COMMENTARY

## Control of legionella in drinking-water systems

*Legionella pneumophila* has been in the news again recently, with the outbreak of Legionnaires' disease associated with contamination of the cooling towers of an aquarium in Melbourne[1] and with the finding of the organism in humidifiers in the machine rooms at the European Parliament's headquarters in Strasbourg.[2] In fact, news of outbreaks crop up regularly because improvements in diagnostic tests have facilitated recognition of the infection.

However, many if not most legionella infections originate from drinking-water systems, the most difficult of water systems in the control of legionella contamination. Such contamination of drinking-water systems in health-care facilities is common. In a national survey of US hospitals, 34% reported recovery of the bacteria from their plumbing system and 29% reported nosocomial Legionnaires' disease.[3] Legionella have been recovered from up to 100% of hospitals in a single area.[4] Because of their ubiquity, the issue is not whether the bacteria are present, but whether circumstances (ie, temperature, stagnation, biofilm) favour amplification.Policies for prevention of legionellosis would be simple if there were a "cut-off" level of bacterial concentration beyond which the risk of infection became unacceptable. However, the predictive value of legionella counts in water samples remains unclear, partly because the counts fluctuate considerably and partly because of substantial interiaboratory variation. Nevertheless, from common sense the presence of legionella in a high proportion of fixtures or very high legionella counts in any water sample are signs of danger.

All methods for preventing die growth of legionella in drinking water (the focus of this commentary) have drawbacks and none is 100% effective. Microbiological testing and decontamination efforts can be expensive, so their implementation is not justified unless they can reduce the risk of disease by a reasonable degree. Decontamination efforts should be sustained, systematic, and not prone to human error. Any control effort should include an assessment of the tecnical weaknesses of the system. Legionella growth is most likely in areas where water stagnates. Moreover, heat and disinfectants such as chlorine do not penetrate these areas well. The prerequisite for success of any legionella-prevention measure is thus removal of "dead legs" (ie, parts of the water system that are not used for long periods) and other structural factors mat may cause stasis.

Temporarily raising water temperature (by superheat-and-flush) will reduce legionella counts for a short while[5] For a long-term effect the water temperature should be maintained above 50°C in every part of the hot-water system. A disadvantage of this method is the risk of scalding. In addition, increasing the hot-water temperature may warm up the cold water because of heat exchange between the two systems. The result could be an increase in cold-water-associated legionella transmission.[6] Cold-water temperatures can also be increased by ambient heating when outside temperatures are high. In buildings that are used intermittently, such as day-care clinics (and the European Parliament building, which is used only for the monthly meeting), this effect may become important because of long periods of stasis in the cold-water system.[7]

Free chlorine and chlorine dioxide are effective if their concentrations are adequate. However, high concentrations of chlorine may corrode plumbing materials, and municipal water plants commonly do not use sufficient concentrations, Moreover,[8] free chlorine and chlorine dioxide do not penetrate into, the biofilm where legionella live,[8] nor do they reach peripheral areas of the plumbing system, Monochloramine may be considerably more effective than free chlorine in municipal water plants or in individual hospitals.[9] For drinking-water systems, residual disinfection (maintenance of disinfectant throughout the system) with monochloramine may become accepted as an additional and potentially very cost-effective method for prevention of nosocomial and communnity-acquired Legionnaires' disease.[10] Copper-silver ionisation for the control of legionella has given variable results. It has reduced legionella counts when used simultaneously with continuous chlorine injection.[11] Unfortunately many subsequent studies on the effectiveness of control with the copper-silver method have not reported chlorine concentrations, so it remains unclear how much of the effect is attributable to copper-silver and how much to, chlorine. In several hospitals legionella have been recovered from water systems and cases of Legionnaires' disease have occurred despite copper-silver ionisation.[3,5]

Recently, tolerance of legionella to long-term exposure to silver has been reported.[12] Ozone and ultraviolet light also seem to reduce growth growth of legionella.[13,14] However, the effect is local, shortlived, and does not penetrate the biofilm.

The mainstay of legionella control in drinking-water systems is thus the checking of water temperatures and disinfectant concentrations at the points of use, together with the prevention of stasis of water. These measures should be undertaken irrespective of whether nosocomial transmission has been identified or whether legionella have been recovered from water. Microbiological testing of water (eg, two to four times a year) could then be considered, as a back-up method, to identify possible lapses in control measures. It is also important that physicians are aware that legionella is a common cause of pneumonia. In the USA the number of reported cases is thought to be less than 5% of the actual number.[15] Legionella infection should thus be included in the diagnostic work up for cases of severe pneumonia, to ensure adequate treatment and timely recognition of outbreaks.

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