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Letters to the Editor

Cost analysis for electron time-flow taps and point of use filters: a comparison of two methods for Legionnaires' disease prevention in hospital water networks

Sir,

Literature data suggest that large hospital water networks with the presence of old and corroded pipelines and dead-end branches, provide optimal conditions for *Legionella* spp. growth in microbial biofilm [1]. Moreover, low water-flow velocities, stagnation, and water-quality deterioration, represent risk factors for *Legionella* spp. resistance to chemical disinfection [2].

In a previous study we evaluated the reduction of *L. pneumophila* colonization in a water network of a 401-bed Italian hospital after time-flow taps (TFTs) installation. The hospital has 320 water outlets, 100 of them are located in high-risk areas. We found that a programmed water flow of 192 L/day, associated with continuous chemical chlorination, could represent a more cost-effective strategy than point of use filters (PUFs) [3].

In this letter we report a cost analysis for TFTs and PUFs, both strategies being combined with chlorine disinfection. We compared the total costs of eight TFTs (located at dead-end branches of the water network) and 100 PUFs (located in high-risk areas) in a 401-bed monoblock hospital with 320 water outlets. Both these arrangements could be considered adequate for Legionnaires's disease prevention.

As described in *Guidelines for Drinking Water Quality* [4] and in *Italian Guidelines for Legionnaires' Disease Prevention and Control* [5], continuous chemical disinfection ensures a residual concentration of the disinfectant throughout the water distribution system in order to minimize colonization. This activity may be enhanced by an appropriate water flushing, performed through electron time-flow taps [3]. Conversely, some chemical disinfectants, such as chlorine, are corrosive and may cause pipeline damage and disinfection by-products formation [5]. For physical disinfection, PUFs are adequate for points of use serving high-risk patients [6]; however, PUFs cannot decolonize water networks as chemical disinfection does.

In our previous study [3], *L. pneumophila* sg 2–14 was initially detected at all of the sampling points ($4 \times 10^4 \pm 3.1 \times 10^4$ cfu/L) despite the use of chemical disinfection. After seven months of TFT use, *Legionella* spp. colonization persisted at one sampling point. From March 2017, *Legionella* spp. was not detected any more. These data assert a slow progressive improvement in water quality and in chlorine dioxide efficacy in reducing the *Legionella* spp. colonization in a flushed water network. On the contrary, PUFs, applied in high-risk areas, guarantee the absence of *Legionella* spp. at those outlets, but not in the network.

Cost analysis of the legionella control measures used in our hospital was performed, i.e. chlorine dioxide disinfection, installation of PUFs and use of TFTs (Table I). Chlorine dioxide disinfection without water flushing has variable and unpredictable efficacy, with an initial cost of €13,500 and ongoing costs of €6,000 per year. Efficacy depends on maintenance procedures and the presence of dead-end branches in water

Table I
Cost comparison of different methods (chlorine dioxide disinfection, point of use filters, electron time flow taps) used for Legionella control in a 401-bed hospital with 320 taps

Method	Cost element	Initial costs (€)	Annual ongoing costs (€)
Chlorine dioxide disinfection	Chlorine dioxide generator and control unit devices	13,000	
	Device installation	500	
	Chlorine dioxide and maintenance cost		6000
31-day point of use filters	Filters (100 units in high-risk areas)		26,400
	Device installation		1200
Electron time flow taps	Taps (8 units in dead-end branches)	400	
	Taps installation and maintenance	170	
	Hot water consumption		800

networks. Installation of 100 PUFs in high-risk areas represents the most effective option to ensure patient safety (100% efficacy declared by the filters validation guides), but costs were high at €27,600 per year. In contrast, TFTs without chemical disinfection do not reduce water colonization because they are not a disinfection treatment (efficacy of 0%). However, they can usefully supplement the efficacy of chemical disinfection, and appear effective in controlling legionella at local outlets. The cost of eight TFT units, installed in dead-end branches, comprised an installation cost of €570, and an ongoing cost of €800 per year.

Legionella control strategies need to be tailored to the individual hospital setting. In high-risk areas, integration of chemical disinfection with chlorine dioxide and the application of PUFs represents the best choice for certainty of prevention of water-borne Legionnaires' disease. In medium- and low-risk areas, the hospitals may choose to supplement chlorine dioxide disinfection with TFTs, especially in areas where water flow is limited (e.g., low-use outlets or presence of dead ends). This strategy may be a sustainable and cost-effective method to improve water quality by reducing biofilm proliferation in water pipelines.

Conflict of interest statement
All authors have no conflicts of interest to declare.

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A new approach to put isolation precaution guidelines into practice

Sir,

A recent article from Lynch *et al.* raised the question whether guidelines for the control of multidrug-resistant Gram-negative organisms can be put into practice [1]. In North Zealand Hospital (NOH), a Danish 570-bed hospital, we have worked hard to ensure that isolation precautions are implemented promptly when needed according to our guidelines. We were quite happy with our results, until we realized that isolation precaution removal was not always timely. Thus, patients were confined to single rooms longer than necessary according to guidelines. This resulted in impaired flow of patients, blocked beds, more work for staff, unnecessary costs, and, perhaps most importantly, a less comfortable hospital stay for the patients involved. The Department of Quality and Improvement worked together with the Infection Control Unit to address this problem. Accordingly, an experienced infection control nurse was hired part time to review the electronic health records of all isolated patients seven days a week. The reason(s) for isolation precautions was audited and possible non-compliance cases of guidelines identified. The wards in question were contacted and inconsistencies resolved. An action card comprising guidelines for most causes of isolation was drafted, tested by two wards, revised, and accordingly published and distributed hospital-wide. Furthermore, education of nurses and healthcare assistants was initiated, focusing on isolation precaution guidelines.

During January through April 2019, 6026 patients were isolated in single rooms at NOH. In 169 (3%) cases isolation was not indicated according to guidelines and could safely be terminated. We estimate that the 169 cases corresponded to a minimum of 338 isolation-days, and a cost–benefit analysis showed that the intervention proved economically beneficial. The most frequent causes of non-compliance were unawareness of cessation of symptoms of gastroenteritis or influenza and of negative screening tests for multidrug-resistant bacteria in patients transferred from non-European hospitals. Nurses