

# Bacterial Colonization of Stethoscope used by Health Care Professionals at a Rural-Based Tertiary Care Hospital and Effective Measures for Its Disinfection

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## ABSTRACT

**INTRODUCTION:** Stethoscopes can be a potential source for transmission of infection among patients as it is most commonly used device by all health professionals. This study was conducted in a rural based tertiary care hospital to determine the growth of different types of pathogens from diaphragms of stethoscopes used by health care professionals and whether decontamination by 70% isopropyl alcohol will be effective in reducing bacterial load.

### AIMS AND OBJECTIVES:

**AIM:** To detect presence of microorganisms on the diaphragm of stethoscope used by Health care workers.

### OBJECTIVES:

- 1) To identify the types of organisms, present on stethoscopes.
- 2) To determine the effectiveness of 70% isopropyl alcohol as a disinfectant.

**MATERIAL AND METHODS:** Fifty stethoscopes of health care professionals of different departments were used for microbiological sampling. Further, the diaphragms of all the stethoscopes were cleaned with 70% isopropyl alcohol and were resampled to detect the effectiveness of 70% isopropyl alcohol as a disinfectant. Antibiotic sensitivity testing of pathogenic bacteria was carried out.

**RESULTS:** Out of randomly selected 50 stethoscopes from different clinical departments 35 stethoscopes (70%) showed significant bacterial growth. Out of the different organisms isolated, Coagulase-negative staphylococci (CoNS) 11 (22%) were predominantly found. On cleaning with 70% isopropyl alcohol, there was a significant decrease in the colonization of organisms.

**CONCLUSION:** The findings of this study demonstrated that stethoscopes are colonized with pathogenic bacteria and use of 70% isopropyl alcohol can significantly reduce contamination and thus should be adopted as a regular practice.

**KEYWORDS:** Stethoscope, 70% isopropyl alcohol, MRSA

## INTRODUCTION

Healthcare-associated infections (HAIs) are a major public health problem worldwide [1] The incidence of healthcare-associated infections is increasing due to the rise in MDR organisms. [3] Healthcare-associated infections may lead to prolonged hospital stays and increase the chances of patient mortality. [4,5]

In developing countries like India rates of HCAI exceed more than 20%, but due to lack of availability of adequate data, more research is needed.[6]

Some non-critical medical devices such as stethoscopes, blood pressure cuffs, thermometers, latex gloves, masks, pens, and white coats may serve as sources of HAIs. [7]. Stethoscopes can be a potential source for transmission of infection among patients as it is the most commonly used device by all health professionals. [8] The diaphragm of stethoscopes comes in direct contact with the patient's body surface, thus increasing the risk of the transmission of pathogens from person to person .[9] The diaphragm of the stethoscope may get contaminated by unclean earpieces with both normal and pathogenic bacteria harboring in health care professionals.[10]

The contaminated stethoscopes is potential source of infection mainly for high risk patients with low immune status and those undergoing surgical manipulation [11].

The recent study analysis have shown that hand hygiene alone is not enough to prevent nosocomial transmission [12]. In addition to hands, various medical devices, including blood pressure cuffs and stethoscopes have been identified as potential vehicles of contact transmission.[13] .

The contamination of stethoscope particularly the diaphragm is reported mainly due to lack of regular disinfection protocols which has to be followed before and after examining each patient [17].

Usually, organisms transmitted by medical devices are MDR which includes methicillin-resistant *Staphylococci*, *Klebsiella pneumoniae*, vancomycin-resistant *Enterococci*, *Pseudomonas*

*aeruginosa*, *Acinetobacter baumannii*, and *Enterobacter cloacae* [18].

The effective infection control measures can reduce rate of nosocomial infection, but proper implementation is not possible due to poor compliance by health care workers. [14,15]. Due to improper sterilization and disinfection of medical equipment, the risk of transmission increases from person to person.[16]

Various chemical methods are suggested for disinfecting stethoscopes like 90% ethanol, chlorhexidine, in liquid formulations, gels, or foams, and in the form of alcohol-soaked wipes. The effective physical methods include the use of UVC-LED (Ultraviolet C rays-Light emitting diodes) devices and stethoscopes with antibacterial copper surfaces. [19,20]

Thus determining levels of contamination and type of bacterial pathogens associated with use of unclean stethoscope may reduce risk of transmission of multidrug-resistant pathogens among hospitalized patients.

This study was conducted in a rural based tertiary care hospital to determine the growth of different types of pathogens from diaphragms of stethoscopes used by health care professionals and whether decontamination by 70% isopropyl alcohol will be effective in reducing bacterial load. It also aimed on gaining insight into the stethoscope disinfection practices currently in used by professionals.

## AIMS AND OBJECTIVES

**AIM:** To detect presence of microorganisms on the diaphragm of stethoscope used by HCWs

## OBJECTIVES:

- 1) To identify the types of organisms present on stethoscopes.
- 2) To determine the effectiveness of 70% isopropyl alcohol as a disinfectant.

## METHODOLOGY

**Type of Study:** Cross sectional prospective study

**Duration of Study:** This study was conducted over a duration of two months after obtaining approval from the ethical committee.

**Sample collected:** Samples were taken randomly from 50 stethoscopes used by doctors, medical residents, and medical students.

**Selection criteria:** Health care professionals (doctors, residents, medical students)

**Data collection procedure:** Consent was obtained by the ethical committee of the institution before starting the research. Informed written consent was obtained from each healthcare worker and the purpose of the study was explained. All measures to maintain the anonymity and confidentiality of participants were taken.

The 50 stethoscopes were collected from health care professionals belonging to different clinical departments like Medicine, Pediatric, Surgery, Anaesthesia, Obstetrics & gynecology and Respiratory Medicine.

The culture from stethoscopes was done twice before and after cleaning with 70% isopropyl alcohol to check the effectiveness of 70% isopropyl alcohol. The semiquantitative culture was performed by swabbing the diaphragm of the stethoscope with a sterile swab moistened with saline. These swabs were streaked on Blood agar and MacConkey agar plates.[2] The diaphragms of all 50 stethoscopes were cleaned with 70% isopropyl alcohol for 45 seconds and repeat swab was collected and cultured.

These two sets of agar plates (before and after cleaning with 70% isopropyl alcohol ) were then incubated aerobically at 37°C for 48 hours.

The bacterial cultures were identified by conventional methods like colony morphologic characteristics, Gram staining characteristics, and biochemical tests like the Catalase test, Coagulase test, Citrate test, TSI test, Urease test, PPA test and sugar fermentation test. Bacterial colony-forming

units CFUs were counted. A colony count of more than  $10^5$ CFU was considered significant.

Antibiotic sensitivity testing was carried out by Kirby Bauer disk diffusion method using Muller Hilton agar plates. Antibiotic disks included: Penicillin, Cefoxitin, Linezolid, Erythromycin, Clindamycin, Gentamicin, Levofloxacin, Meropenem, Piperacillin & Tazobactam, Ceftazidime, Ceftazidime & Clavulanic acid and Cefepime. Vancomycin E strips (0.016-256 ug/ml) were used for *Staphylococcus aureus* isolates.

For interpretation of the AST results The Clinical and Laboratory Standards Institute (CLSI) guidelines 2021 were used.[39]

Health care workers (doctors, residents, medical students, etc.) were asked to fill a preformed self structured questionnaire which included questions about cleaning practices, frequency of cleaning, reasons for not cleaning regularly, and types of agents used for disinfection. Participants were assured that their responses were anonymous and encouraged to respond honestly. In this case, no one participated in the study more than once.

**Ethical consideration:** Informed consent was taken from all health care professionals involved.

**Statistical Methods:** Data was analyzed using Epi info statistical software.  $P < 0.05$  was considered statistically significant.

## RESULT

The 50 stethoscopes were collected from health care professionals belonging to different clinical departments like Medicine, Pediatric, Surgery, Anaesthesia, Obstetrics & gynecology and Respiratory medicine.

Out of 50 stethoscopes (before cleaning with 70% isopropyl alcohol) 35 stethoscopes showed significant bacterial growth and 15 stethoscopes showed no significant bacterial contamination. On cleaning all 50 stethoscopes with 70%

isopropyl alcohol only 4 stethoscope showed positive bacterial growth.

Out of a total of 50 stethoscopes collected from health care professionals following was distribution.12 stethoscopes were collected from the Medicine department,10 from the Obstetrics & gynecology,9 from

the Pediatric Department,9 from the Surgery department, 5 from the Anaesthesia department and 5 from Respiratory medicine department.

The department wise distribution of contaminated and clean stethoscopes is shown in Table 1.

Table 1

Sr. No.	Name of Department	Total Stethoscope collected	No. of Contaminated stethoscope	No. of Clean stethoscope
1	Medicine	12	6	6
2	Obstetrics & gynecology	10	4	6
3	Pediatric	9	8	1
4	Surgery	9	8	1
5	Anaesthesia	5	5	0
6	Respiratory medicine	5	4	1
	Total	50	35	15

Out of total 35 different organisms isolated from 35 contaminated stethoscope Coagulase-negative staphylococci (CoNS) 11 (22%) were predominantly found. Other organisms isolated were *Staphylococcus aureus* {6 (12%)}, *Pseudomonas species* {3 (6%)}, *Klebsiella species* {4 (8%)},

*Acinetobacter species* {3 (6% )} and Gram-positive bacilli {6 (12%)}. There were two fungal isolates *Curvularia* {1 (2%)} and *Aspergillus species* {1(2%)}

Out of the 6 isolates of *Staphylococcus aureus*, 2 (33.33%) were found to be MRSA [Figure 1]

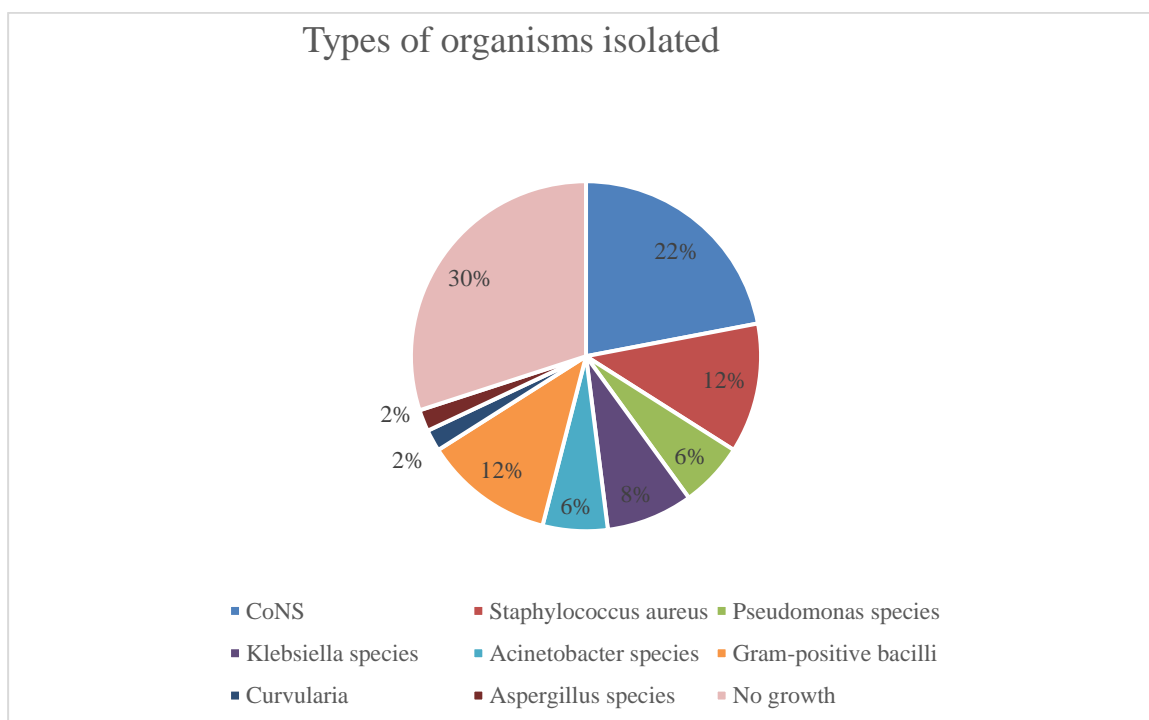


Figure 1: Types of organisms isolated

**Table 2: Distribution of isolates according to department**

Sr. No.	Total isolates	Medicine	Obstetrics & gynecology	Pediatric	Surgery	Anaesthesia	Respiratory medicine
Coagulase-negative staphylococci	11	1	1	4	2	1	2
<i>Staphylococcus aureus</i>	6	1	1	1	2	1	-
<i>Pseudomonas species</i>	3	2	-	-	1	-	-
<i>Klebsiella species</i>	4	1	-	1	-	1	1
<i>Acinetobacter species</i>	3	-	1	-	1	1	-
Gram-positive bacilli	6	1	1	2	2	-	-
<i>Curvularia species</i>	1	-	-	-	-	1	-
<i>Aspergillus species</i>	1	-	-	-	-	-	1
<b>Total</b>	<b>35</b>	<b>6</b>	<b>4</b>	<b>8</b>	<b>8</b>	<b>5</b>	<b>4</b>

Prior to cleaning all contaminated stethoscopes showed more than  $10^5$  CFU/ml of bacterial growth which was considered significant. After cleaning all stethoscopes with 70% isopropyl alcohol, there was a significant decrease to 10 CFU/ml of bacterial count. Only 4 stethoscope showed positive growth after cleaning with 70% isopropyl alcohol. This was statistically significant. (P <0.0001)

#### Antibiotic sensitivity of Gram positive isolates

The results of antibiotic sensitivity testing indicated that all isolates of Coagulase-negative staphylococci were sensitive to Vancomycin (100%) and Linezolid (100%). It showed least sensitivity to Penicillin (55%)

The isolates of *Staphylococcus aureus* also showed 100% sensitivity to Vancomycin and Linezolid, while Clindamycin (83%), Gentamicin (50%), Levofloxacin (66%), Cefoxitin (66%) and Erythromycin (33%) were less sensitive. The isolates were completely resistant to penicillin.

#### Antibiotic sensitivity of Gram negative isolates

Amongst the *Pseudomonas species* Gentamicin, Meropenem and Piperacillin & Tazobactam were found to be 100% sensitive. Levofloxacin was found to be 67% sensitive. Both Ceftazidime and Cefepime were 33% sensitive.

*Acinetobacter species* showed 100% sensitivity to Piperacillin and tazobactam, 67% sensitivity to Gentamicin, Levofloxacin and Meropenem.

*Klebsiella species* were found to be 100% sensitive to Piperacillin and tazobactam, 75% sensitive to Gentamicin and Levofloxacin, 50% sensitive to Meropenem and Ceftazidime and clavulanic acid, 25% sensitivity to Ceftazidime and Cefepime.

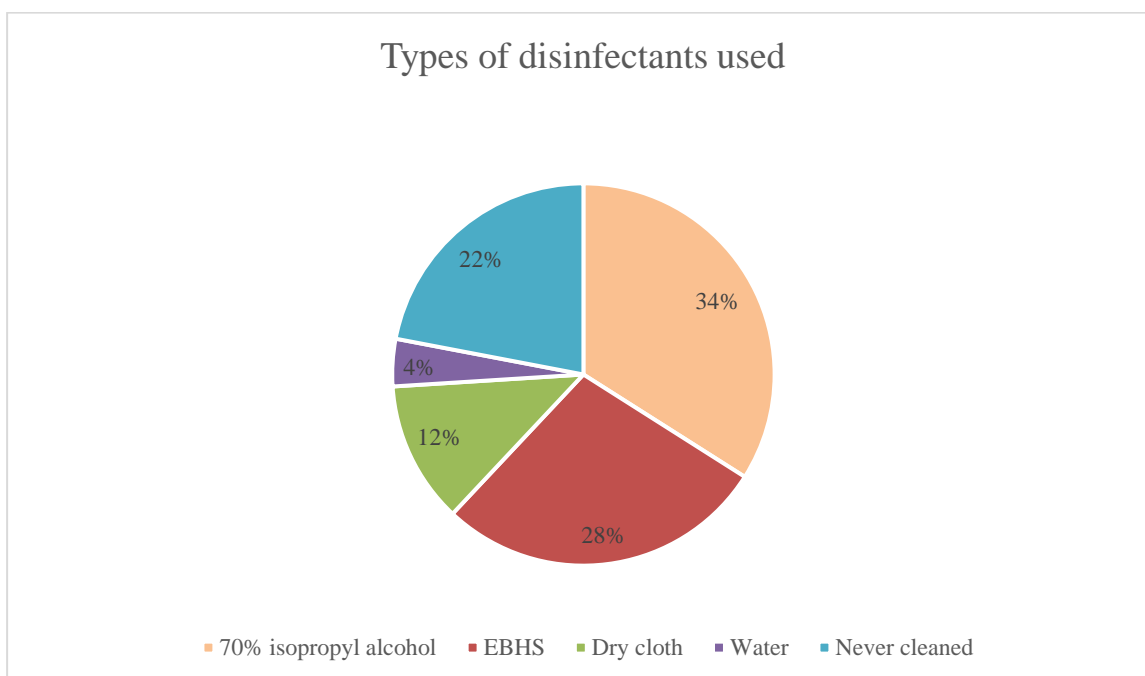
The study's findings, which were based on questionnaires completed by HCWs, showed that only 3(6%) of health care professionals cleaned their stethoscopes on regular basis and 11(22%) of HCW never cleaned their stethoscopes as shown in Table 3.

**Table 3: Frequency of cleaning of Stethoscopes**

Frequency of cleaning of Stethoscopes	Total number of stethoscopes	Number of stethoscopes contaminated
after every patient	0	-
once daily	3	0(0%)
once a week	8	4(50%)
once a month	10	7(70%)
once every three months	7	5(71%)
once every six months	5	4(80%)
once a year	6	5(83.3%)
never cleaned	11	10(90.9%)

The study's findings also revealed that 34% of health care professionals used 70% isopropyl alcohol, 28% used Ethanol-Based Hand Sanitizer (EBHS), 12% used Dry cloth

, 4% used water for cleaning and 22% never cleaned their stethoscope as shown in Figure 2



**Figure 2: Different types of disinfectants used by HCWs**

The most common reason for not disinfecting stethoscopes regularly was found to be lack of time 24 (48%). Other reasons were sharing of stethoscopes (20%), forgetfulness (14%), lack of access to disinfectants (8%) and Concern for damaging stethoscopes (4%). \* Survey also revealed that 96% HCWs believed that stethoscopes can act as a potential vector leading HCAIs infections. 100% HCWs said that they were aware that disinfection of Stethoscopes should be done regularly. 83% HCWs

reported that they had never been taught about stethoscope disinfection.

## DISCUSSION

The incidence of healthcare-associated infections is increasing at an alarming rate [29]. The prevalence of HAI is 15.5 per 100 patients in developing countries.[30].

A stethoscope can serve as a potential source of nosocomial infections.[14]. Other contaminated devices like otoscopes and thermometers can also transmit infection among patients.[36]



In this study out of the 50 samples collected 35 (70%) showed bacterial contamination. This result is comparable to those from previous studies which reported that 71–100% of the stethoscopes were colonized by various bacteria.[23] Whereas study in Saudi Arabia showed that only 48% of the stethoscopes were contaminated, which is significantly less than that which was found in our study [22].

Samples collected from medicine and anesthesia department were highly contaminated as compared to surgical wards. This could be attributed to the fact that stethoscopes are used more frequently by residents/doctors working in medicine and anesthesia department. Similar results were found in a study conducted in Mumbai where also maximum number of contaminated stethoscopes were isolated from medicine department. [31]

In this study, out of all the organisms isolated, coagulase-negative staphylococci CoNS (22%) was found to be the most frequently isolated organism. Similar results were obtained in studies conducted in Pune [25], Azamgarh [27], and Mangalore [28] where CoNS was the most frequently isolated organism. Mostly presence of CoNS may be regarded as contamination but may serve as a potential source of bloodstream infections [11] hence this growth cannot be ignored. The antibiotics sensitivity result showed that some isolates of CoNS had reduced sensitivity to commonly used antibiotics such as Penicillin (55%), Cefoxitin (73%) and Gentamicin (64%).

In our study, there were two MRSA isolates. Whereas In a study done in Meerut, India 55% of the stethoscopes were found contaminated, mainly with *Staphylococcus* sp., out of which only 7.3% were MRSA [32]. *Klebsiella species*. (8%) were also isolated These findings were consistent to research conducted previously. [33]

Other gram-negative bacteria isolated included *Pseudomonas species* (6%) and *Acinetobacter* (6%). Contrary to our findings, *Acinetobacter* was the most

commonly isolated organism in research conducted in Chandigarh, India. [26]. Antibiotic-resistant strains of *Acinetobacter* have caused widespread outbreaks in hospitals in North America and Europe [35] One isolate (2%) *Aspergillus* sp. was also isolated. Similar to this result 2 isolates (4%) of

*Aspergillus fumigatus* was found in a study conducted in Pune, India. [25]

One isolate of *Curvularia* was also found. This hasn't been observed in other studies done previously. Six isolates of gram positive bacilli were also found. This is attributed to the fact that normal skin flora mainly consists of Gram positive bacteria.

In this study it was observed that on cleaning with 70% isopropyl alcohol, only 4 (11.4%) of stethoscopes showed bacterial contamination and reduced number of bacterial colonies hence depicting the effectiveness of 70% isopropyl alcohol as a disinfectant similar results were observed by study conducted in Chandigarh by Mehta et al[26]. A study conducted in in Ujjain, India where also 27.5% of the participants reported using ethyl alcohol [38] These results were similar to previous studies where alcohol based disinfectants reported to be the most commonly used disinfectants [7]

Our study showed that (11) 22% of HCWs had never cleaned their stethoscopes. Similar findings were found in a study in Nigeria where 35% HCWs had never cleaned their stethoscope. [7] On the contrary a study in UK found that 91% HCWs indulged in practice of cleaning their stethoscopes that too after each patient contact [37].

Our study finding shows that despite knowing that stethoscopes can act as vectors, regular disinfection is not done. This could be due to many reasons but this shows the need of implementation of infection control practices.

## CONCLUSION

The findings of this study demonstrated that stethoscopes are colonized with potential

pathogens which are MDR in nature. This implies that these might be potential vectors for the transmission of bacteria leading to subsequent HAI.

All the health care workers must be trained and educated on infection control policies of hospital. All the health care professionals must be encouraged to clean their stethoscopes on regular basis. The use of 70% isopropyl alcohol for cleaning must be encouraged to significantly reduce contamination.

#### **Author's Contribution:**

All named authors have made an active contribution to the conception, design, analysis, interpretation of the data and the drafting of the paper. All authors have critically reviewed its content and have approved the final version submitted for publication.

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