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Concise Communications

Treatment of a *Legionella pneumophila*-Colonized Water Distribution System Using Copper-Silver Ionization and Continuous Chlorination

Amaya Biurrun, MD; Luis Caballero, MD; Carmen Pelaz, PhD; Elena León, ICP; Alberto Gago, MD

ABSTRACT

The detection in April 1997 of a case of nosocomial legionellosis in our hospital led to the discovery that both our hot- and cold-water circuits were heavily colonized with *Legionella pneumophila*. Conventional methods for eradication of the organisms were unsuccessful, so a copper-silver (Cu-Ag) ionization system and a continuous chlorination system were installed. Five months later, the number of colonized sites decreased from an initial 58.3% to 16.7% (*Infect Control Hosp Epidemiol* 1999;20:426-428).

The great diversity of methods proposed for the eradication of *Legionella pneumophila* from colonized hospital water supplies highlights the difficulties this problem entails.¹ In April 1997, a case of nosocomial pneumonia caused by *L pneumophila* serogroup 6 was detected in our hospital. For that reason, we conducted an environmental inspection of the facility, finding that both our cold- and hot-water tanks were colonized by *L pneumophila* serogroup 6. In spite of shock hyperchlorination, colonization persisted in the building.

Due to the poor condition of the plumbing (Figure), it was not possible for us to make use of a thermal flush,² a method successfully employed by some authors as an early measure. After a review of the reported control methods,³ we decided to install a copper-silver (Cu-Ag) ionization system, together with a continuous chlorination device.^{4,6} The Cu-Ag ionization system had not been used previously in any Spanish hospital.

METHODS

Our 250-bed hospital is located in a two-building, 24-year-old facility. The main building has four floors and a cellar, and accommodates all the inpatients, whereas the other has only one floor and houses the rehabilitation service and a large warehouse. The incoming water is supplied by the city and is stored in two 220-m³ cold-water tanks located outdoors. There are also two hot-water tanks, 7 m³ each, and a cooling tower outdoors that usually works from April to September.

Our patient was diagnosed with *L pneumophila* nosocomial pneumonia after a specimen obtained by bronchoalveolar lavage grew *L pneumophila* serogroup 6 on BCYE- α (buffered

charcoal-yeast extract with α -ketog lutarate) medium.

In the environmental survey, we obtained 99 water samples according to a defined sampling method.⁷ Environmental isolates were identified and serotyped as described previously.⁸

Cold-water tanks were emptied, washed, and filled with chlorinated water until a 50-ppm concentration of free chlorine was obtained and left to stand 8 hours, verifying that the free chlorine concentration at the distal outlets was 5 ppm or higher. The tanks then were emptied and refilled. Faucet aerators and shower heads were submerged in a solution of 30% to 36% HCl for 10 hours. On May 22, 1997, we installed a continuous chlorine analyzer connected to a chlorine pump (Vigilant 2, Equipool, Barcelona, Spain), which we set at 1 ppm, so as to obtain a free chlorine concentration of 0.8 ppm at the cold-water outlets.

The Cu-Ag ionization system (Time Pure Water, Desinfecciones Alcora, Zaragoza, Spain) was installed on August 27, 1997. Two units equipped with 70% copper and 30% silver electrodes were installed in the cold-water supply, and a third unit using 75% copper and 25% silver electrodes was placed in the return pipe of the hot-water tanks. The cold units were set at 17 V and the hot unit at 8 V, with an inversion of electrode polarity every 30 seconds to prevent uneven wear of the electrodes and to avoid gassing. At the same time, a recirculation system for the cold-water tanks was installed; hot-water tanks already had it.

The data were analyzed using the McNemar Test or the *T*-table test when (a+b)<10.

RESULTS

After diagnosis of the nosocomial legionnaire's disease case (the first case diagnosed in our public health area), we initiated an environmental investigation that led to the following observations: (1) the patient had been occupying room 114 from the moment of his admission; (2) there was no statement in his medical record about taking any shower; (3) he was treated with an oxygen therapy device connected to a wall humidifier, which was filled with tap water; and (4) the air-conditioning system and the cooling tower were not working at that time.

The first 13 samples exhibited a positivity rate of 62% (Table). Both the hot- and cold-water systems were contaminated, and colonization was detected both in the tanks and in the distal outlets. Contamination of the shower and faucet in room 114 was heavy. *L pneumophila* also was isolated from a humidifier in another room of the same ward. The next step we took was to empty the room and fill the wall humidifiers with sterile water supplied by the pharmacy department. Shock hyperchlorination then was applied

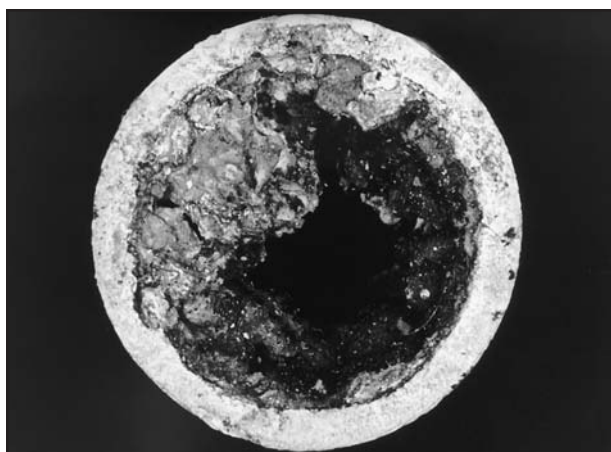


FIGURE. Cross-section of a pipe recently removed from our water distribution system. The large amount of deposit in the lumen provides an excellent environment for the thriving of certain microorganisms, such as *Legionella pneumophila*.

to the cold- and hot-water tanks and to the whole distribution system, including the water in the cooling tower and in the air-conditioning system. Samples from the humidifiers continued to be positive despite having been filled with sterile water, most likely because the personnel continued using tap water for cleaning and rinsing the humidifiers. Of eight samples obtained from the previously positive outlets 24 days after shock hyperchlorination, seven remained positive (Table). At this point, we undertook the following measures: (1) installation of a continuous chlorination system in the cold-water tanks to achieve a steady concentration of free residual chlorine of approximately 0.8 ppm at the outlets (higher levels were not desirable because of the poor condition of the plumbing); (2) elimination of dead legs in the pipe work (Our patient's ward had eight dead legs, corresponding to old faucets that were necessary when the ward was occupied by the obstetrics department.); (3) replacement of the fixtures that were positive for *L pneumophila*; and (4) installation of disposable sterile water containers for the humidifiers to avoid cleaning and rinsing procedures.

These measures markedly reduced *L pneumophila* colonization at the points where we carried out changes, but 24 new samples obtained 1 month later showed that colonization of the building was still high, with a positivity rate of 58%. We therefore added another global method in addition to the continuous chlorination system, a Cu-Ag ionization system, which began to function on August 27, 1997.

During September and October, mean copper concentrations were 0.25 ppm in the hot water and 0.08 ppm in the cold water. The 24 samples obtained on October 30, at the same points as in the previous sample, showed a positivity rate of 13%. When analyzed with the McNemar Test, there was a significant difference between the positivity rate of the samples collected before the installation of the Cu-Ag ionization system and the samples obtained 2 months later ($P=.0034$).

TABLE
RESULTS OF CULTURES OF HOSPITAL WATER FOR *LEGIONELLA PNEUMOPHILA*

Timing of Samples	No. Positive/No. Obtained (%)
Initial	8/13 (62)
Post-hyperchlorination	7/8* (88)
Post-fixture replacement	1/6* (17)
Pre-Cu-Ag ionization	14/24 (58)
2 mo post-Cu-Ag ionization	3/24† (13)
5 mo post-Cu-Ag ionization	4/24† (17)

Abbreviation: Cu-Ag, copper-silver.

* Sites sampled were sites that were positive in the initial sample.

† Sites sampled were the same as those in the pre-Cu-Ag ionization sample.

During November, December, and January, mean copper concentrations were 0.12 ppm in the hot water and 0.02 ppm in the cold water. On February 5, we obtained 24 new samples from the previously sampled points, with a positivity rate of 17%. The comparison with a T table of the two sets of 24 paired samples obtained after the installation of the Cu-Ag ionization system showed no significant differences in positivity rate. On the other hand, the comparison of the samples obtained before the installation of this system and in February 1998 showed again a significant difference among the positivity rate ($P=.002$).

DISCUSSION

Colonization of 62% of hospital environmental samples with the same serogroup of *L pneumophila* that infected our patient prompted the implementation of global *Legionella* control measures. We installed a Cu-Ag ionization device in both the hot- and the cold-water circuits and a continuous chlorination system in the cold-water circuit. Even though present guidelines for Cu-Ag ionization systems recommend only the treatment of hot-water systems,⁹ we decided to treat the cold-water system, too, because the samples obtained from the cold-water tanks were positive, the oxygen therapy humidifiers (which we believe were the most probable source of infection in our patient) were filled with cold water, and cold water also has been implicated in legionellosis outbreaks by other authors.¹⁰ It therefore was necessary to treat a large volume of water, much larger than that in the study of Liu et al⁴ and similar to that treated by Mietzner et al.¹¹

Since the installation of the Cu-Ag ionization system, it has been necessary to clean the hot-water electrodes three times and the cold-water electrodes two times. The low levels of copper and the incomplete eradication of *L pneumophila* from the water system have led to some modifications. An extra unit has been installed in the cold-water system, the proportion of silver in the hot-water electrodes has been raised from 25% to 30%, and the electrodes have been reshaped so as to minimize the accumulation of biofilm. All of these changes have been done to achieve a lower positivity rate by increasing the biocidal concentration.

In the future, we will continue sampling our water distribution system to obtain a long-term efficiency evaluation of the Cu-Ag method combined with water chlorination for the eradication of *L pneumophila* colonization, as recommended by Yu et al.¹² Our aim is to keep the positivity rate as low as possible. The results suggest that the Cu-Ag ionization system is a highly promising method for the control of *L pneumophila* colonization of water distribution systems. The high rate of colonization we found in the initial survey of our hospital could not be reduced by conventional systems, such as hyperchlorination, but fell dramatically shortly after the Cu-Ag electrodes were installed, even though the achieved copper levels were under those recommended by other authors. No new cases of nosocomial legionellosis have been detected since the installation of the Cu-Ag system.

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REFERENCES

- Muraca PW, Yu VL, Goetz A. Disinfection of water distribution systems for *Legionella*: a review of application procedures and methodologies. *Infect Control Hosp Epidemiol* 1990;11:79-88.
- Best M, Yu VL, Stout J, Goetz A, Muder R, Taylor F. *Legionellaceae* in the hospital water-supply. Epidemiological link with disease and evaluation of a method for control of nosocomial legionnaires' disease and Pittsburgh pneumonia. *Lancet* 1983;2:307-310.
- Goetz A, Yu VL. Nosocomial *Legionella* infection. In: Mayhall CG, ed. *Hospital Epidemiology and Infection Control*. 1st ed. Baltimore, MD: Williams & Wilkins; 1996:388-398.
- Liu Z, Stout JE, Tedesco L, Boldin M, Hwang C, Diven WF, Yu VL. Controlled evaluation of copper-silver ionization in eradicating *Legionella pneumophila* from a hospital water distribution system. *J Infect Dis* 1994;169:919-922.
- Landeem LK, Yahya MT, Gerba CP. Efficacy of copper and silver ions and reduced levels of free chlorine in inactivation of *Legionella pneumophila*. *Appl Environ Microbiol* 1989;55:3045-3050.
- Stout JE, Lin YE, Goetz AM, Muder RR. Controlling *Legionella* in hospital water systems: experience with the superheat-and-flush method and copper-silver ionization. *Infect Control Hosp Epidemiol* 1998;19:911-914.
- Pelaz C, Martín-Bourgon C. "Legionelosis: datos de España, diagnóstico de laboratorio y recomendaciones para su prevención y control en instalaciones de edificios." Madrid, Spain: Instituto de Salud Carlos III, Ministerio de Sanidad y Consumo. 1993.
- Pelaz C, García L, Martín-Bourgon C. Legionellae isolated from clinical and environmental samples in Spain (1983-1990): monoclonal typing of *Legionella pneumophila* serogroup 1 isolates. *Epidemiol Infect* 1992;108:397-402.
- Centers for Disease Control and Prevention. Guidelines for prevention of nosocomial pneumonia. *MMWR* 1997;46(RR-1):55-57.
- Helms CM, Massanari RM, Wenzel RP, Pfaller MA, Moyer NP, Hall N, et al. Legionnaires' disease associated with a hospital water system; a five-year progress report on continuous hyperchlorination. *JAMA* 1988;259:2423-2427.
- Mietzner S, Schwille RC, Farley A, Wald ER, Ge JH, States SJ, et al. Efficacy of thermal treatment and copper-silver ionization for controlling *Legionella pneumophila* in high-volume hot water plumbing systems in hospitals. *Am J Infect Control* 1997;25:452-457.
- Yu VL, Liu Z, Stout JE, Goetz A. *Legionella* disinfection of water distribution systems: principles, problems, and practice. *Infect Control Hosp Epidemiol* 1993;14:567-570.