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Fighting the Battle With-Double Edged Weapons – A Prospective Study

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Abstract: *Hospital acquired infections are recognized as critical public health problems. Infections are frequently caused by organisms residing in health care environment, including contaminated medical equipment like Stethoscopes The stethoscope, which is universally used as a medical device by health care workers, is likely to be contaminated by microorganisms .This prospective, cross sectional study was conducted by the Department of Medicine, Mohan kumaramangalam Medical college hospital, Salem during JULY 2016 .in coordination with various medical college hospitals in Tamilnadu . HCWs(health care workers) were included in this study. Of 51 stethoscopes examined, 39 (76.4%) were considerably contaminated (>20 CFUs/diaphragm), and the rest 12 (23.5%) were not contaminated.) The majority of organism isolated were of CoNS (41.1%). Isolated CONs were more sensitive to vancomycin (100%), linezolid (95.2%), doxycycline (52.3%), amikacin (47.6%)..Strict adherence to stethoscope disinfection practices by health workers will minimize cross contamination and ensure improved patient safety in hospitals*

I. Overview

Infections are a significant source of morbidity and mortality for nursing home residents and account for up to half of all nursing home resident transfers to hospitals. Infections result in an estimated 150,000 to 200,000 hospital admissions per year at an estimated cost of $673 million to $2 billion annually.

Confirming and managing an infectious outbreak can be costly and time consuming. An effective facility-wide infection prevention and control program can help to contain costs and reduce adverse consequences. An effective program relies upon the involvement, support, and knowledge of the facility's administration, the entire interdisciplinary team, residents, and visitors. The contamination of physician white coat and stethoscope might be potential vectors of nosocomial infections.There is no sufficient studies conducted in this part of the country to support this. So the main aim of this is to study the varied antibiogram of the stethoscope of the health workers of & its sensitivity to commonly used antibiotics

II. Preventing The Spread Of Infection

A study from India reported that, 45% of general practitioners disinfect their stethoscope once a year or never and 35%disinfect their stethoscope monthly .Infection prevention protocols are effective in reducing the health care associated infections . The use of 70% propyl alcohol found to be effective in reducing contamination of stethoscopes and other medical equipments than other agents like detergents . However, a study conducted by Hayden and his colleagues shows that, the implementation of such programs were hindered by poor compliance of Physicians, Nurses and other health care workers. Inconvenience, time pressures, and skin damage from frequent washing are some of the reasons quoted by the health care personnel in that particular study

A single stethoscope often used for all inpatients and outpatients. The universal and unavoidable use of the stethoscope and its direct contact with multiple patients makes it an important potential factor in the dissemination of microorganisms from one patient to another. Exposure of the already susceptible hospitalized patient to resident flora of the hospital environment (in most cases are multi drug resistant pathogens unless proved) may worsen the clinical condition of the patient.

The aim of this study is to identify the contamination level of a stethoscope, bacterial profile, and antimicrobial susceptibility pattern of bacteria isolated from stethoscope diaphragms and also to survey the practices of cleaning and disinfecting the stethoscope and to suggest remedial measures for it

III. Materials And Methods

This prospective, cross sectional study was conducted by the Department of medicine, Government Mohan kumaramangalam Medical college hospital Salem during 2016 in coordination with various medical college hospitals in Tamilnadu. HCWs including consultants, medical officers, post graduate students, medical interns and staff nurses of the Medicine,Pediatrics ,obstetrics and gynecology, neurology, cardiology, pulmonology, the Emergency Departments and the Intensive Care Unit (ICUs) were included in this study. The participants were given a questionnaire. A total of 51 HCWs participated in the study and the same number of stethoscopes were sampled. Specimens from the diaphragms, bells of the stethoscopes were collected**.**

The diaphragms and the bell of the stethoscopes were swabbed with cotton swab moisture with sterile saline solution and immediately inoculated onto different blood agar, MacConkey agar and Chocolate agar plates The inoculated plates were incubated at 37 C for 24-48 hours. The growth was identified by standard microbiological procedures such as colony morphology, Gram's staining, growth on differential media and conventional biochemical tests. By evaluating the colony characteristics and also by using Gram stain, the isolated bacteria were identified. Antibiotic sensitivity tests were performed by the Kirby Bauer method. Antimicrobial Susceptibility Test (AST) and susceptibility result was interpreted based on Clinical Laboratory Standards Institute (CLSI) guidelines M100S - 26th Edition (2016). Data were entered and analyzed using SPSS version16.0 computer software. Comparisons were made using Chi-square test. P-value of <0.05 was considered indicative of a statistically significant difference. Ethical clearance was secured from Ethical Clearance Committee of College of Salem Mohan Kumara mangalam Government Medical College and Hospital.

IV. Results

Bacterial contamination

Of 51 stethoscopes examined, 39 (76.4%) were considerably contaminated (>20 CFUs/diaphragm), and the rest 12 (23.5%) were not contaminated.(TABLE 1.2) All stethoscopes owned by Specialists, General physician, medical interns and postgraduates and Nurses were contaminated**.** The majority of stethoscopes of Resident students (100.0%), Medical Intern students (85.7%), and general physician (66.6%) were contaminated**..** Relatively least contamination was observed on stethoscope diaphragms owned by obstetricians and gynaecologist (100.0%) and among staff nurses (37.5%) (Table 1.2). The Frequency of contamination was 75% for stethoscopes from ICU, 85 - 100% for Medical ward**.**

The frequency of organisms isolated from bell and diaphragm is recorded in (Table 1.1) The majority of organism isolated were of CoNS (41.1%) followed by**,** Klebsiella spp. (17.64%), coliform (3.92%) and acinetobacter (3.92%) (table 1.1). The percentage of resistance of isolated organism to antibiotics tested according to CLSI, is shown in Tables 1.3

TYPE OF BACTERIAL STRAIN CULTURED	**NUMBERS %**
COAGULASE NEGATIVE STAPHYLOCOCCUS AUREUS	21(41.17%)
KLEBSIELLA PNEUMONIA	9 (17.64%)
GRAM POSITIVE BACILLI	4 (7.84%)
GRAM NEGATIVE BACILLI	1 (1.96%)
COLIFORM BACTERIA	2 (3.92%)
ACETINOBACTER	2 (3.92%)
NO GROWTH	12 (23.52%)
TOTAL	51

Table 1.1 Frequency of organism cultured from stethoscopes

SPECIALITY	CON %	Non CON %	TOTAL
Intensive care unit	3 (75.0%)	1 (25,0%)	4
Anaesthetist	3 (75.0%)	1 (25,0%)	4
Physician	4 (66.6%)	2 (33.3%)	6
Neurologist	2 (100.0%)	0	2
Paediatrician	3 (60.0%)	2 (40.0 %)	5
Cardiologist	2 (100.0%)	0	2
Pulmonologist	2 (100.0%)	0	2
Obstetrics & gynaecologist	0	2 (100.0%)	2
Medical interns	6 (85.7%)	1 (14.2%)	7
Postgraduate students	9 (100.0%)	0	9
Staff nurses	5 (62.5%)	3 (37.5%)	8
total	39	12	51
Rate of contamination versus professional status of the stethoscope owners			

Table 1.2- CON- Contaminated, Non CON-Non Contaminated

Antibiotics	klebsiella	Cons	Coliforms	Acinetobacter
	NO=9	NO=21	NO=2	NO=2
AMP	4 (44.4%)	5 (23.8%)	1 (50.0%)	1 (50.0%)
AMC	6 (66.6%)	3 (14.2%)	0	0
AMK	1 (11.1%)	3 (14.2%)	0	1 (50.0%)
CTX	0	3 (14.2%)	0	1 (50.0%)
CXM	6 (66.6%)	6 (23.0%)	0	0
CFZ	3 (33.3%)	1 (4.7%)	0	0
CIP	6 (66.6%)	9 (42.8%)	0	1 (50.0%)
CLI	6 (66.6%)	5 (23.8%)	0	0
ANTIBIOTIC RESISTANT PATTERNS OF THE CULTURED BACTERIAL STRAINS				

Table 1.3 -Cons- Coagulase Negative Staphylococcus Species, 0- Not Done

AMP- AMPICILLIN, **AMC**- AMOXACILLIN CLAVULANIC ACID, **AMK**- AMIKACIN, **CTX**-CEFOTAXIME**, CXM**-CEFUROXIME, **CFZ**-CEFTAZIDIME, **CIP**-CIPROFLOXACIN, **CLI**-CLINDAMYCIN**, ERY**-ERYTHROMYCIN, **GEN**-GENTAMYCIN, **LNZ**-LINEZOLID, **LVX**-LEVOFLOXACIN, **OFX**-OFLOXACIN, **OXA**-OXACILLIN, **TZP**-PIEPERACILLIN TAZOBACTUM**,** **SXT**-TRIMETHOPRIM/ SULFAMETHOXAZOLE**,**

Antibiotics	klebsiella	Cons	Coliforms	Acinetobacter
	NO=9	NO=21	NO=2	NO=2
ERY	0	6 (23.0%)	0	0
GEN	5 (55.5%)	5 (23.8%)	0	0
LNZ	0	0	1 (50.0%)	0
LVX	0	2 (9.5%)	0	1 (50.0%)
OFX	5 (55.5%)	5 (23.8%)	0	1 (50.0%)
OXA	0	3 (14.2%)	0	0
TZP	4 (44.4%)	1 (4.7%)	0	1 (50.0%)
SXT	6 (66.6%)	6 (23.0%)	0	1 (50.0%)
ANTIBIOTIC RESISTANT PATTERNS OF THE CULTURED BACTERIAL STRAINS				

Table 1.3 Drug Resistant Patterns Of Cultured Bacteria From Stehoscopes Cons- Coagulase Negative Staphylococcus Species, 0- Not Done

Antibiotics	klebseilla	Cons	Acinetobacter	Coliforms	NFR
	NO=9	NO=21	NO=2	NO=2	NO=1
AMC	0	2 (9.5%)	0	0	0
AMK	5 (55.5%)	10 (47.6%)	1 (50.0%)	2 (100%)	0
CZO	0	7 (33.3%)	0	0	1 (100%)
CTX	1 (11.1%)	1 (4.7%)	1 (50.0%)	0	0
CFZ	6 (66.6%)	7 (33.3%)	1 (50.0%)	0	1 (100%)
CIP	2 (22.2%)	5 (23.8%)	0	1 (50.0%)	1 (100%)
CLI	1 (11.1%)	0	1 (50.0%)	0	1 (100%)
DOX	0	11 (52.3%)	0	0	0
ANTIBIOTIC SENSITIVE PATTERNS OF THE CULTURED BACTERIAL STRAINS					

Table 1.4-CONS- coagulase negative staphylococcus species, NFR- Non fermenting rod 0- not done

AMC-AMOXACILLIN CLAVULANIC ACID , **AMK**-AMIKACIN, **CZ0**-CEFAZOLIN, **CTX**-CEFOTAXIME**, CFZ**-CEFTAZIDIME, **CIP**-CIPROFLOXACIN, **CLI**-CLINDAMYCIN **DOX**-DOXYCYCLINE, **GEN**-GENTAMYCIN, **LVX**-LEVOFLOXACIN, **OFX**-OFLOXACIN, **OXA**-OXACILLIN, **TZP**-PIEPERACILLIN TAZOBACTUM**,** VAN-VANCOMYCIN , **LNZ**-LINEZOLID

Antibiotics	**klebseilla**	**Cons**	**Acinetobacter**	**coliforms**	**NFR**
	NO=9	NO=21	NO=2	NO=2	NO=1
GEN	2 (22.2%)	7 (33.3%)	0	2 (100%)	0
LVX	0	2 (9.5%)	0	0	0
OFX	1 (11.1%)	5 (23.8%)	0	0	0
OXA	0	1 (4.7%)	0	0	0
TZP	4 (44.4%)	0	1 (50.0%)	0	1 (100%)
VAN	0	21 (100%)	0	0	0
LNZ	0	20 (95.2%)	0	0	0
ANTIBIOTIC SENSITIVE PATTERNS OF THE CULTURED BACTERIAL STRAINS					

Table 1.4 Antibiotic Sensitive Patterns Of The Cultured Bacterial Strains ,Cons- Coagulase Negative Staphylococcus Species, NFR- Non Fermenting Rods, 0- Not Done

S.NO	Methods	Numbers (%)
1	Spirit swab	7 (13.7%)
2	Dry cotton	5 (9.8%)
3	Cloth	10 (19.6%)
4	Fumigation	0
5	Never Cleaned	29 (56.8%)

Table 1.5 Methods Practiced By Hcw For Cleaning Of Stethoscopes

S.NO	Frequency of cleaning	Numbers %
1	After every patient	0
2	Every day	0
3	Alternate day	0
4	Once a week	3 (13.6%)
5	Once a fortnight	7(31.8%)
6	Once a month	5 (22.7%)
7	Once in two months	7 (31.8%)

Table 1.6 Frequency of disinfection of stethoscopes

From 51 isolated CoNS strains, more than 23 % were resistant to ampicillin, cefuroxime, ciprofloxacin, clindamycin, erythromycin, gentamycin, ofloxacin, penicillin, trimethoprim-sulfmethaxazole **.** A high resistance rate (42.8%) was also reported for ciprofloxacin **.** Less than 14% resistance were documented to amoxicillin clavulanic acid, amikacin, cefazolin, cefataxime, cefaoxitin, cefazoline, levofloxacin, oxacillin, pipperacillin tazobactum**.** Isolated CONs were more sensitive to vancomycin (100%), linezolid (95.2%), doxycycline (52.3%), amikacin (47.6%) (table 1.4)For klebsiella species more than 55% were resistant to amoxacilllin clavulanic acid, cefuroxime , ciprofloxacin, clindamycin ,gentamycin, ofloxacin ,, trimethoprim-sulfmethaxazole (table 1.3). Sensitive pattern for klebsiella revealed 55.5% for amikacin, 66.6% for cefazoline , 44.4% for pipperacillin tazobactum respectively.(table 1.4).Acinetobacter recorded resistance for most class of antibiotics (table 1.3).

Disinfection practice

The details of the questionnaires which were filled by all the HCWs revealed that 43 % of them were aware that stethoscopes could transmit infectious agents, while all the 78% thought that stethoscopes needed to be disinfected. A majority (47%) of the HCWs used stethoscopes on the patients after removing their clothes, while 53% used them without removing the clothes of the patients. Overall, 43.2% of the HCWs (out of 51) reported that they cleaned their stethoscopes by one method or the other, but 56.8 % (out of 51) said that they never cleaned their stethoscopes at all. The methods and the periodicity of cleaning the stethoscopes by the HCWs are summarized in [Table-1.5 &1.6]. The rate of contamination of the stethoscopes and the colony counts were found to be inversely related to the frequency of cleaning and the cleaning procedure of the stethoscopes. No pathogens were isolated from the stethoscopes which were cleaned daily/twice in a week. The growth of multiple organisms with high colony counts was observed on stethoscopes which were never cleaned. Of the 51 stethoscopes studied, none reported that they disinfect their stethoscope, before and after examining each patient.

39.21% of HCWs (Medical staffs and Residents), do not disinfect regularly and the contamination was statistically significant . All Doctors (Specialists, Residents and General Practitioners), Nurses, Medical Interns and Health Officers had reported that, they never disinfected their stethoscope diaphragms regularly. 22 % responded they have no perception about disinfection of stethoscope.

V. Discussion

The results of this study revealed that most diaphragms stethoscopes used by HCWS are contaminated with CoNS. CoNS were isolated on the 41.7% of stethoscopes, in line with what has been reported by many similar studies.[8,9,10,11]. Similarly to Shobha et al. [12] no S.aureus was isolated from the diaphragms and earpieces stethoscopes examined.

According to Cunha et al.[13] CoNS species identification is very important because certain species are associated with nosocomial infections. In low-weight newborns, S. epidermidis have been considered the main cause of hospital infections.[3,14,15]

S. epidermidis multi-resistant strains are well documented as the predominant species of CoNS isolated from hospital infections in population at risk.[3,16] . Multi-resistant strains of S. hominis (subsp. hominis) have been isolated from nosocomial blood stream infections predominantly from ICU.[3,18

Nosocomial infections occur at a rate of 5-10 per 100 hospital admissions each year [19]. Contaminated medical equipments and health care staff have been implicated as the carriers of pathogenic organisms [21-24]. Besides interfering with the conduction of sound waves, clothes can also be an important source of a variety of microorganisms. This was more so in the rural settings in a developing country like India , where high standards of personal hygiene were not always followed.

Despite the growing awareness about the role of the stethoscope as a carrier of microorganisms and the need to clean/disinfect it, this knowledge is not always converted into practice. The results of our study revealed that the rate of the bacterial contamination of the diaphragm was 76.47%, which is comparable to the observations of previous studies, which found that 71% to 100% of the stethoscopes were colonized by various bacteria [23, 24]. The colony counts of the stethoscopes which were used by the post graduate students and interns were comparatively higher than those of the stethoscopes which were used by the consultants and staffs. The present study demonstrated that the bacterial contamination of the stethoscopes was directly related to the area of the stethoscope which was in contact with the patient's skin or clothes. Our study demonstrated the importance of cleaning the stethoscopes with a disinfectant. Comparatively fewer bacterial colonies were obtained from the stethoscopes of the individuals who cleaned their stethoscopes with alcohol.. Poor stethoscope cleaning/disinfection practices were significantly associated with this contamination.

VI. Conclusion

The implication of the findings is that the stethoscope might be a vector playing an important role in the transmission of potential pathogenic microorganisms, as well as in the spread of antibiotic-resistant strains in the hospital environment.. Strict adherence to stethoscope disinfection practices by health workers will minimize cross contamination and ensure improved patient safety in hospitals.

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