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Original Research Article

Study of catheter related infections in patients admitted in ICU of a tertiary care centre

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ABSTRACT

Background: Catheter-related infections (CRIs) are a significant cause of morbidity and mortality in critically ill patients, particularly in intensive care units (ICUs). This study aimed to assess the incidence, microbiological profile, associated complications, and outcomes of CRIs in patients admitted to the ICU of a tertiary care hospital.
Methods: A facility-based longitudinal study was conducted in the ICU of a tertiary care center on patients >12 years old requiring indwelling catheters for >48 hours. Clinical, laboratory, and microbiological data were collected, with blood cultures analyzed using the BacT/ALERT 3D system. Statistical analysis was performed using SPSS v23.0, with $p<0.05$ considered significant.
Results: The mean age of 3.6±9.2 years (range: 21–80 years). The incidence of CRI was 28%, with an infection rate of 24.65 per 1000 catheter-days. The most commonly isolated pathogen was *Staphylococcus aureus* (32.14%), followed by *Klebsiella pneumoniae* (25%), *Enterococcus* (17.86%), *Escherichia coli* (14.29%), and *Pseudomonas aeruginosa* (10.71%). *K. pneumoniae* was significantly associated with Foley's catheter ($p<0.05$). The most common complications included sepsis (17.86%), urinary tract infections (17.86%), and acute pyelonephritis (7.14%). The mortality rate was 14.29%, with renal failure (14.29%), multiple organ dysfunction syndrome (10.71%), and septic shock (7.14%) as major contributors. However, 35.71% of patients had favorable outcomes.
Conclusions: The findings underscore the need for strict aseptic techniques, routine catheter care, early catheter removal, and robust antimicrobial stewardship programs. Preventive measures, including infection control protocols and surveillance systems, can significantly reduce CRI incidence and improve patient outcomes.

Keywords: Bloodstream infections, Catheter-related infections, ICU, *Staphylococcus aureus*, Urinary tract infections

INTRODUCTION

Healthcare-associated infections (HAIs) are among the most common adverse events in hospitalized patients, leading to prolonged hospital stays, increased antimicrobial resistance, financial burden, and higher mortality. "Device-associated HAIs (DA-HAIs)", including catheter-associated infections such as "central-line associated bloodstream infections (CLABSI), catheter-related bloodstream infections (CRBSI), and catheter-associated urinary tract infections (CAUTI)", are particularly prevalent in intensive care units (ICUs).[1-3]

Globally, HAI incidence ranges from 3.6% to 19.1%, with a higher burden in low- and middle-income countries (LMICs). In India, reported HAI rates vary widely, with CRBSI incidence ranging from 0.2% to 28% and infection rates of 0.5-47 per 1,000 catheter days.[4,5] A multicentric study in India identified ventilator-associated pneumonia (VAP) as the most common ICU-acquired infection (58.5%), followed by CRBSI (21.2%), with CRBSI showing the highest mortality (34.6%).[6] The predominant pathogens include *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Escherichia coli*, and *Pseudomonas*

aeruginosa, many of which exhibit significant antibiotic resistance.[7]

Despite the substantial burden of catheter-associated infections, data on their incidence and risk factors remain limited, especially in developing regions. This study aimed to assess the prevalence, microbiological profile, and risk factors of catheter-associated infections among ICU patients in a tertiary care hospital, contributing to improved infection control and patient outcomes.

METHODS

This facility-based longitudinal follow-up study was conducted in the ICU of a tertiary care hospital from December 2021 to June 2024, involving patients requiring catheterization. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants. For illiterate patients, verbal consent was recorded in the presence of a witness after reading out the consent form. Participants were informed about their right to withdraw from the study at any time without consequences.

Patients admitted to the ICU who required catheterization and fulfilled the inclusion and exclusion criteria were enrolled. The inclusion criteria consisted of patients of both sexes aged above 12 years, admitted for more than 48 hours, and requiring an indwelling catheter such as a central line, peripheral line, or urinary catheter. Only those willing to participate voluntarily were included. Patients were excluded if they had fever or other signs of catheter-related infections (CRIs) within 48 hours of admission, had signs of infection but no catheter in situ, had fever on the day of admission, or had VAP. Additionally, obstetric patients, those with a history of surgery, pediatric patients under 12 years in PICU or NICU, and those unwilling to participate were excluded.

All eligible patients were evaluated clinically using a pre-structured and pre-tested proforma. Data collection included demographic details such as age, sex, ICU ward details, date of admission, primary diagnosis, and associated medical conditions. A thorough physical examination was conducted, and laboratory investigations were performed, including complete blood count (CBC) with hemoglobin (Hb%), total leukocyte count (TLC), differential leukocyte count (DLC), platelet count, and hematocrit. Other tests included liver function tests (LFT), blood urea, serum creatinine, and blood glucose levels. Blood counts were monitored periodically as required. Additional investigations such as electrocardiography (ECG), chest X-ray, and ultrasonography (USG) of the abdomen were performed based on clinical indications. The primary outcome measures included the type of catheter-related bloodstream infection (CRBSI), complications associated with CRBSI, prolongation of ICU or hospital stay, morbidity, and mortality.

Patients with an indwelling central catheter exhibiting signs of local phlebitis, inflammation, or pus formation at the insertion site, along with systemic symptoms such as fever, chills, hypotension, and leukocytosis, were suspected of having CRBSI. In such cases, swab samples from the catheter insertion site were sent for microbiological analysis. If CRBSI was suspected, the central venous catheter (CVC) was removed, and its tip, along with paired blood samples (peripheral and central), was sent for culture analysis. Blood cultures were processed using the BacT/ALERT 3D Automated Blood Culture System (BioMérieux). Subcultures were performed on blood agar and CLED agar, incubated at 37°C overnight, and examined the following day. Microbial isolates were identified using standard microbiological techniques, and antimicrobial susceptibility testing was performed using the Kirby-Bauer disc diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines.

Statistical analysis

Data was assessed using SPSS V23.0 software. Quantitative variables were expressed in mean and SD and compared using the Z test. Qualitative variables were shown in frequency and percentage while the Chi-square test was used to compare qualitative variables. $P<0.05$ was considered as statistically significant.

RESULTS

The study included patients admitted to the ICU requiring catheterization, with a mean age of 3.6±9.2 years, ranging from 21 to 80 years. The majority of participants were male (51%), while females comprised 49% of the study population. The baseline characteristics of the study subjects are presented in Table 1.

The most common reason for ICU admission was urosepsis (31%), followed by chronic kidney disease (CKD) (30%), DCLD+UTI+hepatic encephalopathy (12%), CKD+IHD+HTN+DM (5%), ADHF+DCLD (4%), urosepsis with pneumonitis (4%), and DCLD+UTI (4%). The most frequently reported presenting complaint was burning micturition (53%), followed by fever (52%), tiredness/weakness (48%), abdominal pain (48%), and purulence, erythema, and induration at the catheter insertion site (47%). Other less common complaints included abdominal distension (22%), facial puffiness (21%), giddiness (16%), cough/cold, and unconsciousness (5% each).

The mean duration of catheterization was 11.4±2.7 days, with a total catheter duration of 1135 catheter days across all patients. Among the study population, 44% had catheterization for 5-10 days, while 56% had catheterization for 11-15 days (Table 2).

Table 1: Baseline characteristics of the study subjects.

Variables	Subcate-gories	Frequency (n)	Percentage (%)
Age (years)	≤40	8	8
	41-50	28	28
	51-60	45	45
	61-70	16	16
	71-80	3	3
Sex	Female	49	49
	Male	51	51
BMI[a]	Normal	16	16
	Overweight	32	32
	Obese	52	52
Comorbidities	DM[b]	18	18
	HTN[c]	32	32
	None	50	50

a: Body mass index, b: diabetes mellitus, c: hypertension

Table 2: Duration of catheter use.

Duration of catheter use (days)	Frequency (n)	Percentage (%)
5-10	44	44
11-15	56	56
Mean±SD	11.4±2.7	
Total days	1135	

The incidence of CRIs was 28%, with an infection rate of 24.65 per 1000 catheter-days. The most commonly isolated pathogen was *S. aureus* (32.14%), followed by *K. pneumoniae* (25%), *Enterococcus* (17.86%), *E. coli* (14.29%), and *P. aeruginosa* (10.71%) (Table 3). A statistically significant association was observed between *K. pneumoniae* and Foley's catheter ($p<0.05$), while other pathogens were not significantly associated with specific catheter types ($p>0.05$).

Table 3: Catheter related infection.

Catheter related infection	Pathogen	Frequency (n)	Percentage (%)
Present	*S. Aureus*	9	32.14
	K. pneumoniae	7	25
	Enterococcus	5	17.86
	E. coli	4	14.29
	P. aeruginosa	3	10.71
Total		28	100

The most frequently observed complication in patients with CRBSI was sepsis (17.86%), followed by urinary tract infection (UTI) (17.86%), acute pyelonephritis (7.14%), cystitis (7.14%), metabolic acidosis (7.14%), and electrolyte imbalance (7.14%). Regarding patient outcomes, renal failure (14.29%) and death (14.29%) were the most common, followed by multiple organ dysfunction syndrome (MODS) (10.71%), heart failure (7.14%), end-stage renal disease (ESRD) (7.14%), septic shock (7.14%), and coma (3.57%).

DISCUSSION

CRIs are a major concern in critically ill patients, contributing significantly to morbidity, prolonged hospital stays, and increased healthcare costs. The study aimed to assess the prevalence, microbiological profile, and risk factors of catheter-associated infections among ICU patients in a tertiary care hospital, contributing to improved infection control and patient outcomes.

In our study, the incidence of CRI was 28%, with an infection rate of 24.65 per 1000 catheter days, which aligns with previous studies that have reported rates ranging from 20-30 per 1000 catheter-days in ICU settings.[3,8,9] This highlights the substantial burden of catheter-associated infections in hospitalized patients and emphasizes the need for stringent infection control practices.

The mean duration of catheterization was 11.4±2.7 days, with the majority of patients having catheterization for more than 10 days. Prolonged catheterization is a well-documented risk factor for catheter-associated infections. Studies have shown that the risk of CRIs increases significantly after 5–10 days, reinforcing the importance of timely catheter removal when clinically feasible.[3,10]

The microbiological profile of CRIs in our study revealed that Staphylococcus aureus was the most frequently isolated pathogen (32.14%), followed by *Klebsiella pneumoniae* (25%), *Enterococcus* (17.86%), *Escherichia coli* (14.29%), and *Pseudomonas aeruginosa* (10.71%). These findings are in concordance with previous studies, where S. aureus was reported as the leading cause of CRIs, particularly in CRBSIs.[9,11-13] The high prevalence of K. pneumoniae, particularly in association with Foley's catheter ($p<0.05$), underscores its role in catheter-associated urinary tract infections (CAUTIs), a trend observed in earlier studies on nosocomial infections. The presence of multidrug-resistant organisms in CRIs further complicates treatment and highlights the importance of antimicrobial stewardship programs in ICU settings.

The complications associated with CRIs in our study included sepsis (17.86%), urinary tract infections (17.86%), acute pyelonephritis (7.14%), cystitis (7.14%), metabolic acidosis (7.14%), and electrolyte imbalance (7.14%). These complications can significantly impact patient outcomes, leading to increased morbidity and prolonged ICU stays. Notably, renal failure (14.29%) and death (14.29%) were the most common outcomes in CRI patients, followed by multiple organ dysfunction syndrome (MODS) (10.71%), heart failure (7.14%), end-stage renal disease (7.14%), septic shock (7.14%), and coma (3.57%). These findings emphasize the severe consequences of CRIs, particularly in critically ill patients with multiple comorbidities.

Despite the high incidence of CRIs, 35.71% of cases had favorable outcomes, suggesting that early detection, appropriate antibiotic therapy, and supportive management can improve prognosis. Several infection prevention strategies have been identified as effective in reducing the incidence of catheter-associated infections, including strict aseptic insertion techniques, routine catheter care, hand hygiene protocols, early removal of unnecessary catheters, and the use of antimicrobial-coated catheters. Implementing infection surveillance programs and adhering to catheter care bundles have been shown to significantly reduce CRI rates.

One of the strengths of this study is its longitudinal design, which allowed for a detailed follow-up of ICU patients over a prolonged period. Additionally, the microbiological analysis of CRIs provides valuable insight into pathogen prevalence and antibiotic resistance patterns, which can guide targeted infection control measures. However, the study has some limitations. Being a single-center study, the findings may not be generalizable to all ICU settings. Additionally, the study did not evaluate the impact of specific infection control interventions or antibiotic resistance patterns in detail, which could be explored in future research.

CONCLUSION

In conclusion, CRIs remain a significant challenge in ICU patients, leading to severe complications, prolonged hospital stays, and increased mortality. The high prevalence of *S. aureus* and *K. pneumoniae* in our study highlights the need for enhanced infection prevention strategies, including strict aseptic precautions, early catheter removal, and robust antimicrobial stewardship programs. Future research should focus on multicenter studies and the efficacy of catheter care bundles in reducing infection rates. Implementing evidence-based infection control measures can play a crucial role in minimizing the burden of CRIs and improving patient outcomes in ICU settings.

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