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Major Article

Decontamination of stethoscope membranes with chlorhexidine: Should it be recommended?

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Objective: To determine differences in the recontamination of stethoscope membranes after cleaning with chlorhexidine, triclosan, or alcohol.

Methods: Experimental, controlled, blinded trial to determine differences in the bacterial load on stethoscope membranes. Membranes were cultured by direct imprint after disinfection with 70% isopropyl alcohol, 1% triclosan, or 1% chlorhexidine and normal use for 4 hours. As a baseline and an immediate effect control, bacterial load of membranes without disinfection and after 1 minute of disinfection with isopropyl alcohol was determined as well.

Results: Three hundred seventy cultures of in-use stethoscopes were taken, 74 from each arm. In the baseline arm the median growth was 10 CFU (interquartile range [IQR], 32-42 CFU); meanwhile, in the isopropyl alcohol immediate-effect arm it was 0 CFU (IQR, 0-0 CFU). In the arms cultured after 4 hours, a median growth of 8 CFU (IQR, 1-28 CFU) in the isopropyl alcohol arm, 4 CFU (IQR, 0-17 CFU) in the triclosan arm, and 0 CFU (IQR, 0-1 CFU) in the chlorhexidine arm were seen. No significant differences were observed between the bacterial load of the chlorhexidine arm (after 4 hours of use) and that of the isopropyl alcohol arm (after 1 minute without use) ($Z = 2.41$; $P > .05$).

Conclusions: Chlorhexidine can inhibit recontamination of stethoscope membranes and its use could help avoid cross-infection.

During the past 2 decades, a reduction in device-associated infections in health care institutions has been achieved; nevertheless, a simultaneous increase in infections that were not device-associated was observed.[1] A possible interpretation of these findings is that cross-contamination may play a greater role in infection than previously believed. Nowadays, between 20% and 40% of health care-associated infections are linked to cross-contamination.[2] It is also known that the main causal agents of health care-associated infections can survive for months or even years on environmental surfaces, which become efficient reservoirs.[3]

Stethoscopes can be a source of cross-contamination in the same manner as environmental surfaces, permitting the transfer of organisms from the membrane to skin.[4] Between 80% and 100% of in-use stethoscopes are contaminated with organisms such as *Staphylococcus aureus* (up to 85%), of which 20%-40% are resistant to methicillin (MRSA); *Enterococcus faecalis* (8%); and Enterobacteriaceae (6%).[5-7] In addition, the bacterial colonization on stethoscopes increases with the time lapse since their last cleaning.[8] MRSA stands out because it is a common colonizer of human skin and its infections are serious.[9]

According to the Centers for Disease Control and Prevention, the cleaning of stethoscopes must be performed each time that instruments are used, or sooner if visibly contaminated with blood; nevertheless, compliance with this recommendation barely reaches 30%.[10,11] Although disinfection with alcohol decreases the bacterial load on stethoscopes, they quickly become recontaminated because alcohol evaporates and its effect is only extended if items

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Conflicts of interest: VA and AM have obtained economic benefits from Antisepsia Central.

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remain immersed.[6,12,13] On the other hand, antiseptic agents such as chlorhexidine and triclosan exhibit substantivity, which is the capacity of an antiseptic to remain linked to skin cells or fatty acids. As these antiseptics persist on the skin, their bactericidal capacity is prolonged over time and so the surface remains free of organisms in a phenomenon called residual effect.[14-17] Although the substantive effect has only been shown on skin, we hypothesized that this effect could be found on stethoscopes. When a stethoscope is used, it is quickly contaminated with organic matter, which even isopropyl alcohol fails to remove, regardless of its potent microbicidal activity. Because organic matter may persist on a stethoscope's surface, antiseptics with substantivity could remain linked to it; if so, the decontamination of stethoscopes with an antiseptic with substantive effect could be helpful to avoid recontamination and cross-contamination.

METHODS

Institutions

The Hospital General de Leon (hospital A) is a 210-bed secondary-care institution with an average of 700 nonobstetric discharges per month. The Hospital Regional de Alta Especialidad del Bajio (hospital B) is a 184-bed tertiary-care hospital without obstetric services, with an average of 550 discharges per month. Both institutions are teaching hospitals and have committees for infection control. The protocol was approved by the review boards of both institutions.

Design and study products

An experimental, randomized, and blinded trial was performed April-December 2013. The objective was to test differences in the recontamination rates of stethoscope membranes cleaned with 70% v/v isopropyl alcohol, 1% w/v triclosan in 70% v/v isopropyl alcohol (G70 Antisepsis, Leon, Mexico), or 1% v/v chlorhexidine in 70% v/v isopropyl alcohol (G70 Antisepsis, Leon, Mexico). The study was first conducted in hospital A and then reproduced in hospital B.

Intervention methods for measuring recolonization of stethoscopes

The trial had 5 arms: 2 controls and 3 for the intervention itself. Before the intervention was performed, the baseline microbial count on the stethoscope membranes was determined. In this case, the membranes were cultured as found, without disinfection. Importantly, these stethoscopes were used only as the baseline control. A second control to test the immediate effect of isopropyl alcohol was performed. In this case, the membranes were disinfected with swabs impregnated with isopropyl alcohol. The alcohol was rubbed in circular movements from the center to the periphery of the membrane for a period of 10 seconds, and then it was allowed to dry for 60 seconds before culturing. New stethoscopes were used for this control.

The intervention phase was performed by cleaning the membranes with swabs impregnated with alcohol, chlorhexidine, or triclosan and applied as previously described. For the intervention, the antiseptics were masked to both the investigators and the users of the stethoscopes, labeling the substances as 1, 2, or 3. The first stethoscope tested was disinfected with substance 1, the second with substance 2, the third with substance 3, the fourth was disinfected with substance 1 again, and so on. To avoid cross-contamination of antiseptics, the researcher used a new pair of disposable gloves to perform decontamination of each stethoscope. The stethoscope was allowed to dry for 60 seconds, and then it was routinely used over a period of 4 hours, after which the membrane was cultured to determine the count of colony forming units. The stethoscopes had to be used at least once, and were not disinfected during the period of time preceding the culture.

Enrollment

Stethoscopes included for the intervention belonged to the adult emergency room, the pediatric emergency room, the internal medicine ward, the pediatric ward, the intensive care unit, and the pediatric and neonatal intensive care units. The stethoscopes could be used by any health care worker during daily activities, so the same stethoscope could be used by more than 1 person. Before the intervention, the principal investigator discussed the objectives and procedures with the health care workers, recommending that they perform their daily activities as usual. Once a stethoscope was evaluated, it was returned to its ward and was normally used, and needed to be used for at least 2 weeks to be eligible for a second evaluation.

Microbiologic methods

Cultures were performed by placing the membrane of a stethoscope in direct contact with an agar plate, in a firm but gentle manner to avoid rupturing the agar surface. The membranes were not removed from the stethoscopes during this procedure. The plates used for the study contained blocking agents for halogens (0.6% w/v sodium thiosulfate) and chlorhexidine (0.7% w/v L-α-lecithin) (Neutralizing agar D/E; DIFCO, Sparks, MD). The plates were incubated in aerobic conditions for 24 ± 2 hours at a temperature of 35°C ± 1°C. After incubation, a blinded investigator performed the direct count of the colony forming units. The organisms were identified by their biochemical characteristics. Antibiotic susceptibility tests were performed with the agar disk diffusion method. Indicators for drug resistance examined were: resistance to cefoxitin in *S aureus*; resistance to vancomycin in enterococci; resistance to carbapenems, quinolones, and aminoglycosides in *Acinetobacter* sp and *Pseudomonas aeruginosa*; and a positive test of double disk synergy technique for extended-spectrum β-lactamases in Enterobacteriaceae.

Statistical analysis

To test differences among data with nonnormal distribution, a Kruskal-Wallis rank test with 4 degrees of freedom and corrected for ties was performed. The post hoc test of Bonferroni was used to determine differences between the study arms; a P value < .05 was considered significant. For hospital A, a sample size of 54 stethoscopes per group was calculated to determine a difference of 20% in the recolonization with a power of 80% and a significance of 95%. For hospital B, the sample size was recalculated, and a sample size of 20 stethoscopes per group was calculated to find a difference of 30% in recolonization.

RESULTS

A total of 370 cultures were taken, 74 for each study arm. As seen in Table 1, the proportion of stethoscope membranes contaminated was not different for each study arm between the institutions. Table 2 describes the number of contaminated membranes. In the baseline control arm, 31 stethoscopes (42%; 95% confidence interval [CI], 31%-55%) were colonized. *S aureus* was the most commonly isolated organism, followed by gram-negative bacilli, with 3 of them being multidrug-resistant. No colonization of potentially pathogenic bacteria was found in the isopropyl alcohol immediate-effect arm.

Eighteen (24%; 95% CI, 14%-34%) stethoscopes from the residual effect of isopropyl alcohol arm and the triclosan arm were colonized. In both groups, *S aureus* was the most frequently