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## The stethoscope in the emergency department: a vector of infection?

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(Accepted 18 November 1999)

### SUMMARY

The purposes of this study were to determine whether microorganisms can be isolated from the membranes of stethoscopes used by clinicians and nurses, and to analyse whether or not the degree of bacterial colonization could be reduced with different cleaning methods. We designed a transversal before-after study in which 122 stethoscopes were examined. Coagulase negative staphylococci (which are also potentially pathogenic microorganisms) were isolated together with 13 other potentially pathogenic microorganisms, including *S. aureus*, *Acinetobacter* sp. and *Enterobacter agglomerans*. The most effective antiseptic was propyl alcohol. Analysis of the cleaning habits of the Emergency Department (ED) staff, showed that 45% cleaned the stethoscope annually or never. The isolation of potentially pathogenic microorganisms suggests that the stethoscope must be considered as a potential vector of infection not only in the ED but also in other hospital wards and out-patient clinics.

### INTRODUCTION

Nosocomial infections are a significant cause of morbidity and mortality in hospitalized patients [1]. Every member of the health care team must know about these infections and familiarize themselves with their identification since prevention may represent the best rationale for avoiding human suffering. Despite the succession of technological advancements that have been made over the last decade, clinicians still use stethoscopes on a regular basis. It is still one of the cheapest and most convenient tools to assess a patient in the Emergency Department (ED). The invention of the stethoscope in 1816 by the French physician, René Laënnec, allowed for full examination of the thorax for the first time [2]. When first introduced, the device was an object of derision among many. By the close of

the nineteenth century, almost every doctor had a stethoscope to assist in the diagnosis of respiratory diseases.

Recent publications [3–6] have suggested that stethoscopes might be a vector for infection due to their constant contact with many patients. In 1972 [3], Gerken and colleagues from a British teaching hospital, showed that coagulase-positive staphylococci were isolated from 21% of the stethoscopes. In 1992, Breathnach and colleagues [4] demonstrated that most stethoscopes used by physicians were contaminated with staphylococci and speculated that they could serve as vectors of infection. More recently, Marinella and colleagues [5] showed that 40 randomly selected stethoscopes were colonized by potential pathogens.

To the best of our knowledge, no studies with a large series have been published looking at the prevalence of bacterial contamination of stethoscopes in the ED. The purpose of this study was (1) to

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determine the kind of micro-organisms that can be isolated from the membranes of stethoscopes used by physicians and nurses working in an ED, and (2) to find out whether or not the degree of contamination can be diminished with different cleaning techniques and solutions.

## METHODS

### Setting

This study was performed from July to September 1996 in the Emergency Department of the Hospital de la Candelaria in Tenerife, one of the Canary Islands, Spain. Hospital de la Candelaria is a tertiary, teaching hospital with 900 beds, and averages 230 emergency visits daily.

To achieve our objectives, a transversal prospective before–after study was designed. We collected all the stethoscopes from the personnel (physicians and nurses) working in the ED. To hide the real purpose of the study from the staff, two physicians (S.N., A.M.) were in-charge of collecting the stethoscopes. Physicians and nurses participating in the study were unaware of the real purposes of the study, since we used a questionnaire asking questions related to the quality of the stethoscope as part of a survey supported by a ‘non-existent company’ interested in designing a new stethoscope (Table 1). There were no incentives for any person being involved in this study.

The collection of samples was performed during the first 3 days of every week. The maximum number of samples was 10. We did not collect any stethoscope from the same health care worker to avoid duplicate samples. Stethoscopes were collected while physicians and nurses filled in the questionnaire. In a room adjacent to ED, we performed the culture of stethoscope membranes by pressing the membrane on blood-agar for 6–10 s. After 10 min, stethoscopes were returned to the owners. Blood-agar plates were immediately sent to the Department of Microbiology where they were incubated aerobically at 37 °C for 48 h and identified by one of the authors (A.M.). Results were measured as colony-forming units (cfu).

Independently, 49 stethoscope membranes were randomly selected from the rest of the ED physicians and nurses who did not participate in the study with the purpose of establishing the effects of three antiseptic agents: (i) 96% ethyl alcohol ( $n = 19$ ); (ii) a propyl alcohol-based disinfectant (Instrunet® INIBASA S.A., Barcelona, Spain) ( $n = 15$ ); and (iii)

Table 1. Questions from the questionnaire used to disguise the true purpose of the study (Canary Islands, Spain, 1996)

1. Are you happy with the quality of your stethoscope?	A lot
	A little
	Nothing
2. How does the stethoscope fit in your ear?	Well
	Regular
	Badly
3. What degree of sensitivity does the membrane of your stethoscope have?	High
	Medium
	Low
4. Have you developed any allergy from the use of your stethoscope?	Yes
	No
	I don't know

Table 2. Microorganisms isolated from 122 stethoscope membranes, Canary Islands, Spain, 1996

Microorganism*	Cultures before cleaning	
	No.	%
<i>Staphylococcus epidermidis</i>	119	97
<i>Micrococcus</i> sp.	48	40
<i>Corynebacterium</i> sp.	31	26
<i>Bacillus</i> sp.	14	12
<i>Staphylococcus aureus</i>	7	5
<i>Acinetobacter</i> sp.	5	4
<i>Streptococcus viridans</i>	4	3
<i>Enterobacter agglomerans</i>	1	0·8

We isolated the same bacteria from several stethoscope membranes.

an antiseptic soap (formaldehyde, Lifosan® B. Braun-Dexon S.A., Barcelona, Spain) ( $n = 15$ ). These agents were applied to the membranes by rubbing them with a sterile cotton gauze impregnated with each of these antiseptic solutions for about 10 s. After 10 s at room air to facilitate the evaporation, membranes were cultured as previously described.

Upon concluding the microbiologic study, another survey was performed to obtain data on the frequency with which those in the ED cleaned their stethoscope and with which products. At the end of the study and to test the efficacy of the cleaning solutions, we performed a separate experiment, colonizing previously sterile membranes with the same pathogens

Table 3. Culture results before and after cleaning with any antiseptic solution, Canary Islands, Spain, 1996

	Before cleaning		After cleaning	
	Cultures (+) (%)	Cultures (-) (%)	Cultures (+) (%)	Cultures (-) (%)
<i>S. epidermidis</i>	97	3	27	73
<i>Corynebacterium</i> spp.	28	72	3	97
<i>Micrococcus</i> spp.	23	77	0	100

Results analysed using the McNemar test ( $P < 0.005$ ).

isolated in our study, and then we cleaned them using the same technique.

### Data analysis

We stored all data in a computerized database and then processed them with the SPSS/PC 6.01s statistics package (licence 3046). We analysed type of micro-organism, proportion of positive and negative cultures (both before and after cleaning), percentages of colony reduction in the membranes after cleaning, relative frequency of the amount of detected colonies (cfu) and the relative frequencies of cleaning on a regular basis by professional rank. The McNemar test was applied to make comparisons among groups when the results were given as + or -. Pearson's  $\chi^2$  was used to compare frequency distributions among groups and ranks. The level of statistical significance was 5%.

### RESULTS

A total of 122 stethoscopes were examined. The types of bacteria isolated from stethoscope membranes are summarized in Table 2. There was a relevant predominance of microorganisms commonly found as cutaneous flora. Several other potentially pathogenic microorganisms were also isolated, such as *Staphylococcus aureus*, *Acinetobacter* sp. and *Enterobacter agglomerans*. No methicilin-resistant staphylococci were isolated.

The results of culture before and after cleaning the selected sample of 49 stethoscope membranes with three different cleaning agents are shown in Table 3. Before cleaning, the mean number of microorganism colonies was 132 cfu per stethoscope. Disinfecting the stethoscope diaphragm resulted in an immediate reduction in the bacterial count to 0.3 cfu per stethoscope with disinfectant (propyl alcohol), 2.3 cfu per stethoscope with alcohol, and 11.8 cfu per stethoscope with antiseptic soap (Fig. 1). The cleaning of stethoscopes with three different antiseptics was

effective in reducing the contamination of the membranes; however, the antiseptic soap was the least effective. The propyl alcohol-based disinfectants had the best results (99% reduction of colonies) ( $P < 0.01$ ).

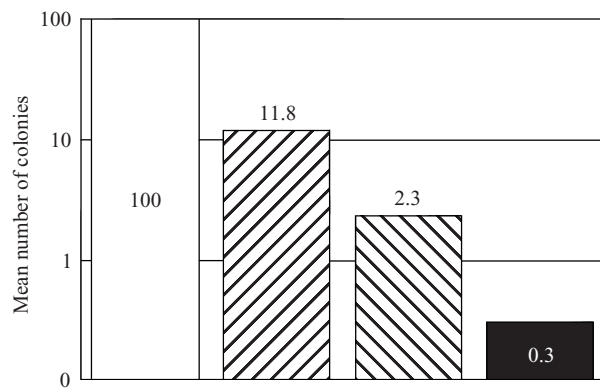
The degree of contamination (bacterial count, cfu/stethoscope) according to professional rank, nursing versus the medical staff's stethoscopes is shown in Figure 2. Although one third of the stethoscopes were contaminated with more than 100 cfu/stethoscope, there were not microbiologically relevant differences ( $P = 0.3$ ) between nurses and physicians.

The frequency of stethoscope cleaning by ED personnel is shown in Figure 3. Upon analysing the stethoscope cleaning habits of the health care staff of the ED, 45% of them cleaned the stethoscope once a year or never and 35% cleaned it monthly. Thirty percent (13/43) of clinicians that were interviewed had never cleaned the stethoscope. Nursing staff cleaned it more frequently: 22% did so weekly/monthly versus 11% of the medical staff ( $P < 0.05$ ). Likewise, the percentage of doctors that cleaned it annually or never (29%) was higher than that of nursing staff (15%) ( $P < 0.05$ ).

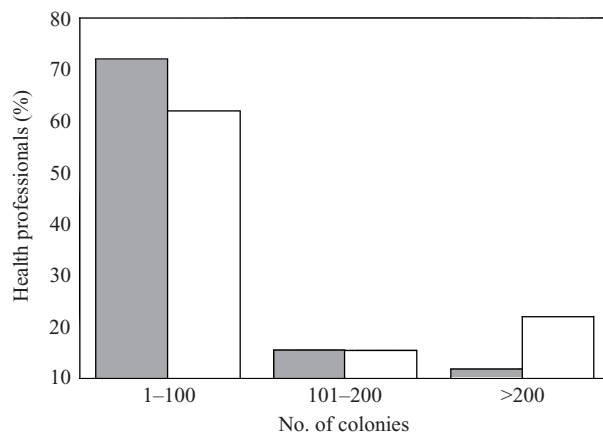
The data in Table 4 show the efficacy of the cleaning solutions which were used and establishes their antiseptic effects on the micro-organisms isolated in our series. This table refers to the separate experiment colonizing previously sterile membranes with the same pathogens isolated in our study, and then cleaned using the same technique. Propyl alcohol and 96% ethyl alcohol were much more effective than antiseptic soap.

### DISCUSSION

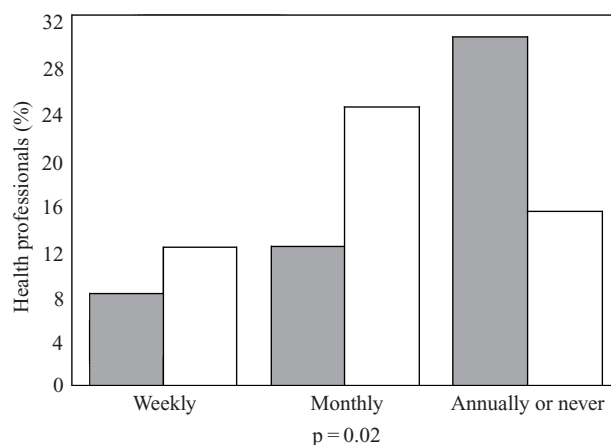
The introduction of an array of medical devices for the modern management and treatment of diseases has contributed to the development of nosocomial



**Fig. 1.** Reduction of microorganisms after cleaning of stethoscopes, Canary Islands, Spain, 1996. The y-axis is a logarithmic scale for better viewing. Propyl was the best antiseptic agent. □ Control; ▨ soap; ▩ ethyl alcohol; ■ propyl alcohol.



**Fig. 2.** Bacteria count (cfu/stethoscope) in stethoscopes of physicians ■ and nurses □ before cleaning, Canary Islands, Spain, 1996.



**Fig. 3.** Frequency of stethoscope cleaning by physicians ■ and nurses □, Canary Islands, Spain, 1996.

infections. The results of this study demonstrated that the majority of stethoscopes, an almost universal tool of the medical and nursing community, at our institution were contaminated with micro-organisms commonly found in cutaneous flora. Although *Staphylococcus epidermidis* was most frequently found (97%), we also found bacterial flora not reported in the previous literature [3–6] which are potentially lethal to humans. Coagulase negative staphylococcus is a microorganism which frequently causes severe systemic infections, including catheter-associated and device-associated sepsis [7–11].

The observation that in our study we were able to isolate other potentially pathogenic microorganisms such as *Staphylococcus aureus*, *Acinetobacter* sp. and *Enterobacter agglomerans*, suggests that the stethoscope should be considered a transmitter of infection, not only in the ED, but also in the rest of the hospital wards and out-patient clinics. This is especially relevant in surgical and internal medicine wards, since health care givers in these areas had stethoscopes that were contaminated with these microorganisms. We would like to emphasize that several physicians in our study were medical and surgical residents who were rotating in the ED as part of their training.

We believe that our series is the largest among the published reports to study the efficacy of antiseptic agents [5, 6, 10]. We discovered that among the substances we examined, isopropyl alcohol was the most efficient antiseptic in reducing cfu, similarly to the results by Marinella and colleagues, who examined bacterial contamination of 40 stethoscopes [5]. However, since 96% ethyl alcohol was almost as effective as isopropyl alcohol, our results and those of Jones and colleagues [6] suggest that it can be a cost-effective alternative for the cleaning of stethoscope membranes.

Our study of bacteria count (cfu/stethoscope) by professional rank showed that there was no statistically significant evidence of a microbiologically relevant difference ( $P = 0.3$ ). In previous published studies, nursing staff had lower levels of bacterial contamination [5, 6]. Results of our study demonstrated that stethoscopes that are utilized in clinical practice on a daily basis carry potentially pathogenic microorganisms. Intact skin is an efficient barrier against most infective agents; however, small skin lesions are frequent and accidental blood–skin contact may occur. This route of exposure should not be underestimated. This is extremely important when treating patients with wounds or burns, or patients with catheters or tracheostomies.

Table 4. *Efficacy of cleaning solutions versus isolated microorganisms, Canary Islands, Spain, 1996*

	Propyl alcohol		Ethyl alcohol		Soap	
	Before	After	Before	After	Before	After
<i>S. aureus</i>	> 1000	(-)	> 1000	(-)	> 1000	270
<i>Acinetobacter</i> sp.	> 1000	(-)	> 1000	(-)	> 1000	100
<i>Enterobacter</i> sp.	> 1000	(-)	> 1000	(-)	> 1000	40

Numbers represent colony forming units (cfu).

We believe that the method we designed to elicit the information from health care givers ('disguised' questionnaire), was an essential tool to avoid interview bias. None of the previously published reports has focused, examined or concentrated on this type of bias.

Although we did not do serial testing, we suspect that contamination would be present within one or two uses of the stethoscope and that, to be effective, decontamination would have to be performed after each application of the stethoscope. However, cleaning may be more important between certain high-risk patients.

We believe that poor cleaning of the stethoscope can turn this tool into a vector of infection. If left uncontrolled, this could cause important nosocomial outbreaks. The prevalence of antibiotic resistant microorganisms is increasing in an exponential manner. Whether or not the stethoscope plays a role as an actual source of infectious diseases is a question that needs to be further investigated. The limited number of published reports on this topic might encourage further studies in this area, particularly in closed units such as the neonatal intensive care and infectious diseases units, where the control of nosocomial infection is extremely important.

#### ACKNOWLEDGMENTS

We thank Armando Aguirre-Jaime and Antonio Cabrera de León, members of the Research Institute of the Hospital de la Candelaria, for their help in the statistical processing of the data. We also thank the

physicians and nurses of the Emergency Department for their cooperation.

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