WATER TREATMENT NEWS

Keep Legionnaires Disease Under Control in Your Facility

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Legionnaires disease is gaining increasing awareness among the general public. It might appear, from a cursory look at the statistics, that the number of cases of the disease occurring each year in the United States is increasing. This is likely not the case; however, the number of cases reported *has* increased, and now numbers between 10,000 and 15,000 per year.

Legionnaires disease, or Legionellosis, is a form of pneumonia caused by Legionella, a widespread family of bacteria that favors warm water environments. The disease and the bacterium were discovered following an outbreak that occurred at an American Legion convention held in Philadelphia in 1976 in which 221 people became ill with what was thought to be regular pneumonia. 34 of those who became ill subsequently died.

Since it is highly unusual for such a large number of people to come down with pneumonia in the same location at the same time, pathologists investigated the outbreak, eventually identifying the causative agent -- a previously-unknown bacteria, which they named Legionella for the attendees of the convention.

As knowledge and understanding of the cause and sources of transmission of the disease increased over the ensuing years, the number of reported cases increased. Because Legionnaires disease presents symptoms similar or identical to regular pneumonia, medical and epidemiological experts believe that many cases are reported as regular pneumonia, and the actual number of cases in the U.S. is higher than the numbers reported. Some estimate the total number of cases to be as high as 100,000 annually.

Although the exact number of annual Legionella cases is not known, it is widely considered that a high percentage of the total cases are nosocomial, or hospital-acquired. There are several reasons for this. Hospitals typically contain both major factors involved in the occurrence of Legionnaires disease – a susceptible population and water systems that are the most common source of transmission of the disease.

The susceptible population – persons most likely to acquire Legionnaires disease – includes the elderly, people with compromised immune systems, e.g., transplant patients taking immuno-suppressive drugs to help prevent organ rejection, cancer patients, persons with other under-lying respiratory conditions, and smokers. Representatives of these groups make up a high percentage of the typical hospital population.

Water-using systems that can serve as sources of transmission of Legionnaires disease include cooling towers, spas and hot tubs, naso-gastric tubes used on many hospital patients and domestic potable hot water systems. Previously, most experts considered cooling towers to be the primary source of transmission of Legionnaires disease, with the route of entry of the bacteria being inhalation of contaminated mist from the tower evaporation plume. Subsequent research, however, has led industry experts to the conclusion that the predominant sources of transmission of Legionnaires disease are domestic potable water systems in large buildings.

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Many hospitals have the type of potable water systems that are the likeliest transmitters of Legionnaires disease – systems that have large hot water storage tanks from which the hot potable water is circulated through the facility. These potable water storage tanks provide an ideal environment for the growth of Legionella bacteria.

When a person from one of the susceptible groups mentioned earlier gets Legionella-contaminated water in his mouth, the water can get into his lungs by aspiration. Aspiration occurs when water in the person's mouth escapes the gag reflex and is drawn into the lungs rather than being swallowed into the stomach. In the lungs, the Legionella bacteria multiply rapidly, overwhelming a weak immune system and causing Legionnaires disease.

Hospital engineering and infectious disease control staff are often confused when they look to public health authorities or professional societies for direction in the prevention of Legionnaires disease in their facilities. This confusion stems from the fact that no consensus on Legionnaires disease prevention exists among these various groups. Opinions vary regarding both Legionella testing and the most effective means of preventing occurrences of the disease.

Some groups recommend regular Legionella testing; others recommend testing only if an incidence of the disease has occurred to identify the source of the occurrence. Similarly, differences of opinion exist among the groups as to the most effective means of controlling the growth of Legionella bacteria in a facility's water system.

A common recommendation has been to maintain the temperature of the hot water in the storage tanks at 140°F and circulate the hot water at 124°F as a means of controlling Legionella growth in the water system. But a study published in 2003 by J. Kusnetsov titled "Colonization of hospital water systems by Legionellae, mycobacteria and other heterotrophic bacteria potentially hazardous to risk group patients" showed that peripheral sites remained heavily colonized by Legionella despite recirculation temperatures greater than 140°F. Other control methods such as restricting showering of high risk patients also proved to be ineffective.

The question for hospital engineering managers is, "Has any prevention method been found that will help keep my facility free from Legionnaires disease?" The staff at a notable hospital appears to have found a positive answer to this question.

Johns Hopkins University Hospital in 1999 began a study whose intent was to determine the most effective means of controlling the growth of Legionella in the hospital's potable water system. The hospital assembled an evaluation team that consisted of personnel from their engineering, medicine, infectious diseases, pathology, microbiology, epidemiology and infection control, health and safety, nursing, administration, public affairs, legal, and risk management departments.

The team began by researching available methods of disinfecting hot and cold potable water systems. From the options available, the team would then chose the method they would employ for their study. One of the team's key requirements was that the method chosen must be Environmental Protection Agency (EPA) approved for potable water disinfection. After extensive research, the team selected chlorine dioxide as the means of providing long-term potable water system Legionella control.

Chlorine dioxide (ClO_2) is EPA approved for use as a potable water disinfectant in CFR Part 141 – National Primary Drinking Water Regulations. In its natural state, ClO_2 is a gas, but it is applied to potable water as an aqueous solution. It is a powerful oxidant that kills micro-organisms via oxidative disruption of cellular processes.

The Johns Hopkins study was conducted on the potable water system in the Weinberg Building, a then-newly-constructed building on the Johns Hopkins Hospital campus. It is a 600,000 sq. ft., 154 bed facility that houses surgical and oncology patients, including bone marrow transplant patients. The building's patient population, then, would be largely those at high risk for contracting nosocomial Legionnaires disease and thus a good basis for the study.

The study protocol called for regular Legionella testing at various points in the system. The hospital laboratory conducted extensive Legionella testing over a 46 month period. Samples of both hot and cold potable water were taken from an average of 28 sites in the system during various stages of the evaluation. Many distal sites – faucets and showerheads – were tested on a regular basis. Samples from all patient-care floors in the facility were regularly tested in both clinical and non-clinical areas. Samples taken included those from faucets that were regularly used as well as those that were seldom-used.

The evaluation was divided into three phases. The first phase involved an assessment of the effectiveness of two commonly-used methods of Legionella control: hyper-chlorination and thermal remediation. The results of this assessment would serve as a baseline against which they could compare the effectiveness of chlorine dioxide.

Hyper-chlorination was implemented prior to the building's occupancy with a free chlorine residual of 200 mg/l for three hours. Water sampling a short time later revealed that the potable water system was colonized with gram-negative bacteria and Legionella. Total rebound of the bacteria occurred in less than two weeks. Hyper-chlorination was repeated on September 2, 2000 with 50 mg/l free chlorine for 24 hours. Water samples taken on September 6, 2000 showed that the system was still colonized with gram-negative bacteria and Legionella. The test results indicated that hyper-chlorination reduced, but did not eliminate, either bacteria strain from the potable system.

Super heating of the potable hot water system was conducted on September 9, 2000. The system water was heated to 180°F and flushed for 10 minutes at each distal site. Water samples taken on September 11, 2000 showed that superheating had little to no effect on the levels of gram-negative bacteria or Legionella.

Phase 2 involved selection and installation of the chlorine dioxide delivery system. The study team chose a chlorine dioxide generation system that converts 25% sodium chlorite into ClO_2 using an electrochemical cassette oxidation process. This phase was completed in May, 2001.

Phase 3 of the study ran from June 2001 to July, 2004. The team established an extensive testing program to monitor ClO_2 levels in the potable water, along with the levels of its reaction by-product, chlorite. The EPA maximum allowable levels of ClO_2 and chlorite in potable water are 0.8 mg/l and 1.0 mg/l, respectively. At the outset of the application of ClO_2 in June 2001, the generator was set to provide a residual of 0.7 mg/l in the potable water, with a maximum of 0.8 mg/l. Test samples were taken from the potable water just after the introduction of the ClO_2 and at various points throughout the potable water system. Based on all the test results, the maximum levels for both ClO_2 and chlorite did not exceed EPA limits during the course of the study.

Legionella testing of samples taken from all the sample points in the potable water system between June 5, 2001 and July 6, 2004 indicated that, initially, the levels of Legionella and gram-negative bacteria both increased, and then gradually decreased to non-detectable levels.

These results were achieved even though three disruptions occurred to the building's potable water supply during that time period. The disruptions, which occurred between September, 2001 and October 2003, involved the introduction of off-colored water with varying levels of sediment into the building's potable water system. During the disruptions, Legionella and gram-negative bacteria levels spiked. In response to these spikes, the hospital developed and implemented a ClO_2 shock and flush procedure. In addition, procedures for daily flushing of distal sites in patient rooms were developed and implemented.

Since December, 2003, Legionella and gram-negative bacteria levels have been non-detectable, with one exception. On April 1, 2004, one patient room tested positive for both

Legionella pneumophila and gram-negative bacteria. An investigation revealed that the room had been unoccupied for weeks and that the flushing procedure had not been conducted on fixtures in the room. After flushing was started in the room, Legionella and gram-negative bacteria levels were reduced to undetectable levels.

During the study, a section of 4" hot water supply piping was removed for inspection. It showed moderate deposits of biofilm, which, when swabbed, tested positive for Legionella and gram-negative bacteria. After a ClO_2 shock and flush procedure, followed by three weeks in which the ClO_2 level in the water was maintained at ≤0.8mg/l, another section of the same pipe was removed from a location approximately three feet from where the first pipe section was removed. Inspection of this pipe section showed that the biofilm had been completely removed.

The evaluation team reached the conclusion that, had a ClO_2 shock and flush procedure been implemented at building start-up, followed by daily flushing of distal sites, Legionella would have been rapidly eradicated. Their conclusion was that "chlorine dioxide is safe and effective in controlling and eliminating Legionella, other pathogenic bacteria and biofilm."

This study clearly suggests that chlorine dioxide is one of the most effective, if not *the* most effective means of preventing the growth of Legionella bacteria in building potable water systems. As such, it is a highly valuable tool for use by building engineering personnel in preventing the occurrence of Legionnaires disease in their facilities.

A major drawback for many engineering and building management personnel regarding the use of chlorine dioxide in their building's potable water system will be the purchase and operation of a ClO_2 generation system. A system such as that in use at Johns Hopkins University Hospital represents an initial investment of upwards of $20,000. In addition, cassettes used in the generator are consumable at considerable additional on-going expense.

An excellent alternative to on-site ClO_2 generation is the use of a stabilized chlorine dioxide solution, such as ACD-300, offered by International Chemtex Corporation (Chemtex). This product, a 3000 part per million (ppm) ClO_2 solution, maintains its full concentration for nine months under proper storage conditions. It can be fed into the water system directly from the drum using a standard chemical injection pump. This technology enables building engineers to maintain effective Legionella control in their facility's potable water system easily and inexpensively.

Preventing Legionnaires disease presents a considerable challenge to engineering staffs in hospitals and other public facilities. Chlorine dioxide has been shown to be a powerful tool in helping meet this challenge. A stabilized chlorine dioxide solution such as Chemtex ACD-300 may well be the best way to apply chlorine dioxide for overall Legionella control.

Contact your Chemtex Representative to discuss concerns about Legionnaires Disease in your facility.