

Original Article

Stethoscope, “the friendly foe” – A study to evaluate bacterial contamination of stethoscopes and disinfection practices

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Abstract

Introduction: Stethoscope is used to assess the health of patients but can also act as a potential source of disease transmission. The study was aimed to find out the contamination rate of stethoscopes, evaluate awareness and attitude of healthcare workers (HCWs) about stethoscope cleaning, and determine the efficacy of 70% alcohol as cleaning agent.

Methodology: This hospital based cross-sectional study was conducted in a tertiary care hospital in October 2015 among healthcare workers. They were asked to fill a questionnaire followed by culturing the diaphragm and bell surfaces of their stethoscopes before and after cleaning with 70% isopropyl alcohol.

Results: Out of 100 stethoscopes cultured, 56 were found to be contaminated at least with one microorganism. *Acinetobacter cbc* was the commonest contaminant followed by *Klebsiella pneumoniae*. Three out of twelve *S. aureus* strains showed methicillin resistance. Stethoscopes used in emergency areas were more contaminated when compared to wards and out-patient departments. Despite 100% awareness among HCWs, the importance of stethoscope cleaning is realized by only 70% who practice it regularly.

Conclusion: Stethoscope is a potential vector for transmission of healthcare associated infections. Hence it is vital to clean it after each use to reduce the load of iatrogenic infections.

Key words: Stethoscope; bacterial contamination; MDR pathogens; isopropyl alcohol.

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Introduction

Healthcare-associated infections (HAIs) are the most frequent and dreaded adverse events of admission to health care settings now-a-days. They can affect patient in any type of care setting and may also appear after discharge. The burden of health care costs has increased because of them and so is the morbidity and mortality among inpatients [1]. Critical or invasive devices have always been held responsible for HAIs, but non-critical devices like electronic thermometers, blood pressure cuffs, stethoscopes, latex gloves, masks, neckties, pens, badges, and white coats also significantly contribute to them and have been implicated in many outbreaks of HAIs [2].

Stethoscope, a doctor’s “friend” can serve as a “foe” for his patients when it acts as a potential vector for transmission of dangerous pathogens. The important parts of stethoscope – diaphragm, bell portions, and ear pieces that come in direct contact with patients’ skin and physicians hand become frequently colonised with pathogenic isolates [3]. Hence is the need for an effective surveillance programme to evaluate the role of the non-invasive devices in transmission of infection.

Numerous studies conducted across the globe have reported a very high contamination rate of stethoscopes ranging from 66%-100% [4]. In order to serve as a potential vector for disease transmission, various factors such as level of contamination, capacity of pathogen to survive on the stethoscope and the level of disinfection comes into play. Regular disinfection of the stethoscopes has been found to decrease the colonization rate [5].

The study was aimed to find out the contamination rate of stethoscopes, evaluate awareness and attitude of healthcare workers (HCWs) that included doctors, medical interns and nursing staff about stethoscope cleaning, and determine the efficacy of 70% alcohol as cleaning agent for stethoscopes.

Methodology

Study design

A hospital based cross-sectional study was conducted by the Department of Microbiology, Government Medical College Hospital (GMCH), Chandigarh in the month of October 2015. Our hospital is a 750 bedded tertiary care hospital with

multidisciplinary intensive care units (ICUs) catering people from Chandigarh and adjoining states like Haryana, Punjab and Himachal Pradesh in north India.

Study population and sample size determination

The study population comprised of HCWs working in the hospital and use stethoscopes that included doctors, nursing staff and the medical interns. The sample size for the study was calculated based on the results of a pilot study done in 10 stethoscopes which showed 50% stethoscope contamination rate. Taking expected prevalence as 50% and keeping confidence level at 95% and absolute precision at 10%, a sample size of 100 was calculated using Daniel’s formula.

The stratified random sampling technique was applied for sampling of the stethoscopes. The study population was divided broadly into two stratified groups (one group of doctors that included interns and other group of nurses) and out of their total hospital population approximately one fourth stethoscopes from two groups was sampled until the sample size was achieved. The stethoscopes of HCWs working in critical areas like ICUs, emergency room, wards, and also from those working in outpatient departments (OPDs) were sampled. The informed written consent from all the participants was incurred and those showing unwillingness were excluded.

Sample collection and processing

The structured questionnaire was distributed among the participants and their answers were evaluated in

order to know their awareness about the stethoscope handling, disinfectant use and adherence to the infection control practices (Table 1). Four samples two each from diaphragm and bell before and 30 seconds after cleaning with 70% isopropyl alcohol or until it dries by using sterile cotton swab moistened with sterile normal saline. Isopropyl alcohol has documented role in disinfection with a wide antimicrobial cover and is easily available disinfectant in a healthcare setting. The collected swab samples were inoculated on sheep blood agar (SBA) and MacConkey agar (Hi-Media, Mumbai, India) followed by incubation at 37°C aerobically for 24 hours. The colony forming units (CFUs) obtained were noted and the bacterial isolates were identified by standard microbiology identification techniques [6]. The antimicrobial susceptibility pattern for the isolated strains was determined as per clinical laboratory standards institute (CLSI) guidelines and drug resistant bacteria like methicillin resistant *Staphylococcus aureus* (MRSA), vancomycin resistance in gram positive cocci, extended spectrum β lactamase (ESBL) and metallo β lactamase (MBL) production in gram negative bacteria were also tested [7,8].

Lastly, the effectiveness of immediate stethoscope cleaning by 70% isopropyl alcohol was determined based on its ability to kill the microorganisms and absence of microbial growth on culture in post alcohol cleaning swab samples. The efficacy was calculated by percentage reduction formula which is as follows:

$$\text{Percent reduction} = A - B \times 100 \div A$$

Table 1. Questionnaire distributed to the healthcare workers and its results.

Questions	Group 1; n = 64		Group 2; n = 36	P value
	Doctors; n = 49	Medical interns; n = 15	Nursing staff; n = 36	
Do you think your stethoscope can transmit infection?	Yes-100%	Yes-100%	Yes-100%	--
If yes, which part of the stethoscope can transmit infection?	Diaphragm-83.7% (41)	Diaphragm-60% (9)	Diaphragm-63.9% (23)	0.087
	Bell-0%	Bell-0%	Bell-5.6% (2)	
	Both-16.3% (8)	Both-40% (6)	Both-30.6% (11)	
How often you clean your stethoscope?	Hourly-0%(0)	Hourly-33.3% (5)	Hourly-44.4% (16)	0.0001
	Weekly-34.7% (17)	Weekly-46.7% (7)	Weekly-16.7% (6)	
	Monthly-28.6% (14)	Monthly-6.7% (1)	Monthly-8.3% (3)	
	Never-36.7% (18)	Never-13.3%(2)	Never-30.6% (11)	
Which chemical disinfectant is used by you to clean the stethoscope?	Spirit-59.2% (29)	Spirit-100% (15)	Spirit-86.1% (31)	0.054
	Others-40.1% (20)	Others-0% (0)	Others-13.9% (5)	
Are you familiar with guidelines for disinfection?	Yes-65.3% (32)	Yes-66.7% (10)	Yes-83.3% (30)	0.058
	No-34.7% (17)	No-33.3% (5)	No-16.7% (6)	

p value: < 0.05 is statistically significant; > 0.05 not significant; *For statistical comparison, the data is distributed among two groups. Group 1 had interns and doctors, while group 2 had nursing staff.

where A is the average CFUs grown before cleaning and B is average CFUs grown after cleaning.

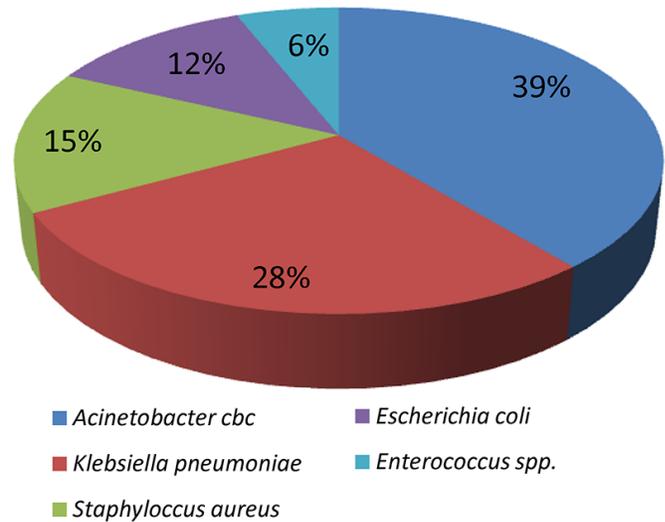
Data analysis and interpretation

The collected information from the questionnaire was analysed and the microbiology findings from the culture were recorded. To identify the association between independent variables with colonization (dependent variable), odds ratios (OR) and 95% confidence intervals (95% CI) were calculated using computer based program statistical package for social sciences (SPSS Inc, Chicago, IL, version 17.0 for Windows). The results of the association were considered as significant when *p* value was below 0.05.

Results

A total of 100 stethoscopes from 64 doctors including interns (n-15) and nursing staff (n-36) were included in the study. The contamination rate of stethoscopes was 56% (n-56) where they were found to be contaminated with at least one type of known pathogenic microorganism. The growth of environmental and skin contaminants was not included in the study. The results of different parameters and risk factors studied are enumerated in Table 2. Total bacterial strains obtained from 56 contaminated stethoscopes were 79 and among all, *Acinetobacter cbc* (n-31; 39.2%) was the commonest followed by *Klebsiella pneumoniae* (n-22; 27.8%) (Figure 1). Twenty-three stethoscopes were colonized with more than one type of pathogenic bacteria.

Figure 1. Bacteriological profile of microorganisms isolated from contaminated stethoscopes (Total isolates- 79).



The screening for drug resistant bacteria revealed three MRSA (25%) while no resistance for vancomycin was observed among 12 *S. aureus* isolates and 5 *Enterococci* strains when tested on cefoxitin and vancomycin screen agar respectively. ESBL and Amp C beta lactamases production was observed in 6.4% (n-4) of all gram negative bacteria (n-62). One *E. coli* and one *K. pneumoniae* showed ESBL production while Amp C production was seen in two *K. pneumoniae* isolates.

The effectiveness of stethoscope cleaning with 70% isopropyl alcohol was calculated based on mean CFUs obtained before (n-65) and after cleaning (n-2.5) and

Table 2. Study of different parameters and risk factors associated with colonization of stethoscopes.

Risk Factors	Colonization	No colonization	Odds ratio	95% confidence interval	<i>p</i> value
Healthcare worker					
Doctors (n-49)	28 (57%)	21			
Medical interns (n-15)	6 (40)	9	----	----	0.37
Nursing Staff (n-36)	22 (61%)	14			
Part of the stethoscope					
Diaphragm (n-100)	53 (53%)	47			
Bell (n-100)	21 (21%)	79	4.242	2.28-7.89	< 0.0001
Hospital areas					
Intensive care units (n-20)	4 (20%)	16			
Emergency ward and labour room (n-20)	14 (70%)	6			
General medical wards (including Pulmonary ward) (n-45)	32 (71%)	13	----	----	0.0005
Out-patient wards (n-15)	6 (40%)	9			
Effect of cleaning the stethoscope with alcohol					
Before cleaning (n-100)	56 (56%)	44			
After cleaning (n-100)	5 (5%)	95	24.18	9.06-64.57	<0.0001

p value: < 0.05 is statistically significant; > 0.05 not significant.

came to be 96.15%. Also, the total count of contaminated stethoscopes also decreased from 56 to only 5 contaminated stethoscopes after alcohol cleaning with a contact time of 30 seconds (Table 2).

The analysis of the filled questionnaire revealed that though all the HCWs possess adequate knowledge about the potential role of stethoscope in disease transmission still 30% of them had never felt the need to clean it. The cleaning frequency observed was much higher among nurses with 44% of them cleaning the stethoscopes on hourly basis while maximum number of doctors (34%) practice once a week cleaning of their stethoscopes. The cleaning frequency in interns was comparable to nurses where 33% of them were practicing it on hourly basis. Alcohol was the preferred cleaning agent by the majority of interns (100%), doctors (59%) and nurses (86%) (Table 1).

Discussion

Worldwide, HAIs represent a considerable health burden and increase the health care costs [9]. Hospital environment is a good reservoir for a wide variety of pathogenic and drug resistant microorganisms and several strains of pathogenic bacteria have been reported to be frequently colonizing medical equipment's including stethoscopes [10].

Stethoscope being one of the most commonly used instruments in daily medical practice frequently gets contaminated as it comes in contact with remarkably large numbers of patients [9]. Such medical devices if not disinfected regularly can become a source of infection especially among admitted patients. Despite a large number of existing infection control guidelines laid by different medical bodies worldwide, their effective implementation is lacking.

The current study screened the stethoscopes of HCWs and found 56% contamination rate. These findings are consistent with another study by Africa-Purino *et al.* [11] who reported contamination rate of 57%, whereas a much higher contamination rates (69% to 87%) had also been reported by Grecia *et al.* [5] and Zuliani-Maluf *et al.* [12]. Few studies have even reported 100% contamination rates [4,10].

The stethoscopes usually get contaminated by the flora present on the hands of HCWs and from the surface they come in contact with. This is the reason why different parts of stethoscopes show varied level of contamination. As the diaphragm of stethoscope has a relatively larger flat surface and frequently comes in contact with patient's skin and clothes, the chances of bacterial colonization are immense when compared to smaller area of bell and its infrequent use by our

clinicians [13]. The present study too reported that diaphragms were significantly more colonized (53.33%) than bell portions (21.33%) of the stethoscopes; (p value < 0.001). This finding was further supported by Bhatta *et al.* who also found higher contamination rate of diaphragms (89.65%) compared to the contamination rate of bells (65.51%) [13].

The difference in level of contamination of stethoscopes among doctors and nurses could occur because of many reasons. Doctors are usually in possession of personal stethoscopes while there is frequent sharing of stethoscopes by the nursing staff. In our study also, all the doctors and interns usually use their own stethoscope and nursing staff were not in possession of their individual stethoscopes and used the stethoscope available in the ward. Higher the number of persons handling, higher will be the chances of microbial contamination. But on the other hand, nurses in their routine duty disinfect or clean the medical devices preventing the microbial colonization. This could be the reason why in our study although the rate of contamination among stethoscopes used by nursing staff was slightly higher (61%) followed by doctors (57%) and interns (40%) but the difference was not statistically significant (p value 0.37). Another study also reported higher contamination rate among stethoscopes used by nurses (83%) while 72% among doctors [14].

Different hospital areas are colonized with varied microbial flora. In frequently fumigated areas like Operation theatres and ICUs, the environmental load of bacteria itself are less, hence the surface contamination will be minimal. Secondly, HCWs in these areas are more compliant and adhere to infection control practices especially hand hygiene which further reduce the chances of contamination of medical devices. While the heavy rush of patients, multiple sharing of the stethoscopes and paucity of time for effective disinfection practices in emergency room, wards and OPDs can result in higher rate of contamination in those areas. In our study too, as expected maximum contamination was observed among stethoscopes being used by HCWs in emergency areas like emergency room and labour room (70%) and also in general wards (71%) while least was seen in ICUs (20%) and the difference was highly significant with p value < 0.001 . Pal *et al.* [15] too reported maximum contamination in stethoscopes sampled from the doctors working in emergency (83.3%) and anaesthesia (71.4%) department and frequent use of stethoscopes in these areas was cited as a possible reason. A contrasting finding was reported by Shiferaw *et al.* [10] who

observed a very high rate of stethoscope contamination (85%) and found 100% contamination rate in ICU, 96% in medical ward and 94.6% in OPDs. Lack of perception to disinfect stethoscopes among HCWs and not the knowledge was found to be the major factor responsible for such high contamination rate.

As the microbial flora contaminating the medical devices usually comprises the skin commensal flora from the hands of HCWs and the hospital environment, hence, *Micrococcus*, *S. aureus*, coagulase negative *staphylococci* (CoNS) from the hands of HCWs and *Acinetobacter* spp. from the hospital environment are commonly isolated from them. Our study found *Acinetobacter cbc* as the commonest contaminant while *S. aureus* remained the third common pathogenic bacteria being isolated from the stethoscopes. Pal *et al.* [15] too in their study found the predominance of *Acinetobacter* spp. among the pathogenic bacteria colonizing stethoscopes, although followed by CoNS as the second commonest. Another study by Gupta *et al.* [16] found *Acinetobacter* spp. as the second commonest bacteria (5%) colonizing stethoscopes after CoNS (77%). While in studies conducted by Uneke *et al.*, *S. aureus* appeared as the commonest contaminant on stethoscopes followed by *P. aeruginosa* [17,18]. The isolation of *Acinetobacter* spp. in such high numbers from the medical devices is a point of concern. This nosocomial pathogen can survive and remain alive on surfaces for long. As they frequently colonize the moist areas of the hospital especially ICUs the chances of colonization of medical devices increases if not cleaned regularly. Another problem with this pathogen is the multidrug resistance (MDR) further increasing the cost of treatment. Other MDR pathogens isolated from our study were MRSA (25%, n-3), ESBL (n-2) and Amp C (n-2) producers. MRSA percentage isolated from contaminated stethoscopes from various studies range from 25-40% [2,10,15]. Although no β lactamases producing gram negative bacteria were isolated from a study by Pal *et al.* [15], still the isolated microorganisms exhibited multi drug resistance. Major concern with these MDR pathogens is the plasmid mediated drug resistance that is easily transferable among bacteria and furthermore increases the total load of MDR pathogens in the hospital environment.

Regular cleaning or disinfection of non critical medical devices including stethoscopes before reuse could help in reducing the bacterial load thereby preventing added infection [18]. Despite the advisory issued by the Centre for Disease Control (CDC) in 2008 for healthcare facilities asking them to develop and implement policies and procedures that ensures the

cleaning and reprocessing of reusable patient care equipment appropriately before use on another patient, still the stethoscope cleaning practices are suboptimal everywhere and also the healthcare personnel are resistant to change these practices [2].

CDC recommends the cleaning of stethoscopes with 70% ethyl or isopropyl alcohol after every use with a contact period of 10 minutes [19]. But for countries like India with high volume clinics such recommended practices are not always feasible [2]. We in our study observed very good results with immediate cleaning with 70% isopropyl alcohol with a contact time of 30 seconds that showed > 90% efficacy in eliminating pathogens bringing down the contamination rate of stethoscopes from 56% pre-cleaning to only 5% in post cleaning swab samples. A study comparing the efficacy of immediate versus daily cleaning of stethoscope using 66% ethyl alcohol too showed comparable effects between the two interventions, with reduction rates of 28% and 25%, respectively [2].

It is a well-documented fact that good infection control practices in the clinical workplace depend upon comprehensive education from the student level up, and from the senior leadership level down [20]. In our questionnaire based assessment of knowledge and attitude of HCWs, it was observed that despite appropriate knowledge and awareness about potential role of these devices in disease transmission, still only few indulge in practices to prevent it. Our study found that nurses (44.4%) and interns (33%) indulge more often in stethoscope cleaning on hourly basis as compared to doctors where none of the doctors do hourly cleaning. Busy schedule of doctors could be one reason for this difference while on the other hand interns seem more motivated for practising infection control practices and for nurses the stethoscope cleaning is usually a part of their routine practice. Overview of several other studies also depicted similar picture with only 40-60% HCWs cleaning their stethoscope weekly [2]. Also a study by Uneke *et al.* [17] found that 35% HCWs had never cleaned their stethoscope. On the contrary some encouraging findings were gathered from a study by Whittington *et al.* where 91% HCWs indulged in practice of cleaning their stethoscopes that too after each patient contact [21].

At the end of our study, we realised that stethoscopes can get easily contaminated but on the other hand regular cleaning may decrease the colonization effectively. The limitation of our study is small sample size which could not be increased further because of limited resources. Secondly, our data is from

a single government hospital and multicentric study including other regional hospitals could be more informative.

Conclusion

A stethoscope is a physician's friend and helps them in the management of patients, but if its cleaning aspect is not taken care of, it can turn into a foe and can hamper patient's health by carrying MDR pathogens on its surface. Disinfecting one's hands and stethoscope after each patient contact remains the simplest infection control measure. Regular surveillance of hospital environment and medical devices is required to identify various potential sources of infection and their regular disinfection should be carried out to curtail transmission. Finally, regular symposiums or lectures should be conducted for educating and motivating HCWs to adhere to infection control practices to prevent the nosocomial infections.

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Ethical considerations

The study was conducted after due approval of hospital research and ethics committee. Also the written informed consent from all the participants was taken while conducting study.

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