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Bacterial Contamination and Disinfection of Stethoscopes: A Knowledge Gap among Health Care Personnel of a Tertiary Care Hospital of Rural Bengal

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Abstract: *Universal use of stethoscope for examination of patients by health care personnel makes it a potential source for spread of nosocomial infection. A cross sectional study was conducted in a tertiary care centre of Eastern Bengal during August-September 2013 to find out incidence and spectrum of bacterial contamination of stethoscopes and knowledge, attitude and practice about cleaning of stethoscopes of health care providers. After getting informed consent, stethoscopes of 100 health care providers were sampled. An anonymous study questionnaire was used to obtain information regarding stethoscope cleaning habits and knowledge of the medical practitioners. Statistical analysis was done by Graph Pad InStat 3.1 version. Fifty two percent of stethoscopes surveyed from the visiting doctors, residents and medical students were found to be contaminated. Total 76 bacteria were isolated, of which 75% were Gram positive organisms. Among the isolates, Bacillus subtilis (36.84%) was prevalent organism followed by Acinetobacter spp (17.11%). Resident doctors and doctors posted in hospital emergency had the most contaminated stethoscopes. Two (40%) S.aureus was found to be Methicillin resistant. Amikacin and amoxicillin-clavulanic acid were the two most sensitive drugs against the Gram Negative bacilli. All the health care professionals were conscious of bacterial contamination of stethoscopes, still only 16% of them practised disinfection of stethoscopes. Apprehension of damaging stethoscopes and lack of knowledge regarding good disinfectant were the underlying causes that prevent cleaning of the stethoscopes. This study confirmed that stethoscopes used by the health care providers of this hospital were contaminated with pathogenic and potential pathogenic bacteria. Study detected a definite deficiency in knowledge among health care provider about the disinfection of stethoscopes. So there is a need to address the issue in an urgent basis.*

Keywords: *Contamination, Disinfection, Health Care Personnel, Stethoscope*

I. Introduction

Stethoscope has always been a part of the physicians' basic tool for examining patients. Stethoscope, through direct dermal contact, acquired pathogens as well as commensals on its diaphragm and subsequently that were transferred to other patients [1,2,3] . Thus health care associated infection (HAI) is always a threat associated to continuous use of contaminated stethoscopes. Health care associated infection is nowadays not only a great challenge for doctors but also for the patients due to increased morbidity and economic burden [4]. Physician hands were the most common vehicle responsible for hospital cross contamination. As an extension of the hand, doctors use their stethoscopes for evaluation of patients and stethoscopes were identified as a fomite since1972[5].

Despite these findings, disinfection of stethoscopes is still not an established and accepted practice among most of the health care personnel (HCP) [6].

With this background the study intended to reveal the extent of contamination of stethoscopes of HCP of this hospital of eastern India and disinfection of stethoscopes practiced by them.

II. Materials And Methods

Type of study: Hospital based Cross sectional study.
Study area: Study was conducted in a tertiary care hospital of rural Bengal. The hospital serves patients from different districts of eastern part of Bengal.
Study population: Health care personnel (Visiting doctors, residents and students) accompanied with stethoscopes.
Selection criteria: Health care personnel, who use stethoscopes at place of work, were selected randomly. Health care providers once participated in the study were excluded from repeat enrolment so that each person submits his or her stethoscope only once.
Study period: Two months (August – September 2013).

Sample size: The sample size (n) was calculated by taking prevalence of bacterial contamination of stethoscope used by health care workers 89.65%, in a previous study in Manipal[7] with the allowance of error (E) of 10% of prevalence rate at 5% level of significance. Contingency for the unknown circumstance was 10%.

$$n = \frac{(Z\alpha/2)^2 \times P(1-P)}{E^2} = \frac{(1.96)^2 \times 89.65(10.35)}{(8.96)^2} = 46 + 10\% = 51$$

So for convenience 100 samples were taken.

Collection of samples: Without any prior intimation the researcher went to any inpatient or outpatient department for collection of the samples. The clinicians present at that time on the floor with their own stethoscopes in hands were included in the study after getting consent. A subject information brochure detailing the procedure was available and an opportunity to decline to participate was given. The surface of the diaphragm of each stethoscope was swabbed with a sterile swab moistened with sterile normal saline (0.9%w/v) and was labeled with a serial number. Names of participants were not being identified in any way. Only the professional role of the participants, such as resident or visiting doctors, medical students and name of the department were recorded. Samples were transferred to the Microbiology Laboratory at earliest. An anonymous study questionnaire was given to participant to obtain information on stethoscope cleaning habits and barriers to stethoscope cleaning.

Processing of the sample in the laboratory:

The swabs were inoculated on the plate of Blood agar media & MacConkey's agar media (Hi-Media Laboratories). The Plates were observed for growth of bacteria after overnight aerobic incubation at 37 ^{o}C.

The colony was identified phenotypically by colony characteristics, Gram staining, motility and biochemical tests as per standard protocol. Colony count $\geq$ 20cfu/diaphragm was considered as significant growth [8]. Antibiotic sensitivity test of pathogenic bacteria was done by modified Kirby Bauer Disc Diffusion method[9] on Muller Hinton's media with proper standardization by ATCC control strains (E.coli-ATCC 25922; S.aureus--ATCC 25923; MRSA – ATCC 43300; Pseudomonas aeruginosa- ATCC 27853).Following antibiotic discs, containing measured and standard amount of antibiotics(procured from HiMedia Pvt.Ltd Mumbai) were used for drug testing:Amikacin (AK- 30mcg), Gentamicin (G-10mcg), Amoxycillin- Clavulanic acid (AMC-20/10mcg), Ampicillin (AMP-10mcg), Ceftriaxone (CTR-30mcg), Cefotaxime (CTX-30mcg), Ceftazidime (CAZ-30mcg), Cefoxitin (CX-30mcg), Chloramphenicol (C-30mcg), Clindamycin (Cd-2mcg), Ciprofloxacin (CIP-5mcg), Levofloxacin (LE-5mcg), Vancomycin (VA-30mcg), Cotrimoxazole (COT 1.25/23.75 mcg).

Statistical analysis was done by Graph Pad InStat 3.1 version. Percentages were used mainly for interpretation of the data in this study. Differences between proportions were evaluated by Chi square test. P value <0.05 was considered significant.

Study was conducted after taking permission from Institutional Ethical Committee.

III. Results

Of the 100 stethoscopes obtained from 40 visiting doctors, 28 residents and 32 medical students, 52% were found to be contaminated with bacteria. Of the 52 Stethoscopes 18 (34.6%) had polymicrobial growth and total 76 bacteria were isolated comprising of 8 different species. Of which 75% (57/76) were Gram positive organisms and 25% (19/76) were Gram negative bacilli. Among the isolates, Bacillus subtilis (36.84%) was prevalent organism followed by Acinetobacter spp(17.11%), Coagulase negative Staphylococcus (14.47%), Micrococcus Spp (10.53%), Staphylococcus aureus (6.58%), Pseudomonas spp (6.58%),Diphtheroids (6.58%), and E.coli (1.32%)(Table /Fig 1).

Stethoscopes of resident doctors were more contaminated (60.7%) than other two categories. But this distribution was not statistically significant (Chi square =1.653, with df=2, P=0.437).

Acinetobacter spp was the most common isolates in visiting doctors, whereas Bacillus spp was predominant one in the stethoscopes of resident doctors and MBBS students (Table /Fig 2).

Stethoscopes sampled from the doctors of emergency (83.3%) and anaesthesia (71.4%) department showed maximum contamination (Table /Fig.3).

Rate of contamination of stethoscopes in male and female doctors were almost equal (Table/Fig 4).

Antibiotic resistance pattern of pathogenic bacteria were shown in Table /Fig 5. Two (40%) of Staphylococcus aureus were found to be methicillin resistant whereas among 13 Coagulase negative Staphylococcus isolates, 2 (18.18%) were resistant to cefoxitin. None was resistant to vancomycin. Chloramphenicol, amikacin and amoxycillin – clavulanic acid were the least resistant drugs against the isolates. Acinetobacter spp., S.aureus and E.coli were found 100% resistant to ampicillin. Though extended spectrum beta lactamase producing bacteria were not present among the isolates multi drug resistant organisms were frequently observed.

All of the participants believe that stethoscope could carry microorganism and that might be a source of HAI, but only 16% of them tried to clean their stethoscopes. Among them 25% were visiting doctors, 21.4% were residents. None of the medical student cleaned his/her stethoscope ever (Table/Fig 6).

Stethoscopes of those 84 participants who never cleaned their stethoscopes, 57.14% (48/84) showed growth of bacteria and 42.86% (36/84) were found sterile, whereas only 25% cleaned stethoscope showed growth of bacteria. This difference was statistically significant (Table /Fig 7).

Those 16 doctors who had an attempt to clean their stethoscopes used hand sanitizer or 70% ethyl alcohol. Thirty seven HCP considered 70% ethyl alcohol as an ideal disinfectant where as hand sanitizer was a good choice for 22 HCP. More than 50% of medical students had no idea about the ideal disinfectant (Table /Fig 8).

Weekly disinfection was considered sufficient for 57% of participants whereas 32% had no idea about the ideal frequency of cleaning stethoscope (Table/Fig 9).

Concern for damage of stethoscope was identified as barrier of cleaning by 60% of participants followed by lack of time and lack of knowledge regarding best cleaner by 21% and 18% participants respectively.

IV. Discussion

In this present study 52% of stethoscopes analyzed were contaminated with various types of bacteria. Incidence of contamination of stethoscope varies from 30% to 100% in different studies[7,10,11,12,13]. Wide range of variation might be due to difference in awareness and attitude regarding stethoscope cleaning methods and practice in different HCP.

A total of 76 bacteria were isolated from 52 samples as polymicrobial growth was detected from 18 stethoscopes. The mean bacterial species count per diaphragm of this study (1.46) was quite lower in comparison to a study in a Ethiopian hospital[8]. Three forth of the isolates were Gram positive organisms. It is quite obvious that Gram positive bacteria are isolated more than Gram negative bacteria as they are the main constituents of normal skin flora. Moreover, the life span of Gram negative bacteria is maximally 6 hours in vitro, Gram positive bacteria remain viable for a longer period of time even up to months [14]. Among the isolates, Bacillus subtilis (36.84%) was predominant one followed by Acinetobacter spp(17.11%), Coagulase negative Staphylococcus (14.47%), Micrococcus Spp (10.53%), Staphylococcus aureus (6.58%), Pseudomonas spp (6.58%), Diphtheroids (6.58%), and E.coli (1.32%). Almost similar bacterial profile was observed in studies conducted in Manipal [7] , Turkey[15], Saudi Arabia[16]. Whereas in studies in Mumbai[10], Meerut [12], Nigeria [11]. Staphylococcus aureus was the most common organism isolated from stethoscopes. Unlike other studies, cluster of Acinetobacter spp (17.11%) isolated from stethoscopes in this study was a matter of concern for Hospital Infection Control Committee. Acinetobacter species are notorious agents for HAI that can remain active on a variety of inert surfaces and are often observed, especially in intensive care units [3]. Presence of Pseudomonas spp also posed a potential threat for HAI.

Isolation rate of bacteria in stethoscopes of resident doctors was more than that of visiting doctors and medical students' .This might be due to the fact that the residents stethoscopes comes in contact with more patients than others. Stethoscopes sampled from the doctors of emergency (83.3%) and anaesthesia (71.4%) department showed maximum contamination in this study, whereas a study in Mumbai showed highest contamination of stethoscopes used in Medicine ward[10]. The doctors posted in emergency and anaesthesia perhaps use stethoscopes more frequently than others this might be the explanation of higher rate of bacterial contamination in them.

Rate of contamination of stethoscopes in male and female doctors were almost equal. But stethoscopes of male doctors were more contaminated than female in a study by Kilic I.H et al [15].

Two (40%) MRSA and 2 (18.18%) methicillin resistant coagulase negative Staphylococcus were isolated from stethoscopes of residents. All the staphylococci were sensitive to vancomycin. This was in concordance to the observation made in study in Mumbai[10]. Isolates in present study showed a variable resistance pattern against fluoroquinolones in contrary to some studies where staphylococci were 100% sensitive to Fluoroqinolones [10,11] .

Incidence of MRSA in stethoscopes ranged between 7.3% to 69.76% in different studies[10,12,17]. Multidrug resistant Acinetobater spp were also prevailing in the stethoscopes of visiting doctors as well as residents. Amikacin , amoxicillin - clavulanic acid and chloramphenicol were found most effective drugs in vitro. Isolation of Multidrug resistant strains was worrisome and a serious public health concern. Multi drug resistant strains are capable of initiating severe HAI which might require contact isolation and aggressive treatment to arrest their spread [18].

The knowledge, attitude and practices regarding the role of stethoscopes as a vector of microorganisms were assessed by a questionnaire in this study.

All of the participants believe that stethoscope could carry microorganism and that could be a source of HAIs. But only 16% of them tried to clean their stethoscopes where as 93%, 87% and 21% of study population had cleaned their stethoscopes in studies in USA [19] UK [6] and Saudi Arabia [16] respectively. So, the magnitude of the problem was much higher in this hospital showing 84% of HCP had never cleaned their stethoscopes. The result of present study also reflected that knowledge was not always converted into practice. There was a statistical significant differences between disinfection of stethoscopes and colonization of the bacteria (P= 0.037). A study in Nigerian Medical students supports the fact [18].

Twenty nine HCP of this hospital accepted that they had no idea about the ideal disinfectant and 32% had no perception about the ideal frequency of cleaning stethoscope. This revealed the knowledge gap and need for immediate sensitization program. Concern for damage of stethoscope was identified as barrier of cleaning by majority of participants in this study followed by lack of time.

It was observed in a study in USA, that cleaning the stethoscope diaphragm resulted in abrupt fall in the bacterial count by 94% with alcohol swabs, 90% with non-ionic detergent, and 75% with antiseptic soap[3]. In another study simple use of alcohol rub produces an effective disinfection of the stethoscopes [11].

In 2008, the Centres for Disease Control (CDC) recommended appropriate disinfection of all reusable gazettes before use on another patient. Cleaning of stethoscopes with 70% ethyl or isopropyl alcohol after every use is recommended by CDC[20], despite these guidelines, proper care of stethoscope was not at all practised currently. However, it is time consuming and not always feasible, especially in a setup where patient load is enormous. So search for feasible but effective disinfection methods are going on. A comparative study showed disinfection with 66% ethyl alcohol after every contact and after the daily work was more or less with same effect[13]. Hence, Health care workers are to be motivated to disinfect their precious paraphernalia as much as they can, at least at the end of the day's work to ensure patient safety.

Though it is difficult to determine the accuracy of present study because it is solely dependent on self-reporting, but based on this fact need for proper training regarding safe stethoscope handling is perceived especially among the medical students.

Another lacuna of the present study was that, the transmission of HAI through stethoscopes was not addressed here. But study showed stethoscopes of HCP were highly contaminated and the strict pursuance of disinfection policies was crucial to alleviate a forthcoming disaster.

Tables & Figures

Table /Fig 1: Distribution of bacteria in stethoscopes

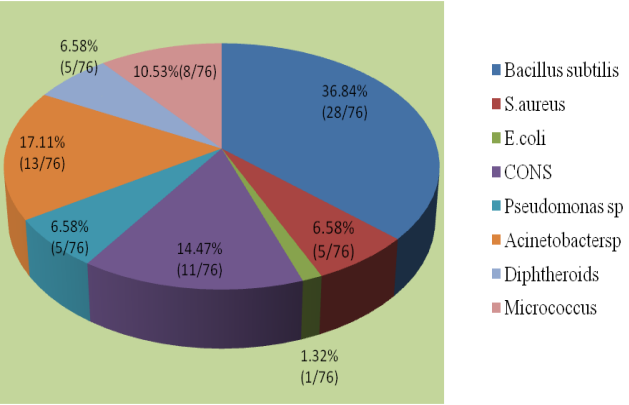
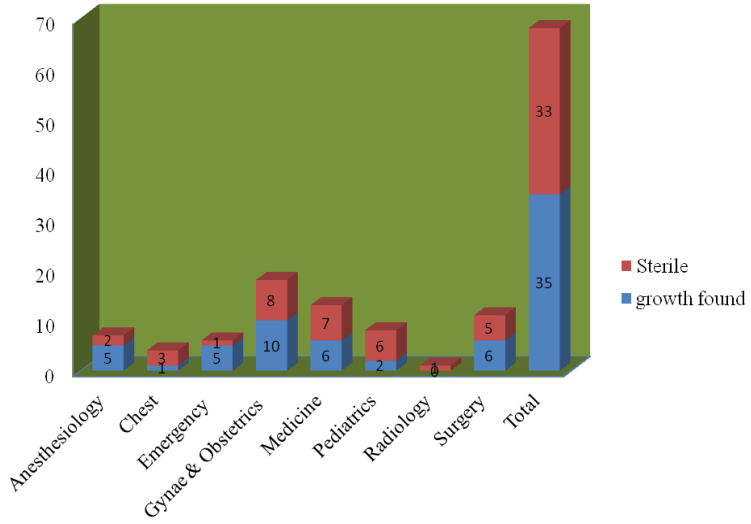


Table /Fig 2: Distribution of bacteria in different categories of health professionals

Isolated organisms	Visiting doctors n=40(%)	Resident n=28(%)	MBBS student n=32(%)	Total n=100(%)
Bacillus subtilis	4(10)	12(42.8)	12(63.1)	28(36.84)
S.aureus	4(10)	1(3.57)	0	5(6.58)
E.coli	1(2.5)	0	0	1(1.32)
CONS	5(12.5)	5(17.8)	1(3.1)	11(14.47)
Pseudomonas sp	0	3(10.8)	2(6.2)	5(6.58)
Acinetobacter sp	7(17.5)	5(17.8)	1(3.1)	13(17.11)
Diphtheroids	4(10)	0	1(3.1)	5(6.58)
Micrococcus	0	6(21.4)	2(6.2)	8(10.53)
Total isolates	25	32	19	76
Growth found	18(45)	17(60.7)	17(53.1)	52
Sterile	22(55)	11(39.2)	15(46.8)	48

Table/Fig 3. Distribution of contaminated stethoscopes among doctors of different Departments



Table/Fig 4. Relationship of Gender and contamination of stethoscopes

	Contaminated	Sterile	Percentage of contamination	Statistics
Female N=38	20	18	52.63	χ^2=0.011, with df= 1 P value = 0.915
Male N=62	32	30	51.61	

Table/Fig 5: Resistance pattern of pathogenic bacteria

ANTIBIOTIC	S.aureus N=5 (R%)	CONS N=11 (R%)	Acineto bacter N=13(R%)	Pseudomonas N=5 (R%)	E.coli N=1 (R%)	Total resistance N=35 (%)
Ampicillin	5(100)	8(72.7)	13(100.00)	4(80)	1(100)	31 (88.57)
Cefoxitin	2(40)	2(18.18)	Not tested	Not tested	Not tested	4(11.4)
Vancomycin	0(0.00)	0(0.00)	Not tested	Not tested	Not tested	0(0.00)
Cefotaxime	4(80)	6 (54.54)	7(53.84)	3(60)	1(100)	21(60)
Ceftriaxone	3(60)	5(45.45)	8(61.53)	3(60)	0(0.00)	19(54.3)
Chloramphenicol	1(20)	4 (36.36)	5(38.46)	2(40)	0(0.00)	12(34.3)
Ciprofloxacin	3(60)	3(27.27)	6(48.52)	3(60)	0(0.00)	15(42.8)
Levofloxacin	2(40)	4(36.36)	6(48.52)	2(40)	0(0.00)	14(40)
Cotrimoxazole	4 (80)	7(63.6)	9(69.23)	4(80)	1(100)	25(71.4)
Gentamicin	1 (20)	5(45.45)	5(38.42)	2(40)	0(0.00)	13(37.1)
Amikacin	1(20)	2(18.28)	4(30.76)	2(40)	0(0.00)	9(25.7)
Amoxyclav	1(20)	2(16.67)	7(53.84)	3(60)	0(0.00)	13(37.1)

Table/Fig 6: Cleaning frequency in different categories of doctors

Cleaned stethoscope	Visiting Doctors n=40	Residents n= 28	Medical Students n=32
Never n= 84	30(75%)	22(78.5%)	32(100%)
Last week n=9	7(17.5%)	2(7.14%)	00(0.00%)
Yesterday n=1	00(0.00%)	1(3.5%)	00(0.00%)
Can not recall n=6	3(7.5%)	3(10.7%)	00(0.00%)

Table /Fig 7: Relationship of cleaning of stethoscope and growth observed from stethoscopes

Status of stethoscope	Growth n=52	Sterile n=48	Statistics
Cleaned n= 16	4(25%)	12(75%)	χ^2=4.350 with df= 1 P value =0.037
Never cleaned n= 84	48(57.14%)	36(42.86%)	

Table /Fig 8: Perception regarding ideal disinfectant in different categories of participants

Individual view regarding ideal disinfectant	Visiting Doctors n=40	Residents n= 28	Medical Students n=32
Soap and water n=7	1(2.5%)	3(10.7%)	3(9.37%)
Normal saline n= 5	2(5%)	1(3.57%)	2(6.25%)
Alcohol based hand sanitizer n=22	09(22.5%)	10(35.7%)	3(9.37%)
70% ethyl alcohol/ isopropyl alcohol n=37	22(55%)	9(32.1%)	6(18.75%)
No idea n=29	6(15%)	5(17.8%)	18(56.25%)

Table /Fig 9: Individual perception regarding cleaning frequency in different categories of participants

Individual view regarding frequency that stethoscope should be cleaned	Visiting Doctors n=40	Residents n= 28	Medical Students n=32
Before /after every patients n=9	6(15%)	3(10.7%)	0(0.00%)
At start/end of the day n=2	0(0.00%)	2(7.14%)	0(0.00%)
Weekly n= 57	26(65%)	13(46.42%)	18(56.25%)
No idea n=32	8(25%)	10(35.7%)	14(43.75%)

V. Conclusion

Bacteriological analysis of stethoscopes used by the HCP of this hospital revealed that more than 50% of stethoscopes were colonized by the various groups of bacteria including MRSA and multidrug resistant strains. In spite of awareness regarding contamination of stethoscopes only a handful of medical persons practice regular disinfection. Concern for damage of stethoscopes, shortage of time and lack of knowledge about the ideal disinfectant were the main hindrances for cleaning stethoscopes.

This study revealed an urgent need of a training program to percolate already prevailing CDC guidelines regarding disinfection of stethoscopes. Regular sensitization programs about the hygienic use of stethoscopes are to be conducted. Motivation of health care providers to convert their knowledge to practice could be the next step to decrease the bacterial load significantly from the stethoscope which will automatically minimize cross-contamination and ensure improved patient safety in the hospital.

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