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Stethoscope: What Are You Hiding?

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Abstract: ***Stethoscope is used by all the people involved in health care service and is a potential source of infection if not decontaminated effectively. We conducted a cross sectional study with the aim of finding out the incidence and spectrum of contamination on stethoscope and the antibiotic resistance pattern observed amongst these organisms. We also assessed the effectiveness of 70% ethyl alcohol-based disinfectant. A total of 320 stethoscopes used by health care workers were sampled. Overall contamination was 76.25% of sampled stethoscopes. Coagulase Negative Staphylococcus (48%) was the most common organism isolated followed by Staphylococcus aureus (41%). MRSA was present at the rate of 21.4% of total contamination rates. The incidence of contamination with gram negative organisms were not that frequent,Klebsiella (3%), Pseudomonas (2%), E. coli (2%) and Acinetobacter (2%). Antimicrobial susceptibility of these isolates was carried out using the Kirby Bauer's disk diffusion method recommended in CLSI Guidelines 2017. The Gram-positive organisms showed resistance to penicillin (72.14%) and cefoxitin (44.29%). Decontamination with 70% ethyl alcohol was 94.6% effective. This study confirmed that the stethoscopes used by health care professionals can act as a potential carrier of infectious organisms.***

Keywords: Stethoscope, infection, contamination, health care worker, disinfection

1. Introduction

Nosocomial infections or HealthCare Associated Infections (HCAI) are the infections that are acquired by the patient in a medical setup. These infections can spread via numerous routes, be it air of hospital, another patient or the doctor himself. Nosocomial infections are on a rise today and the most feared aspect of such infection is resistance. Since these infections originate in hospital setups where a lot of antibiotics are being used on daily basis, these nosocomial infection causing organisms are multidrug resistant. A meta-analysis has reported prevalence of HCAI of 15.5% patients in developing countries, which is much higher than in developed countries[1].The Centres for Disease Control and Prevention has estimated that in United States, roughly 1.7 million HAIs are reported in a year. This contributes to 99,000 deaths each year and a direct medical cost of about $4.5 billion/year. A study has estimated that out of total patients admitted to a health care facility, 5%-10% are of HAI and out of these roughly 20% could have been prevented by following strict, simple infection control guidelines[2].
HCAIsare a great challenge not only for doctors but also for the patients due to increased morbidity and economic burden[3].Two most common things of doctor that comes in contact with patient are his hand and his most trusted partner, his stethoscope. Most doctors do accept that hands can be a source of infection and it has received the attention it needed, but rarely anyone thinks of stethoscope. Is stethoscope as innocent as it looks, or is it a foe in friend's face? Does it actually add to patients worry?

While examining patients the Stethoscope, through direct dermal contact, acquires pathogens as well as commensals on its diaphragm and subsequently theyare transferred to other patients. As stethoscope is a non-disposable instrument, it can serve as a potential fomite in the hospital unless regularly disinfected.

Stethoscopes used by medical practitioners, students and health care workers (HCW) have been shown to be a potential vector in the transmission of nosocomial infections in various parts of the world. Furthermore, disinfection of devices is not done as a routine[4]. Studies have shown that stethoscope can harbour bacteria on its diaphragm. The most common ones include *S.aureus, Corynebacteria, Bacillus, E.coli and Klebsiellae*, and *Candida* [5].

Despite stethoscopes being a potential vector for the transmission of HCAIs, disinfection of stethoscopes is often neglected by HCWs. Currently the gold standard method for disinfection of stethoscope is alcohol swiping[6].This study will be directed towards finding the profile of micro-organisms colonising in stethoscope used by health care professionals of our tertiary care hospital and their antimicrobial resistance. We will also be finding the effectiveness of alcohol-based disinfectants in decontamination of stethoscopes. In our study we will be including stethoscopes used by doctors, nurses, medical students and paramedical staff.

2. Review of Literature

Most of the researches that were carried out on stethoscope to find its role in nosocomial infections were prospective or cross sectional observational studies[7]. Majority of these studies carried out the estimation of contamination by swabbing or taking imprints of the diaphragm or bell. The imprints were taken on various selective and nonselective medias. These studies reported the level of contamination in terms of percentage or number of colony forming units (cfu) per stethoscope [8]. These researches can be divided into two types. First that reported identification of organisms isolated as proportion of all the organisms recover from the stethoscope and second, researches that focussed on certain specific organisms, example *Staphylococcus aureus*, MRSA, VRE, *Clostridium difficile* [9-12].Majority of the investigators sampled Health Care Workers (HCW) with questionnaires to establish their stethoscope cleaning

practices. Few of these studies had introduced an intervention with aim to reducing contamination in the stethoscopes [13].The mean contamination rate across 28 studies was 85.1%(range: 47-100) [14]. Overall, studies suggest a range of contamination between zero to 221 cfu per stethoscope. In another study, stethoscopes were rendered clean with 70% alcohol and was examined after 8 hrs of use on patients without further decontamination. Results showed 1000cfu per membrane after 8 hrs [15].

The level contamination and the organisms identified varied to a great extent in different studies. Non-pathogenic organisms and skin commensals made up the majority of organisms isolated;Coagulase negative Staphylococcus were isolated from 97% of stethoscopes [16]. Other non-pathogenic bacteria included *Corynebacterium* spp., Diphtheroids and *Bacillus* spp.Out of the pathogenic organisms, *Staphylococcus aureus* was the most common bacteria isolated. The overall frequency of isolation of S. aureus ranged from 1.9% to 100%[7]. Other pathogenic organisms isolated included *E. coli, K. pneumoniae, Enterobacter spp., Acinetobacter*, etc. In previous researches following bacteria have been identified as potential pathogens which are found on stethoscope [7].

Potentially Pathogenic Bacteria Recovered From Stethoscope	No. of Studies Reporting The Pathogen
Staphylococcus aureus	27 (87%)
Enterobacteriaceae	17 (55%)
Acinetobacter spp.	9 (29%)
Enterococci	8 (26%)
Pseudomonas aeruginosa	7 (23%)
Stenotrophomonas maltophilia	2 (6%)

In two separate studies by Tang PH et al. and Jones JS et al., contamination with *Staphylococcus* spp. were reported at the rates of 54% and 89% [11] [17]. In study done by Edwin ER et al. *Staphylococcusaureus* was the only organism reported with contamination rates of 57% [18]. Studies have also been conducted on MRSA contamination rates. A contamination rate of 37% with MRSA was found in an emergency department study involving 50 stethoscopes [16].

There were two studies that focused on Vancomycin resistant Enterococcus (VRE). In a study by Lange CG et al., VRE was cultured from 3.4% of 71 stethoscopes after routine examination [10]. In another study by Zachary KC et al. stethoscopes which were initially demonstrated to be free of VRE became contaminated with VRE at rate of 31% after routine examination of 49 VRE colonizes patients [19].

Clostridium difficile was found in 4.9% of stethoscopes in a research set in outbreak setting [12]. The authors had expressed their uncertainty as to the clinical significance of this low yield C. difficile.

Nosocomial infections and stethoscope

None of the studies derived for literature review have been designed to evaluate whether stethoscope contamination is associated with HCAI or not. An investigation of samples of *Klebsiella pneumoniae* blood stream infections in neonate ICU revealed that the outbreak had been from 3 stethoscopes from which those strains of Klebsiella were isolated [20]. The strains were cultured from the healthcare worker's hands and stethoscope after the outbreak. In another case, P. aeruginosa was cultured from sinks and stethoscope. 37.5% of infected patients died in this outbreak [21].

Evaluation of stethoscope disinfection practices among health care workers

Questionnaires were used for evaluation of cleaning practices among the health care workers. Most of the health care workers favoured use of isopropyl alcohol swabs as ideal method for cleaning [22].

Many studies found that about 47% of HCW either never cleaned their stethoscopes or cleaned them once a year [23]. In another study reporting a stethoscope contamination rate of 92%, the main culprits were the medical students of whom only 6% has ever disinfected their stethoscope [24]. There were many factors that affected cleaning of stethoscopes among the students and these include-knowledge about how to clean the stethoscope, thinking that cleaning was important and presence of role models.

There are very few studies which have studied the antimicrobial resistance patterns in pathogenic bacteria isolated from the stethoscopes. We in this study tried to profile the antibiotic resistance of the potential pathogenic organisms isolated from the stethoscopes.

3. Aims and Objectives

a) To determine the stethoscope contamination by pathogenic bacterial and fungal organisms in a tertiary care institution.
b) To find the pattern of antimicrobial resistance in these pathogenic organisms.
c) To find out the effectiveness of 70% ethyl alcohol-based disinfectants in decontamination of stethoscopes.

4. Materials and Methods

The study was conducted at Department of Microbiology in a tertiary care institution. Ethical clearance was obtained from the Institutional Ethical Committee. A total of 320 stethoscopes used by health care workers – doctors, nurses, para- medical staff were included in the study. We used simple random sampling method to obtain the samples. Sampling of the stethoscopes used by health care workers was done onto culture media – Blood and MacConkey Agars. Since the diaphragm of the stethoscope comes in contact with the patient's skin, imprint smears of the diaphragmatic side of stethoscope was taken onto surface of sterile agar plates. (Image.1)

Impression of stethoscope on blood agar showing various organisms (Image 1)

Inoculated agar plates were incubated at 37°C in an incubator for 24- hours. The organisms that grew on culture media were identified by standard, conventional methods. The antimicrobial resistance pattern was determined by Kirby-Bauer disk diffusion method using CLSI guidelines (2017).

The diaphragm was then decontaminated with a swab having 70% ethyl alcohol. The surface of diaphragm was allowed to dry, after which the imprints were taken again to find out the effectiveness of this disinfectant.

P value for statistical analysis was calculated by the z score method at 5% level of significance.

5. Results

Out of 320 stethoscopes that were sampled, 244 (76.25%) were found to be contaminated with various micro-organisms. This was statistically significant (P value <0.00001).The organisms isolated from the stethoscopes were *Staphylococcus aureus* (41%), Coagulase negative *Staphylococcus*(48%), *Klebsiella* (3%), *Candida* (2%), *Pseudomonas* (2%), *E.coli* (2%) and *Acinetobacter* (2%) [Fig.1].

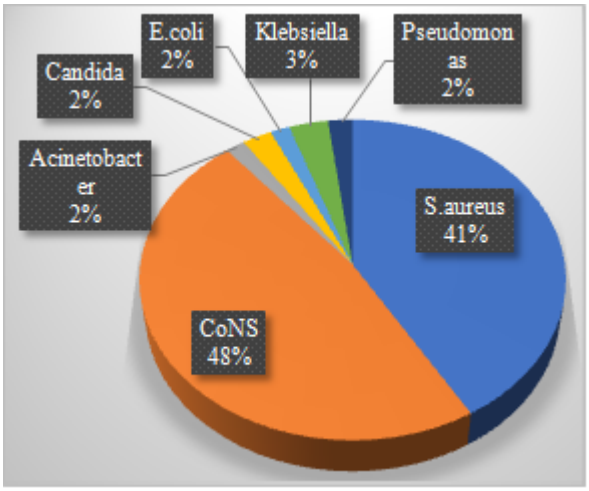

Figure 1: Pathogenic Organisms Isolated

The predominant contamination of stethoscopes in our study is with Gram- Positive Cocci (GPC) 219 (89.7%). Antimicrobial susceptibility of these isolates was carried out using the Kirby Bauer's disk diffusion method recommended in CLSI Guidelines 2017. The resistance pattern observed has been demonstrated in graph given below (Fig.2).

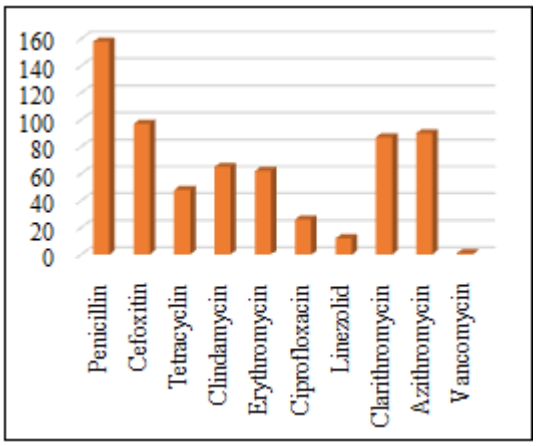

Figure 2: Resistance Pattern in GPC

72.14% (158/219) of the isolated pathogenic GPCs were resistant to penicillin and 44.29% (97/219) were cefoxitin resistant. The resistance percentage of GPC to various antibiotics is given below (Table 1).

Table 1

Antibiotic	*% of Antibiotic Resistant GPC (GPC n= 219)*
Penicillin	72.14% (158)
Cefoxitin	44.29% (97)
Tetracyclin	15.04% (48)
Clindamycin	29.68% (65)
Erythromycin	28.31% (62)
Ciprofloxacin	11.87% (26)
Linezolid	5.47% (12)
Clarithromycin	39.72% (87)
Azithromycin	41.09% (90)
Vancomycin	0.45% (1)

Of the 219 stethoscopes with GPCs, 103 stethoscopes (41% of total contamination) were contaminated with S. aureus and118 stethoscopes with CoNS.MRSA amongst the S. aureuswas present at the rate of 24.4% while CoNS showed methicillin resistance at the rate of 36.4%.

The antimicrobial susceptibility of Gram-negative organisms was performed but not discussed here as their numbers are very few.

Decontamination with 70% ethyl alcohol was 94.6% effective. Of the 244 contaminated stethoscopes, 231 were completely cleared of the contaminant organisms (P value was 0.000046). However, the decontaminant was not very effective in removing the spores (Fig.3)

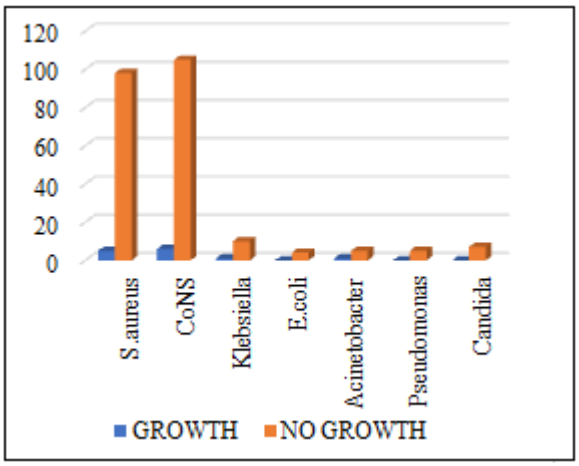

Figure 3: Effectiveness of Decontamination

The 320 stethoscopes that were sampled belonged to students, residents, nurses and para medical staff. The pattern of contamination observed was as follows (Table 2)

Table 2

Category	*Total Stethoscopes*	*Contaminated Stethoscopes*	*Contamination Rate*
Students	160	127	79.3%
Resident	60	42	70%
Paramedical Staff	50	38	76%
Nurses	50	37	74%
Total	320	244	76.25%

6. Discussion

The health care workers and their instruments are often associated with spread of pathogenic organisms in any medical setup. Our study showed contamination rates of 76.25% which is comparable to data from studies done by Thapa et al. and N. O'Flaherty et al., which state contamination rate of 72.1% and 74% respectively [5][6][7]. The predominant organisms isolated from the contaminated stethoscopes were Gram positive cocci. Of these, CoNS was the most commonly isolated pathogenic organism followed by *S. aureus*.

Our study revealed that S. aureus had a contamination rate of 41%. Other investigators have reported this rate to be between 15.8%- 89% [6]. This is a matter of concern as S. aureus has been associated with a number of infections, be it UTI, Respiratory Tract Infections, Skin and Soft tissue infections, Toxic Shock Syndrome, etc. The CoNS had a contamination rate of 48%. These organisms, though not as common as S. aureus, are sometimes associated with Endocarditis and UTI. The ABST results showed that 21.4% of all the isolated pathogens were MRSA, similar findings of MRSA contamination at 14% by D. Jeyakumari *et al* [4], and 17.2% were reported by Thapa et al. [6]. All the isolates of MRSA strains were sensitive to Vancomycin, which is used as drug of choice.

The contamination rates by Gram negative bacteria is low in our setup which is a better finding when compared to a study by D. Jeyakumari *et al* which have revealed their contamination rates to be as high as 20% especially of *Klebsiella spp.* [4]. This organism is associated with nosocomial blood stream infections, especially among the immunocompromised patients and infants. There is evidence of infections at neonatal ICU with Klebsiella from Health Care Worker's hands and stethoscope [20].

Contamination by Gram negative organismswere about 9%, and that of fungus was very low. Candida was the only fungal contaminant isolated with the contamination rate of 2%.

Decontamination with 70% Ethyl- alcohol based disinfectant proved to be effective with decontamination rate of 94.6%. This proves the effectiveness of 70% ethyl alcohol swabs in removing the contaminant organisms from stethoscope. Thus, a simple step of swabbing diaphragm of stethoscope with this disinfectant can prove to be effective in removing many possible pathogens of nosocomial infections. The health care workers need to be made aware that the stethoscopes that they are using on daily basis if not properly decontaminated can do more harm than benefit to some patients.Just like the hand washing lectures, classes must be taken on stethoscope decontamination in the undergraduate days itself to produce more responsible HCWs.

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