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TO ESTABLISH A LINK BETWEEN HEALTH CARE ASSOCIATED INFECTION, PATHOGENIC BACTERIA FROM HEALTH CARE WORKERS AND BIO-MEDICAL WASTE MANAGEMENT PRACTICES IN A LEADING TERTIARY CARE CENTRE FROM INDIA

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ABSTRACT

Health care associated infection (HCAI) is a serious problem both in patient care and amongst health care workers (HCW) which adversely affect the mortality and morbidity despite antimicrobial therapy and advances in supportive care. Today over 1.4 billon people worldwide are suffering from HCAI. Although the role of the hand and nasal flora of HCW in the development of HCAI has been less evaluated by studies. The proper handling and disposal of bio-medical waste (BMW) ensures proper hospital hygiene and safety of the HCW. Due to improper waste management there are potential risks of the spread of pathogens causing HCAI. The aims of this study is to determine the presence of potentially pathogenic micro organisms in the collected hand and nasal swab samples from HCWs and to establish a link between pathogenic micro organisms of hand and nose from HCW, HCAI and BMW practices. A 3 months pilot study was conducted over 100 randomly selected HCW shows MSSA is the most common isolate from their hand and nose swabs and also the most common pathogen isolated from the different waste bins from different wards.

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INTRODUCTION

Hospitals are places where infective agents abound. Health care associated infection (HCAI) is defined as the infection that originates or occurs in a hospital or hospital-like settings. HCAIs are serious problems both in patients care and amongst health care workers (HCW) which adversely affect the mortality and morbidity despite antimicrobial therapy and advances in supportive care (Vincent *et al.,* 2003). HCW, relatives of patients and students practising in the hospital environment are often exposed to these infective agents. HCAI negatively impacts on patient outcomes and causes substantial additional resources to be worked for the management of it (Haley *et al.,* 1980) (Ducel *et al.,* 2002). In developing countries like India, HCAI is a major cause of death and disability for patients. Today over 1.4 billon people worldwide are suffering from HCAI. About 25% of patients are admitted to hospital and nursing homes in India. Although the role of the hand and nasal flora of HCW in the development of HCAI has been emphasised by earlier studies, there are a limited number of studies which investigate the hand and nasal flora of population (Akpinar *et al.,* 2009).

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HCAI can emanate from endemic hospital strains or from microorganisms endogenous in the community. Infections associated with health care have adverse effects in health protection (Mittmann *et al.,* 2012) (Jha *et al.,* 2010). In the late 20th century, evidence was mounting about the risk of HCAI to patients from transient pathogens on HCW's hands (Lowy *et al*., 1964) (Sanford *et al*., 1994) (Larson *et al.,* 2000).

The generation of waste and the collection, processing, transport and disposal of waste—the process of 'waste management'—is important for both the health of the public and environmental reasons. The proper handling and disposal of bio-medical waste (BMW) is very imperative. It ensures proper hospital hygiene and safety of the HCW. In India, in 1998, Ministry of Health of Environment & Forest under section 6, 8 and 25 of the Environment (Protection) Act, 1986 notified the rules for the management and handling of BMW which was later amended in 2003 (Pandit *et al.,* 2005). It emphasized on proper management of range of activities, such as collection, transportation, operation and treatment of processing systems and disposal of waste. Due to improper waste management there are potential risks of the spread of pathogens causing HCAI.

It is ironic that the health care facilities which restore the health of the diseased person pose a huge health risk and environmental degradation due to improper hospital waste management (Chattopdhhyay *et al.,* 2010).

Aims and Objectives

1. To determine the presence of potentially pathogenic micro organisms in the collected hand and nasal swab samples from HCWs.
2. To establish a link between pathogenic micro organisms of hand and nose from HCW, HCAI and BMW practices.

MATERIALS AND METHODS

A pilot study was conducted in 1650 bedded leading tertiary health care hospital among the HCW's (both males and females) over a period of 3 months from June 2013 to August 2013 using a combination of microbiological techniques to see the presence of pathogens like methicillin resistant *Staphylococcus aureus* (MRSA), methicillin sensitive *Staphylococcus aureus* (MSSA), *Pseudomonas* species, *Escherichia coli, Streptococcus epidermidis, Klebsiella* species, *Acinetobacter* species, and vancomycin-resistant *Enterococci* (VRE) that are known to cause HCAI. Subjects were fully informed about the design and purpose of the study and a written informed consent was obtained. A sample size of 100 randomly selected HCWs consisting of doctors (20), nurses (20), undergraduate medical students (20), nursing attendants (20) and sweepers (20) working in five departments were taken. The 5 departments included were Intensive care units (ICU's), Labour rooms, Paediatrics ward, Casualty and the Burns department. The hand and nasal swabs of the study population and swabs from the waste bin from these wards were also taken, under all aseptic precautions and transferred to a sterile brain heart infusion (BHI) broth.

Table 1. Pathogens isolated from hand imprints of study population

Occupation	MRSA	MSSA	*Kle* spe	*Pseudo* spe	*Acineto* spe	*Entero*
Doctors	4(20%)	12(60%)	3(15%)	0(0%)	0(0%)	1(5%)
Nurses	5(25%)	6(30%)	5(25%)	3(15%)	1(5%)	0(0%)
Nursing Attendants	4(20%)	8(40%)	2(10%)	4(20%)	2(10%)	0(0%)
Students	6(30%)	8(40%)	4(20%)	0(0%)	2(10%)	0(0%)
Sweepers	7(35%)	10(50%)	2(10%)	1(5%)	0(0%)	0(0%)
Total	26(26%)	44(44%)	16(16%)	8(8%)	5(5%)	1(1%)

MRSA- methicillin resistant staphylococcus aureus, MSSA- methicillin sensitive *staphylococcus aureus*, *Kle* spe- *Klebsiella* species, *Pseudo* spe- *Pseudomonas* species, *Acineto* spe- *Acinetobacter* species, *Entero- Enterobacter*

Table 2. Pathogens isolated from nasal swabs of the study samples

Occupation	MRSA	MSSA	*Kleb* spe	*Pseudo* spe	*Staphylococcus epi*
Doctors (20)	2(10%)	14(70%)	1(5%)	0(0%)	3(15%)
Nurses (20)	1(5%)	16(80%)	1(5%)	0(0%)	2(10%)
Nursing (20) Attendants	1(5%)	15(75%)	1(5%)	0(0%)	3(15%)
Students (20)	2(10%)	10(50%)	1(5%)	1(5%)	6(30%)
Sweepers (20)	4(20%)	8(40%)	2(10%)	2(10%)	4(20%)
Total (100)	10(10%)	63(63%)	6(6%)	3(3%)	18(18%)

MRSA- methicillin resistant staphylococcus aureus, MSSA- methicillin sensitive *staphylococcus aureus*, *Kle* spe- *Klebsiella* species, *Pseudo* spe- *Pseudomonas* species, *Staphylococcus epi- Staphylococcus epidermidis*

Table 3. Pathogens isolated from the waste bins of the different departments

Wards	Yellow waste bin	Blue waste bin	Black waste bin
ICU	*Staphylo aureus Acineto*	*Staphylo aureus*	*Staphylo aureus Entero*
Burn	*Staphylo aureus Kleb spe, Pseudo*	*Staphylo aureu, Kleb spe*	*Kleb spe, Pseud spespe*
Causality	*Staphylo aureus Pseudo spe*	*Staphylo aureu,*	*Staphylo aureu*
Paediatrics	*Staphulo aureus Pseudo spe*	*Staphylo aureus, Kleb sp*	*Staphylo aureus*
Labour Room	*Staphylo aureus,*	*Staphylo aureus*	*Staphylo aureus, Kleb spe*

It was then transported to the Microbiology laboratory as soon as possible. Here, each sample was plated within an hour on Blood Agar (BA) and Mac Conkey's agar (MA). All culture media were then processed as per standard protocol (CLSI guideline 2013) and the isolates were identified by standard bacteriological methods, i.e. smear examination by Grams stain, motility by Hanging drop and appropriate biochemical tests. The antimicrobial susceptibility tests were performed by disc diffusion technique and the findings were recorded.

RESULTS

A total of 100 HCWs participated in the study, including 20 doctors (20%), 20 nurses (20%), 20 under-graduates medical students (20%), 20 nursing attendants (20%), & 20 sweepers (20%). Hand imprints, nasal swabs, waste bin isolates were analysed for pathogens.

Hand imprints

Pathogens isolated were Methicilin sensitive *Staphylococcus aureus* (MSSA) (44%), followed by Methicilin resistant *Staphylococcus aureus* (MRSA) (26%), *Klebsiella* species (16%) and *Pseudomonas* species (8%). From some samples *Acinetobacter* species (5%) and *Enterobacter* (1%) were also isolated. The distribution of the study subjects as per the occupation and the organism isolated is as follows in Table I.

Nasal swabs

Pathogens isolated were Methicilin sensitive *Staphylococcus aureus* (MSSA) (63%) followed by *Staphylococcus epidermidis* (18%), Methicilin resistant *Staphylococcus aureus* (MRSA) (10%), *Klebsiella* species (6%) and *Pseudomonas* species (3%). The distribution of organism according to their wards is as follows in Table II.

Waste sample

Samples were also taken from the waste bins present in Intensive care units (ICU's), Labour rooms, Paediatrics ward, Casualty & the Burns department from where the samples of the study subjects were taken. Pathogens isolated from the bins of the different departments were *Staphylococcus aureus, Acinetobacter, Klebsiella* species, *Enterobacter* species, and *Pseudomonas* species as follows in Table III .

Bio- medical waste (BMW) management policy in the Hospital

In our tertiary care hospital the quantum of waste generated per day was 3500-3600kg. Out of this, general waste constituted 3000kg/day and biomedical waste (including both sharps and infectious waste) constituted 550-600kg/day. The hospital has a waste management plan and a waste management team. The waste management team is headed by the Additional Medical Superintendent, doctors from various departments both clinical and teaching and waste handling staff. There is also an authorization from Pollution Control Board for hospital waste management.

For waste segregation, there are 3 colour bins e.g. yellow for infectious agents, blue for sharp waste and black for non-infectious waste which was kept in all the departments and they were emptied 8 hourly when they were 2/3rd filled. There is clearly segregation of wastes from specified units of the hospital by an external agency. The collection of waste from different departments is done on regular basis. The sharps are collected in puncture resistant blue containers. There are 12 trolleys available for internal segregation transportation. The containers are washed and disinfected after emptying. The collected waste is stored in a specified area identified specially for this purpose. They were inaccessible to unauthorised persons & animals. There is no separate storage room for radioactive waste. The untreated waste is not stored for more than 48 hours.

DISCUSSION

Present study has tried to establish a link between the pathogens isolated from nasal and hand swabs of HCW with HCAI and BMW practices. In our study, waste disposal is done by an external agency. In the present study MSSA is the most common organism isolated from hand (44%) and nasal swab (63%) of study population and also from waste bins from different wards. A study was undertaken by Paul *et al.,* to find

out the prevalence of bacterial contamination on the hands of doctors in the Medicine and Dermatology wards showed that there was significant contamination of the doctors' hands at entry (59.1%) and at exit (90.9%) of which *Staphylococcus* species was the predominant organism (59% at entry and 85% at exit), among the gram negative organisms, *Escherichia coli* (4.5%), *Pseudomonas* species (4.5%), *Enterococus* species (13.6%) and *Klebsiella* species (9%) were the main ones isolated (Paul *et al.,* 2011). From another study by Pittet *et al.,* Gebreyesus *et al.,* hand flora from the HCW can significantly transfer the pathogens to patients and the carriage rate was higher among nurses and doctors which is similar to our study where the most common isolate is MSSA from doctor's hand (60%) (Pittet *et al.,* 2006) (Gebreyesus *et al.,* 2013). In our study MSSA (44%) is followed by MRSA (26%), *Klebsiella* species (16%), *Pseudomonas* species (8%), *Acinetobacter* (5%) and *Enterobacter* (1%) from the hand imprints as shown in Figure I.

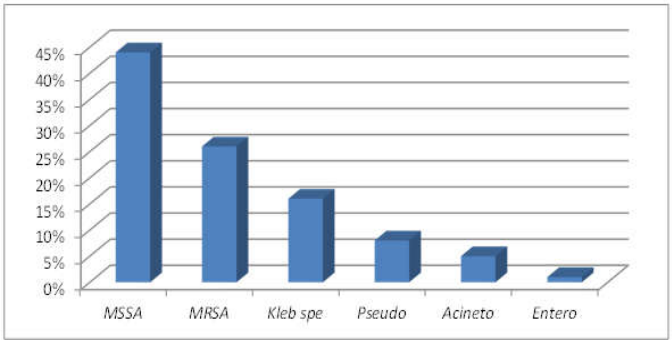

Figure 1. Hand imprint micro organisms from study population

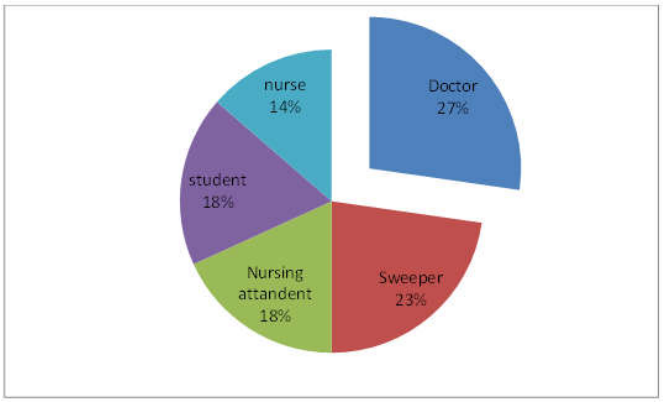

Figure 2. Distribution of MSSA from hand swab between study populations

Maximum number of MSSA was isolated from the hands of doctors (60%) followed by sweepers (50%), nursing attendants (40%), students (40%) and minimum number from hands of nurses (30%) as depicted in Figure II. From one study from Iran in hemodialyzed patients, nasal carriage of MRSA and MSSA were 6.56% and 13.11% respectively in studied staffs (Tashakori *et al.,* 2014). In our study MSSA (63%) is followed by *Syaphylococcus epidermidis* (18%), MRSA (10%) *klebsiella* species (6%), *Pseudomonas* species (3%) from the nasal swabs as shown in figure III, and maximum number of MSSA are isolated from the nose of nurse (80%) and minimum number from sweepers (40%).

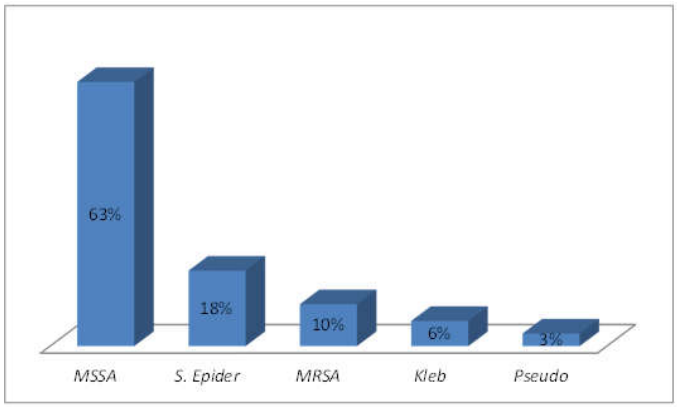

Figure 3. Showing nose flora distribution in study population

Pathogens isolated from the bins of the different departments were *Staphylococcus aureus, Acinetobacter, Klebsiella* species, *Enterobacter,* and *Pseudomonas* species which were again same as the pathogens isolated from the hand and nasal swabs of the study subjects working in the respective departments. As it is evident from our data that there is a definite link between the HCW's bacterial flora, HCAI and BMW. A study conducted at Department of Environmental Health, School of Public Health, Seoul National University, Seoul, Korea for detection and hazard assessment of pathogenic microorganisms in medical wastes showed a number of (opportunistic) pathogenic bacteria, including *Pseudomonas* spp., *Lactobacillus* spp., *Staphylococcus* spp, *Micrococcus* spp, *Kocuria* spp, *Brevibacillus* spp, *Microbacterium oxydans, and Propionibacterium acnes*, all capable of causing HCAI (Park *et al.,* 2009). A study conducted by School of Science and Technology, University of Northampton, Northampton NN2 6JD, UK suggests that when the waste is properly contained and managed, it should not pose a significant risk in terms of the spread of the four bacteria like MRSA, MSSA, *Clostridium difficile* and vancomycin-resistant *Enterococci* (VRE) (Tudor *et al.,* 2010). Thus, medical waste should be carefully controlled and monitored to prevent HCAI associated with the exposure to these wastes.

In the present study, there are defined methods for disposal of these wastes, starting from the personnel responsible for collection to transport of the wastes to the disposal site. Moreover, there are specific regulations or guidelines for segregation of wastes. On the basis of the present study, it is recommended that an existing seminars and training programme needs to be further strengthened. A massive drive should be launched by the hospital to generate awareness regarding serious environmental and health hazards of BMW. All measures should be adopted to inform the HCWs about legislation regarding BMW management. Workshops, seminars, exhibition etc. must be organized from time to time with representatives from various units related to BMW management. Information about the risks linked to health care waste can be displayed by poster exhibitions in hospitals, at strategic points such as waste bin locations, giving instructions on waste segregation. These posters should be explicit, using diagrams and illustrations to convey the message that could be understood by all HCWs as well as general public who make regular visits to health care establishment.

All the Government agencies and private health care facilities, local help groups and general public should work together to find a proper BMW management and handling procedures, which should be in accordance with the spirit of Bio-medical waste (Management & Handling) Rules, 1998. HAI cannot successfully be implemented without the willingness, devotion, self-motivation, cooperation and participation of all sections of employees of any health care establishment.

Conclusion

HCAIs can be linked to the improper waste management and bacterial flora of the HCWs. These issues need to be addressed through appropriate education and other interventional strategies by the infection control committee to reduce the infections in the patients. These changes might help to bring down the incidence of HCAI rate, thus reducing the morbidity and the mortality rate. In conclusion it may be inferred that due to improper BMW management practices, there is increased spread of HCAI and it is manifested as presence of similar potentially pathogenic organisms isolated from the hands and nasal cavity of HCWs as isolated from the bins kept in their respective working area. Further investigation of the isolates from nasal swabs, hands of healthcare workers and waste bins by molecular studies and genotyping is desirable, in order to establish the authenticity, identity and inter- relationship of the isolated organisms, and prove their roles in infection causation. Although our study was a short time period study. For better results a large population study should be carried out.

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