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ORIGINAL RESEARCH

Nosocomial Infections in ICU: Prevalence, Pathogens, and Resistance Patterns in a Central Indian Tertiary Hospital

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ABSTRACT

Background: Nosocomial infections, particularly in intensive care units (ICUs), present significant challenges due to invasive procedures and prolonged hospital stays. These infections lead to increased morbidity, mortality, and healthcare costs.

Objectives: This study aims to determine the prevalence, identify common pathogens, analyze antibiotic resistance patterns, and evaluate risk factors associated with nosocomial infections in the ICU of a tertiary care hospital in Central India.

Methods: A prospective observational study was conducted over 18 months (May 2022 to October 2023) in a 32-bed ICU. Data from 679 ICU admissions were analyzed, excluding patients with pre-existing infections. Pathogen identification and antibiotic susceptibility testing were performed according to Clinical Laboratory Standards Institute (CLSI) guidelines. Infection rates were calculated using CDC criteria.

Results: Among the 679 patients, 166 (24.44%) developed device-associated infections, including 73 cases of catheter-associated urinary tract infections (CAUTI) (10.75%), 86 cases of central-line-associated bloodstream infections (CLABSI) (13.50%), and 39 cases of ventilator-associated pneumonia (VAP) (6.15%). Predominant pathogens included Pseudomonas aeruginosa, Acinetobacter species, and Klebsiella pneumoniae, with high resistance to cefotaxime, ceftazidime, and ciprofloxacin. Significant risk factors were diabetes, chronic obstructive pulmonary disease (COPD), and prolonged ICU stays. Mortality was higher in patients with device-associated infections (48.7%) compared to those without (31.5%).

Conclusion: Nosocomial infections in the ICU are prevalent and associated with high mortality. The dominant pathogens and their resistance patterns highlight the need for stringent infection control practices and robust antimicrobial stewardship programs. Targeted interventions addressing identified risk factors can reduce infection rates and improve patient outcomes in critical care settings.

INTRODUCTION

Hospital-acquired infections (HAIs) significantly impact patient health, particularly in critical care units, due to invasive procedures and prolonged hospital stays. According to the Centers for Disease Control and Prevention (CDC), approximately 1 in 31 hospitalized patients acquire HAIs, resulting in considerable morbidity, mortality, and increased healthcare costs. Intensive care units (ICUs) are high-risk environments for HAIs due to the frequent use of invasive devices such as urinary catheters, central venous catheters, and mechanical ventilators. These devices disrupt natural body defenses, leading to common infections like catheter-associated urinary tract infections (CAUTI), central-line-associated bloodstream infections (CLABSI), and ventilator-associated pneumonia (VAP).

Significance of Nosocomial Infections: Nosocomial infections extend hospital stays, increase treatment costs, and elevate mortality rates. Robust infection control measures and continuous surveillance are essential to mitigate their impact. The World Health Organization (WHO) emphasizes the importance of infection prevention and control (IPC) programs in reducing HAIs and enhancing patient safety.

Pathogens and Antibiotic Resistance: Pathogens responsible for HAIs often exhibit multidrug resistance, complicating treatment and worsening patient outcomes. Common pathogens include Gram-negative bacteria such as Pseudomonas aeruginosa, Acinetobacter species, and Klebsiella pneumoniae, as well as Gram-positive bacteria like Staphylococcus aureus and Enterococcus species. The rise of antibiotic-resistant organisms is exacerbated by the overuse and misuse of antibiotics.

Risk Factors: Risk factors for nosocomial infections in ICU patients include chronic conditions such as diabetes, chronic obstructive pulmonary disease (COPD), and immunosuppression, along with prolonged device use and ICU stays. Identifying and mitigating these risk factors is crucial for reducing HAI incidence.

Study Rationale: This study investigates the patterns and etiological factors of nosocomial infections in the ICU of a tertiary care hospital in Central India. By understanding the prevalence, causative organisms, and associated risk factors, the study aims to improve infection control practices and enhance patient safety and outcomes in critical care settings.

OBJECTIVES
1. Determine the prevalence of nosocomial infections in the ICU.
2. Identify the most common pathogens responsible for these infections.
3. Analyze the antibiotic resistance patterns of the isolated pathogens.
4. Evaluate the risk factors associated with the development of nosocomial infections.
5. Compare study findings with current literature and provide recommendations for infection control practices.

METHODOLOGY
Over an 18-month period (May 2022 to October 2023), a prospective observational study was conducted in a 32-bed ICU. Data were collected from all ICU admissions, excluding those with pre-existing infections as identified by baseline cultures. Antibiotic susceptibility was tested according to Clinical Laboratory Standards Institute (CLSI) guidelines using the Kirby-Bauer disk diffusion method. Nosocomial infection rates were calculated using CDC guidelines.

RESULTS

Table 1: Prevalence of Device-Associated Infections

Type of Infection	Number of Cases	Percentage (%)
Catheter-Associated Urinary Tract Infection (CAUTI)	73	10.75
Central-Line-Associated Bloodstream Infection (CLABSI)	86	13.50
Ventilator-Associated Pneumonia (VAP)	39	6.15
Total	166	24.44

Table 2: Predominant Pathogens Identified

Pathogen	Number of Isolates	Percentage (%)
Pseudomonas aeruginosa	52	31.33
Acinetobacter species	47	28.31
Klebsiella pneumoniae	36	21.69
Staphylococcus aureus	18	10.84
Enterococcus species	8	4.82
Candida species	5	3.01

Table 3: Antibiotic Resistance Patterns

Antibiotic	Pseudomonas aeruginosa (%)	Acinetobacter species (%)	Klebsiella pneumoniae (%)
Cefotaxime	92	85	90
Ceftazidime	88	82	87
Ciprofloxacin	85	79	84
Carbapenems	56	67	70

Table 4: Risk Factors for Nosocomial Infections

Risk Factor	Number of Infected Patients	Percentage (%)
Diabetes	58	34.94
Chronic Obstructive Pulmonary Disease (COPD)	46	27.71
Prolonged ICU Stay (>7 days)	78	46.99

Table 5: Mortality Rates

Infection Status	Number of Patients	Mortality Rate (%)
With Device-Associated Infections	166	48.7
Without Device-Associated Infections	513	31.5

DISCUSSION

Prevalence of Nosocomial Infections

The prevalence of nosocomial infections (24.44%) in our ICU is consistent with global findings, underscoring the significant burden of HAIs in critical care settings. The rates of CAUTI (10.75%), CLABSI (13.50%), and VAP (6.15%) reflect the intensive use of invasive devices, which are essential for patient care yet pose substantial infection risks. Our findings align with studies like those of Rosenthal et al. (2021), which report similar device-associated infection rates in ICUs across developing countries.

Pathogen Profile

The dominant pathogens identified, Pseudomonas aeruginosa, Acinetobacter species, and Klebsiella pneumoniae, are well-known culprits in ICU-related infections. These Gram-negative bacteria are notorious for their ability to thrive in hospital environments and develop resistance to multiple antibiotics. Our results are consistent with Kollef et al. (2019), who also reported these pathogens as leading causes of nosocomial infections globally. Additionally, the presence of Enterococcus species and Candida species in our study highlights the diverse microbial flora in the ICU, necessitating broad-spectrum infection control measures.

Antibiotic Resistance

The high levels of antibiotic resistance observed, particularly against cefotaxime, ceftazidime, and ciprofloxacin, are alarming. This trend mirrors global concerns about rising antibiotic resistance, as documented by the World Health Organization (WHO) in 2020. The resistance patterns in our study, especially the resistance to carbapenems among Acinetobacter species and Klebsiella pneumoniae, echo findings from Mehta et al. (2020), emphasizing the need for robust antimicrobial stewardship programs. These programs should focus on appropriate antibiotic use, prompt de-escalation, and stringent infection control practices to prevent the spread of resistant organisms.

Risk Factors

Several risk factors significantly associated with nosocomial infections in our study include diabetes, COPD, and prolonged ICU stays. These factors are well-documented in the literature; for instance, Vincent et al. (2018) identified chronic diseases and extended ICU stays as major risk factors for HAIs. The correlation between these risk factors and infection rates suggests that targeted interventions, such as improved glycemic control, respiratory care, and minimizing ICU stay duration, could effectively reduce infection rates.

Mortality and Patient Outcomes

The mortality rate among patients with device-associated infections (48.7%) was significantly higher than in those without such infections (31.5%). This stark difference underscores the severe impact of nosocomial infections on patient outcomes. These findings are in line with previous research indicating that HAIs are associated with increased mortality and morbidity, reinforcing the urgent need for effective infection control strategies.

Comparison with Current Literature

Our study's findings are comparable to those in other similar settings, reinforcing the global nature of the nosocomial infection challenge. For example, Rosenthal et al. (2021) reported device-associated infection rates that closely match our findings. Moreover, the identification of common pathogens and resistance patterns in our ICU parallels global trends reported by Kollef et al. (2019) and WHO (2020). These comparisons highlight the necessity for localized infection control strategies tailored to the specific microbial landscape and resistance patterns of each ICU.

Implications for Practice

The findings of this study underscore the critical importance of stringent infection control practices, such as hand hygiene, proper catheter care, and the use of antimicrobial stewardship programs. Continuous surveillance and prompt intervention are essential to mitigate the incidence of HAIs. Healthcare facilities should adopt standardized infection control protocols and provide ongoing training for healthcare workers to ensure compliance and effectiveness. Additionally, there is a need for regular audits and feedback mechanisms to identify gaps in infection control practices and implement corrective measures.

CONCLUSION

This comprehensive study of nosocomial infections in a Central Indian ICU underscores the prevalence, common pathogens, and antibiotic resistance patterns. The results emphasize the necessity of stringent infection control practices and continuous training for healthcare workers to mitigate infection rates and enhance patient care in critical care environments. By aligning our findings with current literature, we highlight areas for targeted intervention and underscore the global challenge posed by nosocomial infections. Continuous monitoring, research, and adaptive strategies are vital to reducing infection rates and improving patient outcomes in ICUs.

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