ORIGINAL ARTICLE

Antimicrobial Resistance Profile in ICUs of Tertiary Care Hospital—A Worrisome State of Affairs

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ABSTRACT

Background and objectives: Nosocomial infections/Hospital-acquired infections (HAI) constitute an important problem worldwide accounting for high morbidity and mortality as well as longer hospital cost and stay. An intensive care unit (ICU) is often the epicenter of infection, due to its extremely vulnerable population. Consequently, ICUs have highest occurrence rates of nosocomial infections causing an enormous impact on health and often survival. This study was therefore aimed to know the prevalence and antibiotic susceptibility profile of various organisms causing HAI in ICUs of a Tertiary Care Hospital and Medical College.

Materials and methods: A total of 847 consecutive samples mostly respiratory secretions, blood, and urine were collected from patients admitted in 6 ICUs of a tertiary care hospital and medical college from January 2017 to December 2017 and processed as per Clinical and Laboratory Standards Institute (CLSI) guidelines in the Microbiology department. Final identification and antimicrobial susceptibility testing of isolates were done by the automated Vitek 2 system.

Results: Among the 847 samples processed 513 (60.5%) were positive for growth. Gram-negative organisms 366/513 (71.34%) were more commonly isolated than 147/513 (28.65%) Gram-positive organisms. Multidrug-resistant (MDR), *Klebsiellapneumoniae*, *Acinetobacterbaumannii* complex and *Pseudomonasaeruginosa* along with Extended-spectrum beta-lactamases (ESBL) producing *Escherichia coli* among Gram-negative organisms and *methicillin-resistant Staphylococcus aureus* (MRSA) and *Vancomycin-resistant Enterococci* (VRE) among Gram-positive were the most conspicuous findings.

Conclusion: Our results showed higher resistance among all microorganisms in the ICUs compared to the rest of the hospital, the fact that highlights that ICUs should act as a critical point in the control of nosocomial infections.

Keywords: Intensive care units (ICUs), Nosocomial infections, Multi drug resistance organisms (MDROs).

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INTRODUCTION

An ICU is often called the epicenter of infection due to its extremely vulnerable population having reduced host defenses deregulating the immune responses and increased risk of acquiring infections due to multiple procedures and/use of invasive devices namely (intubation, mechanical ventilation, vascular access, etc.) that distort the anatomical integrity and protective barriers of the patient. Consequently, the ICU population has one of the highest rates of nosocomial infections (20 to 30% of all admissions leading to enormous impact on morbidity, hospital cost and often survival).[1]

The ICU has also been described as a factor for creating, disseminating and amplifying antimicrobial resistance. Several factors influence the rapid spread of MDR pathogens in the ICU namely new mutations, selections of resistant strains and suboptimal infection control. Intensive care units (ICUs) remain the potential source of drug-resistant nosocomial infections even in countries where extensive infection control measures are routinely implemented.

Unabated antimicrobial resistance can initiate the end of modern medicine if the current trends continue so much so that sophisticated interventions, such as organ transplantation, joint replacements, cancer chemotherapy and care of preterm infants will become more difficult or even too dangerous to undertake.

Currently, *Methicillin-resistant Staphylococcus aureus* and *Vancomycin-resistant Enterococci* among Gram-positive organisms and MDROs. *Klebsiellapneumoniae*, *Acinetobacterbaumannii* complex, *Pseudomonas aeruginosa*, Extended spectrum beta-lactamase production in Escherichia coli, *Enterobacter spp.* and *Citrobacter spp.* among the gram-negative organisms are most worrisome pathogens.[2]

Antibiotic use should be optimized in ICUs as the antibiotic resistance is on a steep rise and due to lack of newer antimicrobial in the pipeline.[3-5] Studies have shown that 30 to 60% of antibiotics that are prescribed

in critical care settings are unnecessary, inappropriate or suboptimal.[6-8]

Antimicrobial resistance (AMR) is an important tool to identify the rate of AMR and also to provide necessary antibiogram data so that local treatment strategy can be planned.[9]

This study was therefore aimed to know the prevalence and antibiotic susceptibility profile of various organisms causing HAI in ICU's of a tertiary care hospital and Medical College.

MATERIALS AND METHODS

A total of 847 consecutive samples mostly respiratory secretions, blood and urine were collected from patients admitted in 6 ICU's of a tertiary care hospital and medical college in Amritsar, India from January 2017 to December 2017 and processed as per CLSI guidelines in the Microbiology department after receiving the Ethical Clearance from Sri Guru Ram Das University of Health Sciences respective Ethical Committee.

All samples other than blood were processed using both conventional techniques and the automated Vitek 2 system as per CLSI guidelines. Blood, however, was inoculated into blood culture bottles after aseptic collection as per World Health Organization (WHO) guidelines. The blood culture bottles were then incubated in an automated BacT/alert 3D microbial identification system as recommended by the manufacturer for 7 days before discarding it as negative.

During the 7 days incubation, whenever the system indicated a positive result, 3 to 5 drops of blood culture fluid was drawn using a sterile syringe for inoculation onto 5% sheep blood agar and/or chocolate agar and Mac Conkey agar which were then incubated aerobically for 24 hours at 37° C.

Colony characters of all pure cultures obtained were observed before by identification by gram staining and biochemical reactions. Final identification and antimicrobial susceptibility testing were done by the automated Vitek 2 system as per manufacturer's guidelines.

For this, a sterile swab or applicator stick was used to transfer 3 to 5 similar looking colonies of overnight culture into 1 mL of sterile saline which was vortexed thoroughly to make a uniform suspension. The turbidity of which was matched by Densi check having McFarland 0.50 to 0.63 for Gram-positive and gram-negative bacteria.

Following Vitek cards ID 21341 card for gram-negative bacteria, AST N280 and N235 card for Gram-negative bacteria, ID 21342 card for gram-positive bacteria, AST P628 card for gram-positive Bacteria were used.

RESULTS

During the study period, 847 samples were processed out of which 513 were positive (60.5% culture positivity). Gram-negative bacteria 366/513 (71.34%) were encountered far more often than Gram-positive organisms 147/513 (28.65%) as shown in Table 1.

Among the gram-negative isolates *Klebsiella pneumoniae* 146/366 (40%), *Escherichia coli* 97/366 (26.6%), *Acinetobacter baumannii* complex 49/366 (13.33%), *Pseudomonas aeruginosa* 22/366 (6.25%) were obtained in the descending order of prevalence. Remaining 50/366 (13.82%) constituted miscellaneous gram-negative bacteria other than mentioned earlier as shown in Table 2.

On the contrary, Gram-positive cocci constituted only 147/513 (28.65%) and comprised mainly of Coagulase negative *Staphylococcus aureus* (CoNS) 113/147 (76.87%), *Staphylococcus aureus* 28/147 (18.61%) *Enterococcus faecium* 7/147 (4.57%) as shown in Table 3.

Klebsiella pneumoniae subspecies pneumoniae were multidrug resistant (ESBL and Carbapenemase producers) showing 89.28%, 83.8% and 79.86% sensitivity to *colistin, polymyxin B and tigecycline* respectively.

Similarly, *Acinetobacterbaumanii* complex showed multidrug resistance being sensitive only to colistin (91.68%) and tigecycline (88.25%) in the majority of the cases.

Table 1: Distribution of Gram-positive and Gram-negative isolates in the ICU

Total samples processed	847
Total positive samples	513 (60.5%)
Gram-negative isolates	
366 (71.34%)	
Gram-positive isolates	
147 (28.65%)	

Table 2: Prevalence of Gram-negative isolates in the ICUs

Isolates	Percentage
Total Gram-negative isolates	366/513 (71.34%)
Klebsiella pneumoniae	146/366 (40%)
E.coli	97/366 (26.6%)
Acinetobacterbaumannii complex	49/366 (13.33%)
Pseudomonas aeruginosa	22/366 (6.25%)
Others	50/366 (13.82%

Table 3: Prevalence of Gram-positive isolates in the ICUs

Isolates	Percentage
Total Gram-positive isolates	147/513 (28.65%)
CONS	113/147 (76.87%)
Staphylococcus aureus	28/147 (18.61%)
Enterococcus faecium	7/147 (4.57%)

While *E. coli* showed sensitivity to following antibiotics in the decreasing order: Fosfomycin (98%), tigecycline (92.8%), colistin (91.26%), imipenem (81.25%) cefoperazone-sulbactam (78.2%), ertapenem (78.23%), gentamicin (76.82%) meropenem (71.89%)

Similarly, sensitivity pattern of *Staphylococcus aureus* in decreasing order was tigecycline (96.86%), vancomycin (92.86%), linezolid (88.69%), teicoplanin (83.78%), daptomycin (82.97%), clindamycin (72.65%), and erythromycin (70.24%), whereas the more resistant E. faecium showed sensitivity in decreasing order to vancomycin (91.68%), tigecycline (91.26%), teicoplanin (88.62%), linezolid (84.62%), and rifampicin (73.48%). *Staphylococcus aureus* (CoNS) isolated from a single blood culture was ignored as a probable contaminant.

DISCUSSION

Intensive care units (ICUs) are one of the critical hospital environments where resistant bacteria are found extensively, transmission of which can be reduced by basic infection control techniques three patients in ICUs have nosocomial infection rates that are 5 to 10 times greater than those in the general wards.[1] Nosocomial lower respiratory tract infection is the most common in the ICU patients followed by bloodstream infections and urinary tract infections.[4] The species profile of isolated gram-negative bacteria in our study differed in several ways from other European and USA surveys.[10-14] Contrary to these studies, *Klebsiella pneumoniae* was the most frequently isolated Gram-negative microorganisms (146/366) 40% followed by *E. coli* (97/366) 26.6% *Acinetobacterbaumannii* complex (22/366) 13.33% and *Psuedomonas aeruginosa* (22/366) 6.25%. Among Gram-positive bacteria, the most commonly isolated were CONS (113/147) 76.87% followed by *Staphylococcus aureus* (28/147) 18.61% and *Enterococcus faecium* (7/147) 4.57%.

Also in our study, multi-resistant pathogens were more prevalent than the European and USA ICU surveys. We found very high resistant rates to antibiotics, commonly used to treat nosocomial infections. The reason for this might be that ours is a tertiary care hospital and patients had already consumed broad-spectrum antibiotics before getting admitted to our ICUs. However, resistance to polymyxin B, colistin, tigecycline, vancomycin, and Linezolid was the lowest among our isolates.

Increasing antimicrobial resistance to all antibiotics can be countered by effective hospital infection control measures and having good antibiotic stewardship.

CONCLUSION

A multi-pronged approach including early and accurate microbiological diagnosis, narrowing and de-escalation of antibiotics based on culture reports and antibiotic stewardship along with strict implementation and compliance of Infection control practices can go a long way in preventing the emergence of MDR nosocomial pathogens.

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