seeing that chlorine dioxide was the best and only solution to resolve this problem, we decided to wait the short period until the first ones became available," he added. In the meantime, David Davies increased the existing monitoring programme to ensure any problems could be identified and addressed.

Legionella beaters: *(left to right) Gary Sewell, Envirox senior engineer, Aquazur; David Davies, estates engineering manager, North Cambridgeshire Hospital and Mick Halpin, Envirox sales manager, Aquazur.*

Within a few weeks an Envirox unit, treating approximately $20m^3$ of water a day, was installed at the North Cambridgeshire Hospital. The system was very carefully monitored over the following weeks, isolating small levels of Chlorine Dioxide at various outlets. "Within about five weeks, it was another story, the biofilm was almost completely gone, with 0.2ppm of Chlorine Dioxide isolated at every outlet," adds David Davies.

"And from just two months after installation in July 1999, right through to the present day the chlorine dioxide levels at each outlet are maintained at between 0.3 - 0.5 ppm. We've never had any further problems with biofilm at the North Cambridgeshire since installation. Indeed the quality of the water has improved, the condition of the system has improved and no biofilm has been found.

No compromise

Gary Sewell concludes: "The water system at the North Cambridgeshire Hospital was successfully treated using the Envirox generated chlorine dioxide, and health and safety was not compromised as Envirox doesn't require dangerous or hazardous chemicals to act as precursors, and is therefore completely safe."