

Overview of Pathogens causing Nosocomial Infections in Various Wards of a Tertiary Health Care Hospital and their Antimicrobial Susceptibility Pattern - A Prospective Surveillance Study

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Abstract

The major problem encountered in recent days due to the advent of emerging antimicrobial resistance strains is Hospital Acquired Infections (HAIs). The spread of HAI is mainly through the hospital staff and the hospital settings' inanimate surfaces. The study includes the surveillance of hospital surfaces, including wards and ICUs, by taking swabs dipped in normal saline. *Pseudomonas aeruginosa* (53.8%) was found to be the most common pathogen isolated, followed by *Klebsiella* species (18%), Methicillin-Sensitive *Staphylococcus aureus* (16%), Coagulase-Negative Staphylococci (6%), Methicillin-Resistant *Staphylococcus aureus* (3%). The widespread presence of bacterial sensitivity to antimicrobials and the modifications insensitivity forms the basis for designing antibacterial therapy's practical recommendations and rational use of antimicrobials. Proper display of all Information, Education, and Communication (IEC) materials at appropriate places play a significant role in preventing nosocomial infections. Audiovisual aids and training to the staff play utmost importance in preventing the spread of HAIs. All these can reduce the occurrence and outbreak of nosocomial conditions. Overall, these minimize health care costs.

Keywords: Hospital Acquired Infections, *Pseudomonas aeruginosa*, Information, Education and Communication, *Klebsiella* species, antimicrobial resistance

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INTRODUCTION

Hospital Acquired Infections (HAIs) serves as one of the major threat in the medical field even after the beginning of much antimicrobial therapy and progress in supportive care management.¹ The hospital environment, objects/instruments, and health-care workers are likely to get populated by various microbial agents. Disease transmission leads to morbidity and mortality due to contact with things handled by infected and colonized patients and direct communication with such patients^{1,2} and also at least 90,000 of them die due to HAI.^{3,4} Healthcare-associated infections are the fifth major cause of death in critical-care hospitals. The proportion of HAI patients in developing countries is neither recorded nor appropriately reported due to various reasons like difficulty in collecting reliable data and improper follow-up of HAI surveillance system.⁵ A summary of evidence has estimated the frequency of HAIs to be 7.6% in high-income countries and 10.1% in middle-income countries.⁶

These HAIs produce mortality at high rates in neonates, especially in premature and low birth weight babies. Worldwide, out of the five million neonatal deaths, 4% to 56% of neonatal deaths are due to this hospital-acquired infections.⁷ Moreover, these HAI occur mainly in developing countries; there is the fact that about 98% of these neonatal deaths occur in developing nations. In high-income countries, the prevalence of HAI is about 7.6% which is less than 10.1% in middle-income countries.^{6,10} Multidrug-resistant pathogens are now emerging as a global threat, and neonates are most commonly affected by their low immune status. Most frequently, the contaminated hands of the health care workers and the hospital environmental surfaces serve as the primary source of infection for all these HAIs. Methicillin-Resistant *Staphylococcus aureus* (MRSA) strains continue to be the main threat to community and hospital-acquired diseases. These staphylococcus shows high resistance to the drug Vancomycin, one of the most common susceptible drugs for *Staphylococcus aureus*.⁸ In this study, about 17.5% were MRSA strains, and 5% of vancomycin-resistant strains were identified.⁸ Certain studies tell us the persistence of bacterial pathogens on the hospital floors and wards inanimate surfaces. These serve as the primary

source of transmission of nosocomial pathogens and remain a danger to susceptible patients or health care workers.⁹

The present study aims to detect the potential source of infection responsible for HAI in various wards, labor rooms, ICUs and identification of bacterial isolates along with their antibiotic resistance pattern.

MATERIALS AND METHODS

A prospective surveillance study of pathogens causing a potential infection source at various tertiary care hospital wards was conducted. The study period was about four months, from May 2019 to August 2019. A total of 150 samples were obtained from sterile swabs dipped in normal saline. The samples were taken from the floors, walls, air conditioning vent, door handles, medicine racks, oxygen cylinders, bed, and cots. After collection, the swabs were immediately transferred to the laboratory and inoculated into the brain heart infusion broth for 24 hours. After incubation, the samples were sub-cultured in Blood agar and MacConkey agar. Thereafter, incubated at 37°C for the next 24-hour period. All positive cultures were identified using biochemical tests such as indole, sugars, citrate, urease, and triple sugar iron medium. The disc diffusion method in Muller Hinton Agar (MHA) determined the antibiotic sensitivity profile of each identified organism, as per the Clinical and Laboratory Standards Institute (CLSI) 2019 guidelines. Resistance to Methicillin was detected on all *Staphylococcus aureus* isolates using Cefoxitin (30mcg).

RESULTS

Around 150 samples were collected from the medical, surgical, paediatric ICUs and wards, labor room, and post-operative ward. Among the samples, 43.3% (65) were positive for bacterial isolates. Table 1 identifies possible sources of infection within various wards. In this, 93.3% of bacteria isolated from surgical wards, 73.3% from paediatric wards, 66.7% from medicine wards, 30% from labor room, and 20% from medical, surgical, and paediatric ICUs. *Pseudomonas aeruginosa* was the predominant organism isolated in major wards and ICUs, followed by *Klebsiella* species, Methicillin-Sensitive *Staphylococcus aureus*

(MSSA), Coagulase-Negative *Staphylococci* (CONS), Methicillin-Resistant *Staphylococcus aureus* (MRSA). Apart from these, *Enterococcus* spp was also isolated rarely. Overall, the study revealed a predominant presence of strains of *Pseudomonas aeruginosa* from the medical, surgical, paediatric, work room and post-operative intensive care rooms from which the swabs were taken.

Among the 150 cultures done, 65 plates showed growth in the blood agar and MacConkey agar which was followed by biochemical tests as a further step to identify the pathogenic species. Among those 65 positive cultures, 53.8% (35) were isolated as *Pseudomonas aeruginosa*, 18% (12) isolates were identified as *Klebsiella pneumonia*, 16% (11) isolates were Methicillin-Sensitive *Staphylococcus aureus* (MSSA), 6% (4) were Coagulase-Negative *Staphylococcus* (CONS), 3% (2) were Methicillin-Resistant *Staphylococcus*

aureus (MRSA) and 1.6% (1) were identified as *Enterococcus* species.

The antibiotic sensitivity testing for all the isolates was done using the Kirby-Bauer disc diffusion method as per standards to identify the multidrug-resistant strains (MDR) and MRSA. The various drugs used for Gram negative bacilli were ampicillin, piperacillin-tazobactam, ceftazidime, cefepime, cefaperazone-sulbactam, amikacin, gentamicin, ciprofloxacin, imipenem, meropenem and cotrimoxazole. For Gram positive isolates, amoxicillin-clavulanic acid, vancomycin, linezolid, ceftoxitin, erythromycin, clindamycin and tetracyclines were used. The predominant isolate of this study was *Pseudomonas aeruginosa*. Among 65 positive cultures identified, 53.8% (35) were positive for *Pseudomonas*. It was identified by using various biochemical tests such as oxidase

Table 1. Positive Bacterial growth in different areas of the hospital

No.	Places where swabs taken	Number of swabs taken	Positive culture	Percentage (%)
1	Medicine ICU	20	4	20
2	Surgical ICU	25	5	20
3	Paediatric ICU (NICU&PICU)	20	4	20
4	Medicine Ward	15	10	66.7
5	Surgical ward	15	14	93.3
6	Paediatric ward	15	11	73.3
7	Labour room	20	6	30
8	Postop	20	11	55

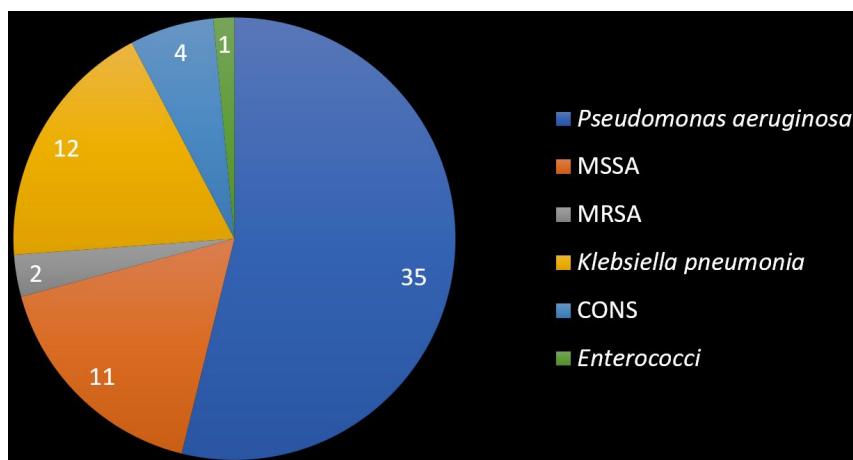


Fig 1. Pie diagram showing the number of isolates.

positive, citrate positive, TSI (K/K-), indole negative and also with the help of pigment production.

Among 35 isolates of *Pseudomonas aeruginosa* identified, 74% (26) were sensitive to piperacillin-tazobactam, ceftazidime, cefepime, cefaperazone-sulbactam, amikacin, gentamicin, ciprofloxacin, imipenem, meropenem and 26% (9) were identified as resistant to all the above drugs and sensitive only to higher group of drugs like colistin. All isolates of *Pseudomonas aeruginosa* identified were intrinsically resistant to Cotrimoxazole by disc diffusion method. Fig.

2 illustrates the sensitive strains and Multi drug resistant *Pseudomonas aeruginosa* strains.

Klebsiella pneumonia was the next predominate organism that was isolated. Among 65 (53.8%) positive cultures, 12 (18%) were identified as *Klebsiella pneumonia* by doing biochemical tests such as indole negative, citrate positive, Mannitol motility medium showing its fermentation of mannitol and also its non-motile behaviour. *Klebsiella pneumonia* was isolated from all wards except surgical ward.

Table 2. Distribution of Resistant strains and Methicillin Resistant *Staphylococcus aureus* (MRSA)

Name of the isolate	Ward /ICUS	Number of isolate	Sensitive strains	Resistant strains
<i>Pseudomonas aeruginosa</i>	Surgical ward	11	9	2
	Medical ward	4	3	1
	Labour room	4	3	1
	Paediatric ward	7	3	4
	Post op	4	3	1
	PICU/NICU	2	2	0
	SurgicalICU	2	2	0
	Medical ICU	1	1	0
<i>Klebsiella pneumonia</i>	Surgical ward	2	2	0
	Medical ward	3	2	1
	Labour room	2	1	1
	Paediatric ward	2	2	0
	Post op	1	1	0
	PICU/NICU	1	0	1
	Medical ICU	1	1	0
MRSAs	Postop	2	1	1

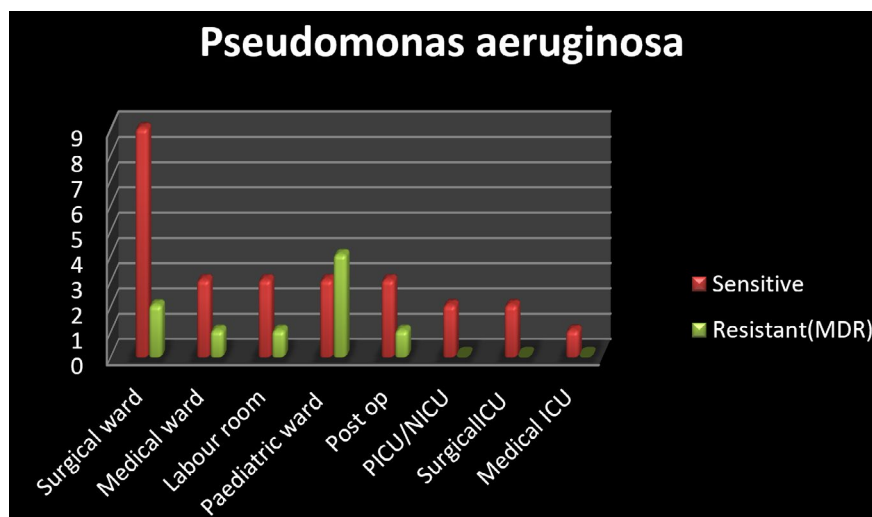


Fig 2. illustrates the sensitive strains and MDR *Pseudomonas aeruginosa* strains.

Among twelve isolates, nine of them were sensitive to drugs like amoxicillin-clavulanic acid, cefotaxime, ceftriaxone, ceftazidime, imipenem, amikacin, gentamicin and cotrimoxazole and three isolates were resistant to all the above drugs. *Klebsiella pneumoniae* is intrinsically resistant to ampicillin. Fig. 3 illustrates the sensitive strains and resistant strains of *Klebsiella pneumoniae*.

From sixty five positive cultures, seventeen (26%) were identified as Gram positive cocci in clusters and only one (1.5%) isolate was seen as Gram positive cocci in pairs. *Staphylococcus aureus* identified by doing positive catalase test, coagulase test and cefoxitin disc for identification of MSSA and MRSA. Only two isolates were found to be MRSA in postoperative wards. *Enterococcus* species was identified by positive bile esculin test and is sensitive to all drugs including high level gentamicin. Table 2 shows the distribution of Multi-drug resistant strains and Methicillin-Resistant *Staphylococcus aureus* (MRSA).

DISCUSSION

Infectious bacteria found in different parts of hospitals are often known to be the common cause of HAI. Infected patients, colonized with bacteria and healthcare providers are the main source of contamination. The main source of infection is coughing, sneezing, talking and uncontrolled movement within and outside

the hospital. A hospital monitoring study in Ghana found that 91% of swabs were positive for various micro-organisms such as coagulase-negative staphylococcus, *Bacillus* sp, *E.coli*, *Klebsiella* sp., and *Pseudomonas aeruginosa*.^{11,12} In another study by poline et al, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Enterococcus* species are responsible for nosocomial infections.

These organisms are constantly present in the hospital, whereas, in our study, 53.8% (35) were isolated as *Pseudomonas aeruginosa*, 18% (12) isolates were identified as *Klebsiella pneumoniae*, 16% (11) isolates were Methicillin-Sensitive *Staphylococcus aureus* (MSSA), 6% (4) were Coagulase-Negative Staphylococcus (CONS), 3% (2) were Methicillin-Resistant *Staphylococcus aureus* (MRSA) and 1.6% (1) were identified as *Enterococcus* species.

Pseudomonas aeruginosa was the predominant microorganism causing HAIs. Certain studies show that 34% of *Pseudomonas aeruginosa* were multidrug-resistant, and 22% were sensitive strains compared to our research, which shows 26% were MDR *pseudomonas* and 74% were sensitive strains.¹² *Staphylococcus aureus* was identified as the predominant cause of HAIs. It spreads through the hands of health care personnel. Different studies from South Africa and Switzerland have reported the appearance

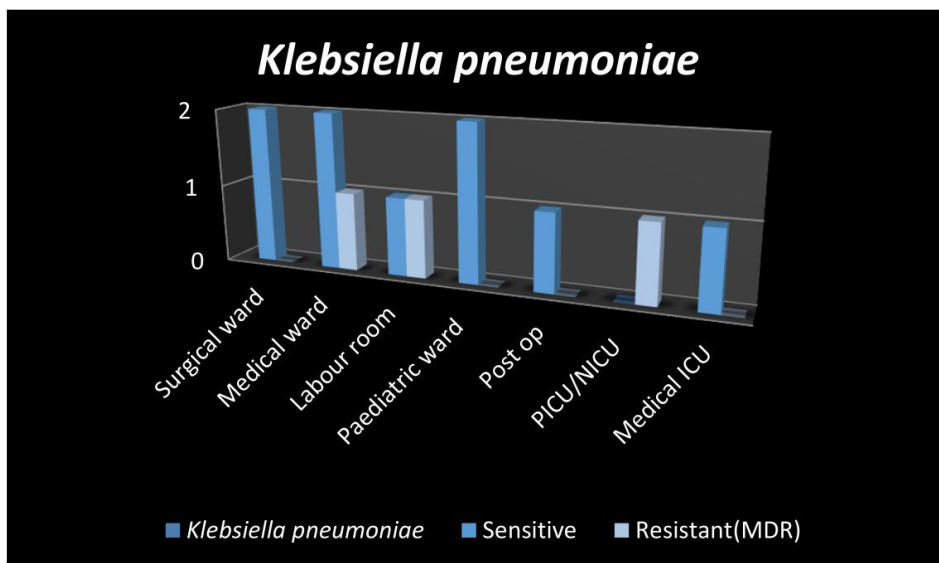


Fig 3. The sensitive strains and resistant strains of *Klebsiella pneumoniae*.

of resistance to antibacterial agents by *Klebsiella* and *Enterobacter* strains has caused Healthcare-associated infections related to the gram-negative bacteria.^{13,14} In our study, 12 (18%) were identified as *Klebsiella pneumoniae* causing the nosocomial attacks. Among twelve isolates, nine were sensitive to drugs like amoxicillin-clavulanic acid, cefotaxime, ceftriaxone, ceftazidime, imipenem, amikacin, gentamicin, and cotrimoxazole and three isolates were resistant to all the drugs.

In the study done by Marisa et al., 25% of isolates in the labor room were *Staphylococcus aureus*. In our study, 16% (11) isolates were Methicillin-Sensitive *Staphylococcus aureus* (MSSA), 6% (4) were Coagulase-Negative *Staphylococcus* (CONS), 3% (2) were Methicillin-Resistant *Staphylococcus aureus* (MRSA), and 1.6% (1) was identified as *Enterococcus* species¹⁵. A study done in 1992 by Omori et al. showed the presence of MRSA in environmental samples collected by wiping of floors.¹⁶ A further study in China found that 60% of MRSA isolates came from environmental samples, while in our study only 3% were identified as MRSA.

CONCLUSION

The prevention and control measures of all nosocomial infections are based on minimizing microorganisms' transmission among the health care personnel and the patients. Also, the prevalence of bacterial sensitivity to antimicrobials forms the basis for designing antibacterial therapy's practical recommendations and for more rational use of antimicrobials. Many measures are taken to control and prevent HAIs, such as hand hygiene technique, wearing personal protective equipment, proper donning and doffing of PPE kits used, aseptic non-touch techniques especially in neonatal and paediatric ICUs, and maintaining good respiratory hygiene. Any act of carelessness in the hospital premises like improper maintenance of the wards, poor hand hygiene can lead to nosocomial outbreaks. Proper display of all Information, Education, and Communication (IEC) materials at appropriate places play a significant role in preventing nosocomial infections. Audiovisual aids and training to the staff play utmost importance in preventing the spread of Hospital Acquired

Infections. These all can reduce the occurrence and outbreak of nosocomial infection and reduce the health care cost.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTION

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

FUNDING

None.

DATA AVAILABILITY

All datasets generated or analyzed during this study are included in the manuscript

ETHICS STATEMENT

Not applicable.

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