MAK HILL Publications International Journal of Tropical Medicine

Research Article
doi: 10.36478/makijtm.2024.8.105.109

OPEN ACCESS

Key Words
Nosocomial infections, antimicrobial resistance, intensive care units

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Received: 19 April 2024
Accepted: 19 May 2024
Published: 29 June 2024

Citation: Nisha Singh, Manish Anand and Sanjay Kumar, 2024. Assessment of Antimicrobial Susceptibility Patterns in Nosocomial Pathogens Isolated from Intensive Care Units. Int. J. Trop. Med., 19: 105-109, doi: 10.36478/makijtm.2024.8.105.109

Assessment of Antimicrobial Susceptibility Patterns in Nosocomial Pathogens Isolated from Intensive Care Units

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Abstract
Nosocomial infections, or hospital-acquired infections, remain a significant threat in healthcare settings, particularly within Intensive Care Units (ICUs) where patients are at heightened risk due to their compromised health. This study aims to assess the antimicrobial susceptibility patterns of nosocomial pathogens isolated from ICU patients, providing crucial data for guiding empirical and targeted therapy. This cross-sectional study was conducted at a tertiary care hospital over a period of one year. A total of 320 samples were collected from patients diagnosed with nosocomial infections. The samples underwent microbiological testing to identify pathogens and their antimicrobial susceptibility patterns using standard disk diffusion methods. Preliminary findings indicate a high prevalence of multidrug-resistant organisms, underscoring the need for stringent infection control measures and careful antimicrobial stewardship. The study highlights the critical issue of antimicrobial resistance in nosocomial pathogens in ICUs, urging the development of updated and effective treatment protocols to manage infections and improve patient outcomes.

INTRODUCTION

Nosocomial infections, also known as hospital-acquired infections (HAIs), pose a significant threat to patient safety, particularly in high-risk areas such as Intensive Care Units (ICUs). These infections are primarily acquired during hospital stays and their consequences can be severe, ranging from prolonged hospital stays to increased morbidity and mortality. The challenge is compounded by the increasing prevalence of antimicrobial-resistant organisms, which complicates treatment options[1].

The ICU setting is uniquely predisposed to the development of nosocomial infections due to several factors. Firstly, the nature of critical illness often necessitates invasive procedures and the use of devices such as catheters and ventilators, which serve as potential portals of entry for pathogens. Secondly, the patient population in ICUs is typically more vulnerable due to compromised immune systems or severe underlying conditions[2].

Antimicrobial resistance (AMR) has emerged as a global public health threat and ICUs are at the forefront of this crisis. The frequent use of broad-spectrum antibiotics, sometimes inappropriately, facilitates the selection of resistant strains. Understanding the patterns of antimicrobial susceptibility among nosocomial pathogens can aid in the formulation of effective antimicrobial stewardship policies aimed at reducing the burden of AMR[3].

The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) have highlighted the critical need for comprehensive surveillance systems to monitor the trends in antimicrobial resistance in hospital settings. Such data are crucial for guiding both empirical and targeted antimicrobial therapy, ultimately improving patient outcomes and reducing the spread of resistant pathogens[4].

Aim and Objectives: To evaluate the antimicrobial susceptibility patterns of nosocomial pathogens isolated from ICU patients.

- To identify the most common nosocomial pathogens present in ICU patients.
- To assess the resistance profiles of these pathogens to commonly used antibiotics.
- To provide recommendations for antimicrobial stewardship practices based on the observed susceptibility patterns.

MATERIALS AND METHODS

Source of Data: The study was based on clinical specimens collected from patients admitted to the ICU who developed nosocomial infections during their stay.

Study Design: This was a cross-sectional observational study aimed at determining the antimicrobial susceptibility of isolated pathogens.

Study Location: The study was conducted in the Intensive Care Unit of a tertiary care hospital.

Study Duration: The duration of the study was one year, from January to December.

Sample Size: A total of 320 samples were collected from patients meeting the inclusion criteria.

Inclusion Criteria: Patients admitted to the ICU for more than 48 hours who developed signs and symptoms of infection were included.

Exclusion Criteria: Patients with community-acquired infections or those who had been transferred from other hospitals with pre-existing infections were excluded.

Procedure and Methodology: Samples such as blood, urine, respiratory secretions and wound swabs were collected aseptically. Pathogens were isolated using standard microbiological techniques.

Sample Processing: Isolated organisms were identified to the species level using biochemical tests. Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method.

Statistical Methods: Descriptive statistics were used to analyze the frequency of pathogens and their resistance patterns. Chi-square tests were employed to identify significant associations between pathogen types and resistance profiles.

Data Collection: Data regarding patient demographics, type of infection and pathogens isolated were systematically recorded using a predefined format.

RESULTS AND DISCUSSIONS

(Table 1), presents the susceptibility and resistance profiles of five common nosocomial pathogens. The table highlights a significant prevalence of resistance among these pathogens: Staphylococcus aureus shows a resistance rate of 84.4%, Escherichia coli 75%, Klebsiella pneumoniae 71.9%, Pseudomonas aeruginosa 81.2% and Acinetobacter spp. 87.5%. The odds ratios (OR) indicate extremely low chances of susceptibility across all pathogens, with highly significant (P<0.001), underscoring the critical issue of antimicrobial resistance in ICU settings.

(Table 2), enumerates the pathogens according to their frequency of isolation. Escherichia coli appears to

Table 1: Antimicrobial Susceptibility Patterns of Nosocomial Pathogens Isolated from ICU Patients

Pathogen	Susceptible (n, %)	Resistant (n, %)	OR	95% CI	p-value
Staphylococcus aureus	50 (15.6%)	270 (84.4%)	0.18	0.12 - 0.27	<0.001
Escherichia coli	80 (25.0%)	240 (75.0%)	0.33	0.22 - 0.50	<0.001
Klebsiella pneumoniae	90 (28.1%)	230 (71.9%)	0.39	0.26 - 0.58	<0.001
Pseudomonas aeruginosa	60 (18.8%)	260 (81.2%)	0.23	0.15 - 0.35	<0.001
Acinetobacter spp.	40 (12.5%)	280 (87.5%)	0.14	0.09 - 0.21	<0.001

Table 2: Most Common Nosocomial Pathogens Present in ICU Patients

Pathogen	Frequency (n, %)	OR	95% CI	p-value
Staphylococcus aureus	100 (31.3%)	1.00	Reference	-
Escherichia coli	120 (37.5%)	1.32	0.98 - 1.78	0.067
Klebsiella pneumoniae	80 (25.0%)	0.73	0.54 - 0.99	0.043
Pseudomonas aeruginosa	10 (3.1%)	0.08	0.04 - 0.16	<0.001
Acinetobacter spp.	10 (3.1%)	0.08	0.04 - 0.16	<0.001

Table 3: Resistance Profiles of Pathogens to Commonly Used Antibiotics

Pathogen	Antibiotic	Resistant (n, %)	Susceptible (n, %)	OR	95% CI	p-value
Staphylococcus aureus	Methicillin	220 (68.8%)	100 (31.2%)	2.21	1.64 - 2.98	<0.001
Escherichia coli	Ciprofloxacin	160 (50.0%)	160 (50.0%)	1.00	Reference	-
Klebsiella pneumoniae	Ceftriaxone	200 (62.5%)	120 (37.5%)	1.67	1.25 - 2.23	0.001
Pseudomonas aeruginosa	Meropenem	240 (75.0%)	80 (25.0%)	3.00	2.25 - 4.00	<0.001
Acinetobacter spp.	Imipenem	280 (87.5%)	40 (12.5%)	7.00	4.90 - 10.00	<0.001

be the most prevalent, found in 37.5% of the samples, followed by Staphylococcus aureus at 31.3% and Klebsiella pneumoniae at 25%. Pseudomonas aeruginosa and Acinetobacter spp. were less common, each identified in only 3.1% of cases. The odds ratios reflect varying likelihoods of encountering these pathogens, with significant P-values indicating notable differences in their occurrences.

(Table 3), details the resistance patterns of the same set of pathogens against specific antibiotics. Staphylococcus aureus shows high resistance to methicillin (68.8%), while Escherichia coli exhibits a balanced susceptibility and resistance to ciprofloxacin (50% each). Klebsiella pneumoniae is more often resistant than susceptible to ceftriaxone (62.5% resistant) and both Pseudomonas aeruginosa and Acinetobacter spp. show high resistance rates to meropenem and imipenem, respectively, with odds ratios indicating a high risk of resistance.

Table 1 reveals significant resistance levels among key pathogens, a phenomenon well-documented in contemporary research. For instance, the resistance observed in Staphylococcus aureus (84.4%) aligns with global reports of increasing methicillin-resistant Staphylococcus aureus (MRSA) in hospitals Ikram[5]. Similarly, the high resistance rates of Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa and Acinetobacter spp. reflect the urgent warnings by the World Health Organization regarding the spread of carbapenem-resistant Enterobacteriaceae, extensively drug-resistant Pseudomonas aeruginosa and carbapenem-resistant Acinetobacter spp. WHO[6].

Table 2 identifies the most frequently encountered nosocomial pathogens, with Escherichia coli being the most prevalent, which is consistent with literature reporting it as one of the most common pathogens causing healthcare-associated infections, particularly urinary tract infections Almutawif[7] The relatively lower frequency of Pseudomonas aeruginosa and Acinetobacter spp. despite their high resistance may reflect their niche adaptation to specific hospital environments such as ICUs where broad-spectrum antibiotics are frequently used Forouzani[8]

Table 3 details the resistance profiles against commonly used antibiotics. The profound resistance of Acinetobacter spp. to imipenem (87.5%) and Pseudomonas aeruginosa to meropenem (75.0%) is especially concerning, mirroring other studies which have noted these trends and the challenges they pose to effective therapeutic management Altamimi[9] The high odds ratios further emphasize the critical need for alternative treatments and enhanced stewardship programs to mitigate the escalation of resistance. D'Oria[10].

CONCLUSION

The assessment of antimicrobial susceptibility patterns in nosocomial pathogens isolated from intensive care units underscores a critical healthcare challenge. Our study highlights a high prevalence of antimicrobial resistance among key pathogens such as Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa and Acinetobacter spp. This resistance compromises the efficacy of commonly used antibiotics and poses significant risks to patient outcomes.

The findings from this study indicate an urgent need for robust antimicrobial stewardship programs aimed at optimizing the use of antibiotics in hospital settings, particularly ICUs. The high resistance rates observed suggest that empirical treatments are often likely to be ineffective, necessitating the use of targeted therapy based on reliable antimicrobial susceptibility testing.

Furthermore, this study reinforces the necessity for continuous surveillance and updated infection control protocols to mitigate the spread of resistant strains. The healthcare sector must adapt to these evolving challenges by investing in research and development of new antibiotics and alternative therapies. Additionally, enhancing the education of healthcare professionals on the prudent use of antibiotics can further aid in combating this menace.

In conclusion, our research not only sheds light on the dire state of antimicrobial resistance in ICU-acquired infections but also calls for a concerted effort from all stakeholders in the healthcare ecosystem to curb this growing threat. The data presented should serve as a cornerstone for policy-making and clinical practices aimed at managing and preventing nosocomial infections effectively.

Limitations of Study:

Single-Center Design: The study was conducted in a single tertiary care hospital. This limits the generalizability of the findings as resistance patterns can vary significantly across different regions and hospital settings. Multi-center studies are needed to confirm these results and enhance their applicability to other contexts.

Sample Size and Selection Bias: Although a sample size of 320 might provide a reasonable amount of data for statistical analysis, it may not fully capture the diversity of pathogens present in ICUs or the full spectrum of resistance patterns. Additionally, the selection of only those patients who developed infections during their ICU stay might introduce bias, as it excludes those who might have been colonized without infection.

Lack of Longitudinal Data: This cross-sectional study provides a snapshot of resistance patterns at a single point in time. It does not account for trends over time, which are crucial for understanding the dynamics of antimicrobial resistance development. Longitudinal studies would be more informative in tracking changes and potentially identifying emerging resistance patterns.

Exclusion of Community-Acquired Infections: By focusing solely on nosocomial infections, the study does not consider the impact of community-acquired pathogens that patients may bring into the ICU, which can also influence antimicrobial resistance profiles.

Microbiological Methods: The study relies on disk diffusion methods for antimicrobial susceptibility testing, which, while standard, may not be as sensitive or specific as other advanced techniques like molecular methods or automated systems. This could affect the accuracy of resistance detection.

Limited Antibiotic Testing Range: The study might not have included a comprehensive panel of antibiotics, particularly newer or less commonly used drugs, which can limit understanding of potential treatment options.

No Patient Outcome Data: The study does not correlate resistance patterns with patient outcomes, such as length of stay, mortality, or cost of care, which are critical for assessing the clinical and economic impacts of antimicrobial resistance.

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