Enferm Infecc Microbiol Clin. 2018;36(4):207–208

Enfermedades Infecciosas y Microbiología Clínica

www.elsevier.es/eimc

Editorial

Control of the spread of resistant pathogens in health centers: Beyond the standard prevention measures

Control de la diseminación de patógenos resistentes en los centros sanitarios: más allá de las medidas estándar de prevención

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In recent years there has been growing awareness that the hospital environment plays a very important role in the origin of hospital infections, as a facilitator, generator and even in the perpetuation of certain outbreaks.[1] Despite this recognition, both the cleaning and the search for environmental reservoirs are hardly standardized and we do not have manuals, guides or recommendations. Currently, we lack hospital cleaning standards that go beyond visual inspection, which would allow us to adequately and systemically monitor its adequate performance.[2] Nor is there a regulation or critical levels established in areas of care units, except in the case of *Legionella* spp. in sanitary water systems, filamentous fungi in the air of risk areas or controlled atmospheres in clean rooms.[3] In addition, there are devices that, being in frequent contact with patients or health personnel hands, are "orphans" and are not usually included in any recommendations, such as mobiles, digital pulsometers, glucometers, or tablets.[4] Taking into account this issue, we must also add hospital water supply systems, which in recent years have proved to be one of the most important and unexpected source of etiological agents of nosocomial infection.

The design of the sinks facilitates the formation of polymicrobial biofilms in the end of the tap, if it has an aerator, as in the drain valve and the siphon. These sinks components provide rough surfaces for the settlement of heterogeneous communities of microorganisms adapted to the aquatic environment and transported by the turbulent flow of water. Although these communities are probably composed of a wide variety of microorganisms, including bacteria, amoebae, fungi, and viruses, only bacterial populations have been actually studied. The bacterial count present in the water droplets that have been in contact with these biofilms had been found related to the counting in the biofilms, the material on which it sits and the concentration of disinfectants.[5] It is described that sink drains in hospitals contain approximately 10^3–10^5 CFU/ml Gram-negative rods, especially waterborne bacteria.[6]

In hospital outbreaks described to date, we can differentiate those associated with the aerator from those associated with drainage according to the type of bacterial species. In the incoming water and aerators as well as in the siphons, species well adapted to water such as *Pseudomonas* spp.,[7] *Acinetobacter* spp.,[8] or other non-fermentative Gram negative rods are recovered. In this issue, a case associated with *Chryseobacterium* and aerators is discussed.[9] To these are added those that may come from patient exudates and settle later in the outcoming water, siphons or drainage pipes, including all types of Enterobacteriales: mainly *K. oxytoca*,[10] but also *K. pneumoniae*,[11] *Citrobacter* and *Enterobacter*.[12]

Different aspects are shared by the outbreaks associated with sinks or taps, whether if they come from aerators or from drainage systems, especially the latter. The first common characteristic fact is the duration of the outbreaks. The cases do not usually accumulate in a period of a few days, but they appear in the affected unit over several months, even with intercurrent periods without cases, and thanks to the molecular typing a relationship could be stablished. Knoester et al. described an outbreak associated with VIM-producing *P. aeruginosa* affecting 44 patients from February 2009 to January 2012.[13] Longer periods have also been described, up to 2 years the same strain of IMP-8-producing *K. oxytoca* in an ICU in Andalusia[14] and up to 4 years the same strains of ESBL-producing *K. pneumoniae* were maintained in an ICU in Toronto.[10] The second aspect that characterizes this type of reservoirs is that the number of strains involved point to one sink or the whole ICU set of pipes are affected. A single strain may be involved when only one tap or sink is contaminated or when the drainage of the sinks is common. The isolates infecting patients and the environmental isolates are usually identical during the whole period, such us the case in an ICU in Chicago between 2004 and 2005, where the isolates from 11 patients were found to be genotypically to the sink trap strain of *A. baumannii* and the entire horizontal drainage system was suspected to be colonized.[15]

On other occasions, what is observed is the persistence of a single mobile element over time. This phenomenon is revealed because an unusual determinant of resistance is detected in a

DOI of original article: http://dx.doi.org/10.1016/j.eimc.2017.01.008
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healthcare unit, with carbapenemases being the most common genes in recent years. In these situations, the suspicion that the biofilms of the sinks or faucets are the reservoir begins when the same mobile element is detected over a very long period of time in different strains. In a study conducted in the ICU of a Norwegian hospital, it was observed that all KPC-2-producing clinical and environmental isolates, including 2 pulsotypes of *K. pneumoniae* and 2 pulsotypes of *E. asburiae*, carrier an identical Inc FII plasmid profile.[16] The environmental isolates were recovered from the sinks in a 4 year interval. The same determinant and plasmid profile were also observed in two different pulsotypes of ESBL-producing *K. pneumoniae* during a 4-year period,[10] as well as in isolates from 5 different species producing OXA-48 in an ICU of Bruxelles.[6] The persistence of a plasmid or a mobile element in the environment changes our classic outbreak concept by a strain or pathogen to outbreak produced by a genetic element. The contamination of faucet aerator, such as the outbreak described in this issue, is reported much less frequently.[9] In the cases described in this issue we do not know if it is the same strain that is detected in the positive aerator and in the patients, since a genetic comparison has not been carried out. What we do know in the previous reported outbreaks associated with aerators and taps, is that several strains may be involved, since at least 2 strains were identified.[8,12]

The colonization of sinks by multiresistant bacteria on the one hand of taps or faucets and on the other of the sinks must be treated differently, collaborating in the design of measures both the infection control team and the maintenance service of the hospital. The control measures that have been used to date in the case of sinks and siphons can be grouped into 4, which are sometimes used in stages: (1) the use of different types of disinfectants, (2) replacement of sinks and pipes, (3) design changes of the drains and (4) changes in the use of the sinks. The most widespread and simplest initial measure is the use of chemical disinfectants, such as bleach,[13,14] persulfate based disinfectant,[15] hydrogen peroxide,[7,10] quaternary ammonium,[6] and acetic acid.[16] However, these attempts use to yield positive follow-up cultures after a period of time and drain, sinks and plumbing need to be removed and replaced.[6,7,11,13,14] In those cases where drainage design is inadequate, interventions have had to include redesigns of these systems[10] as well as the measures to minimize splash back.[7] To these structural measures must be added those that improve the use of sinks, reducing it to clean procedures and avoiding the dumping of medicines or waste from patients.[11,13]

The elimination of the contamination of taps and aerators can be even more complicated than that of the drains and siphons. The sanitary water contains Gram-negative bacilli well adapted to the concentrations of chlorine and that can generate biofilms in the terminal aerators. The initial measures in this case focus on the replacement of the aerators by others with a better design, with radially and vertically lamellae,[8,9] or by the periodic replacement to avoid the establishment of biofilms.[12] In units with especially susceptible patients, such as oncohematology units, the use of filters for incoming water, despite being a measure with high maintenance costs, has been effective.[17]

In addition, sometimes it has had to resort to more drastic measures, completely eliminating the faucets and sinks both for the hygiene of patients and for the hygiene of hands of the staff.[9] A "bed bath" system for cleaning of patients with wipes[15] and wipes to remove extensive contamination from staff hands, following by disinfection alcohol-based hand rub has been stablished.[18] The water-free patient care has been associated in a pre and post intervention with a significant reduction of patient colonization with all kind of Gram negative rods of and this effect was most pronounced in patients with a longer ICU length of stay.[18] This solution ends with contact with any type of biofilm, but requires a deeper assessment in the long term and in all types of ICUs and groups of patients.

The study of hidden reservoirs in the system of pipes, faucets and sinks has been neglected for a long time. We only have information when there are outbreaks and very few of the interventions analyze the impact of the measures in the long term. The recognition of an outbreak has been possible thanks to the molecular typing of isolates and mobile elements, but it has only been used when the accumulation of unusual resistance profiles or rare microorganisms attracted attention. More general studies that include continuous monitoring in different types of care units are needed to really know the role they play in nosocomial infection.

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