Section: Anaesthesiology

Original Research Article

A PROSPECTIVE OBSERVATIONAL STUDY ON INCIDENCE AND ASSOCIATED FACTORS OF CATHETER-RELATED BLOODSTREAM INFECTIONS IN ICU AND SURGICAL PATIENTS

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ABSTRACT

Background: Central venous catheter (CVC) is a medical device used to access a patient's blood stream for various purposes. Catheter Related Blood Stream Infections (CRBSI) pose a significant risk to critically ill patients. Our study was aimed at an integrated evaluation of CRBSI incidence, microbiological profile, and potential factors associated specifically comparing post-surgical and ICU patients within the same cohort in a tertiary care setting**.** It also focuses on determining the factors associated with the development of infections through CVCs. **Materials and Methods:** Ethics committee approval was obtained (Approval number: KMCT/RP 2022/IEC/35). Clinical trial registry number: NIL. A prospective observational study was conducted on 130 patients over 24 months in a tertiary health care institute who underwent central venous catheterisation in surgical and intensive care settings. Blood samples from central and peripheral lines, along with catheter tip cultures, were analysed. Statistical analysis was performed using appropriate tests, and a P value <0.05 was considered significant. **Results:** Overall CRBSI incidence was 5.38% (7/130). Patients with catheter dwell time exceeding 14 days had the highest observed CRBSI incidence (35.7%). Although CRBSI incidence was numerically higher among ICU patients (9.30%) than surgical patients (3.45%), this difference was not statistically significant (Fisher's exact test, P = 0.23). Clinical signs suggestive of infection were significantly more frequent among ICU patients (30.2% vs 8.0%; $\chi^2 = 10.88$, P = 0.001), although these findings were nonspecific and should not be interpreted as evidence of increased catheter-related bloodstream infection. **Conclusion:** Confirmed CRBSI incidence was 5.38%. Prolonged catheter dwell time (>14 days) was associated with the highest observed CRBSI incidence. Confirmed CRBSI did not differ significantly between ICU and surgical patients. Although nonspecific clinical signs of infection were more frequent in ICU patients, these should not be interpreted as evidence of increased catheter-related bloodstream infection. Prolonged catheterisation was associated with increased CRBSI risk, while the presence of multiple invasive devices was frequently observed among infected patients.

INTRODUCTION

Central venous catheters are the most important component of medical practice nowadays. It is inserted in large veins in the form of venous access (e.g., Subclavian vein, Internal jugular vein, femoral vein). It is used to administer medicines and fluids, for prolonged intravenous therapies, parenteral nutrition, and hemodialysis. In addition, it is used for the monitoring of the hemodynamic status of critically ill patients and those undergoing surgery. CVCs are associated with several complications,

including catheter-related bloodstream infection and catheter-associated thrombosis.[1,3] There are many risk factors associated with infections related to central venous catheters, including breach in aseptic precautions during insertion, prolonged duration of catheterization, operator inexperience, use of parenteral nutrition, and site of catheter insertion, all of which have been well described in previous studies.[1,3,7,8] The presence of additional indwelling devices was associated with a higher occurrence of infection in our cohort. Many microorganisms like bacteria and fungi are the cause of CRBSI.[3]

Preventive measures include strict aseptic precautions during insertion, execution by a skilled person, reducing puncturing attempts, reducing the duration of catheter stay, and proper maintenance of lines. This study focuses on Central lines inserted during elective surgeries and in ICUs in our hospital to identify infectious outcomes and associated factors at a tertiary healthcare institute. The present study aimed to evaluate the incidence of catheter-related bloodstream infections, identify the microbial profile, and determine associated risk factors. Although catheter-related bloodstream infections have been widely studied, there is limited prospective data from our region evaluating their incidence, microbiological profile, and associated clinical factors within a single cohort. Additionally, comparative data between ICU and post-surgical patients in the same setting are sparse. This study was therefore undertaken to address these gaps and provide context-specific insights into CRBSI in our institution.

MATERIALS AND METHODS

A prospective observational study was conducted among consecutive patients with the following

Inclusion Criteria

- Patients aged ≥18 years
- Patients undergoing central venous catheterization for surgical indications or admitted to the intensive care unit
- Patients in whom the catheter was inserted under aseptic precautions in our institution.
- Patients who provided informed consent (or consent from legally authorized representatives) who had central venous catheters inserted during surgery and patients admitted in intensive care units at a tertiary healthcare institute.

Exclusion Criteria

- Patients with pre-existing bloodstream infection at the time of catheter insertion
- Patients in whom catheter tip or blood culture samples could not be obtained
- Patients with incomplete clinical or microbiological data.

Under strict aseptic precautions, central venous catheters were inserted using the Seldinger technique under ultrasound guidance. The placement and maintenance were performed utilizing large sterile drapes, sterile gowns, gloves, and surgical antiseptics. CRBSI was defined according to the diagnostic criteria outlined in the 2009 IDSA1 guideline for intravascular catheter-related infection, requiring isolation of the same organism from peripheral blood and catheter cultures (or other accepted microbiological evidence of catheter-related infection) in the absence of another identifiable source of bloodstream infection and Bloodstream Infection (BSI) was defined as the presence of a recognized pathogen isolated from one or more blood cultures in a patient with clinical signs of infection (fever, chills, or hypotension). The site of insertion, indication (post-surgical or ICU), and duration of catheter stay were noted. Patients were monitored for signs of infection, including fever, erythema, swelling, and discharge at the insertion site. The presence of concurrent devices (endotracheal tube, epidural catheter, Ryle's tube, Foley's catheter, pacemaker) was also documented. Blood investigations (CBC, RBS, Serum Electrolytes, RFT, C-reactive protein) were sent at insertion, 48 hours post-insertion, and upon removal. Blood Culture and Catheter Tip Processing: Blood samples were collected aseptically from both peripheral veins and central venous catheters at the time of suspected infection. Samples were processed using standard microbiological techniques. Blood cultures were incubated using automated culture systems/manual methods as per institutional protocol. Positive cultures were identified based on colony morphology, Gram staining, and standard biochemical tests. Antimicrobial susceptibility testing was performed using standard guidelines (e.g., CLSI) The distal 4 cm of the catheter tip was cultured using the semiquantitative roll-plate method, and growth of ≥15 colony-forming units (CFU) was considered significant. Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 20.0 software. Figures were generated from the dataset using descriptive statistics. The study was primarily powered to estimate CRBSI incidence; analyses of associated risk factors were exploratory in nature. The sample size was calculated for estimating the proportion of catheter-related bloodstream infections (CRBSI). Based on previous literature reporting central line-associated bloodstream infection (CLABSI) or catheter-related infection rates in the range of approximately 5%–7%, the expected proportion (p) was conservatively estimated at 0.05 for sample-size planning purposes. The expected infection proportion (5%) was selected as a pragmatic estimate based on published observational studies,[3,4,5] reporting catheter-associated bloodstream infection rates in hospitalized patients. Because reported rates vary according to the surveillance definition used (e.g., CLABSI versus microbiologically confirmed CRBSI), the value was used solely for sample-size planning purposes and not for direct comparison with the primary study outcome. Using the formula: $n = Z^2 \times p \times (1 - p) / d^2$

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where Z = 1.96 for a 95% confidence interval and precision (d) was set at 4% (0.04), the calculated sample size was 114. To account for possible dropouts and incomplete data, the sample size was rounded up to 130 patients. Quantitative variables were expressed as mean ± standard deviation, and qualitative variables as frequencies and percentages. Comparisons of categorical variables were performed using the Pearson chi-square test when its assumptions were satisfied; Fisher's exact test was used when expected cell counts were small. Continuous variables were compared using the independent t-test. A two-tailed P value <0.05 was considered statistically significant.

RESULTS

A total of 130 patients were enrolled with a mean age of 70.2 ± 12.7 years (range: 40–94 years). Although patients aged ≥18 years were eligible, no eligible participants younger than 40 years underwent central venous catheterization during the study period. Males constituted 52.3% of the study population and females 47.7%. The most common comorbidities were hypertension (48.5%), coronary artery disease (47.6%), and diabetes mellitus (46.2%). Other comorbidities included cerebrovascular accident (21.5%), bronchial asthma/COPD (19.2%), chronic kidney disease (16.9%), and chronic liver disease (10%) (Table 1). CVCs were inserted for surgical indications in 66.9% of patients and 33.1% in ICU patients. In the surgical group, signs of infection were present in 8.0% of patients (7/87), whereas in the ICU group, signs of infection were present in 30.2% of patients (13/43). This difference was statistically significant (χ^2 = 10.88, df = 1, P = 0.001), with an absolute difference of 22.2% (95% confidence interval: 7.4%–37.0%) (Table 2). Confirmed CRBSI was identified in 7 patients (5.38%). The observed incidence was numerically higher among ICU patients (9.30%; 4/43) compared to surgical patients (3.45%; 3/87). However, this difference was not statistically significant on Fisher's exact test (two-tailed). The most common insertion site was the right subclavian vein (78.5%), followed by the right internal jugular vein (21.5%). Catheter dwell time was <7 days in 61.5%, 7-14 days in 27.7%, and >14 days in 10.8% of patients (Fig:1). Out of 130 patients, 7 fulfilled the predefined IDSA criteria for catheter-related bloodstream infection (CRBSI), giving an overall incidence of 5.38% (95% CI: 2.2%–10.8%) (Table 4) (Fig. 2). Among ICU patients, the incidence was 9.30% (4/43; 95% CI: 2.6%–22.1%), whereas among surgical patients the incidence was 3.45% (3/87; 95% CI: 0.7%–9.7%) (Fig. 3). The observed CRBSI incidence was numerically higher among ICU patients compared with surgical patients; however, this difference was not statistically significant on Fisher's exact test (two-tailed) (Table 3).

Among patients with catheter duration <7 days, the infection rate was 1.25% (1/80; 95% CI: 0.03%–6.8%). For catheter duration between 7–14 days, the infection rate was 2.78% (1/36; 95% CI: 0.07%–14.5%). Among patients with catheter duration >14 days, 5 out of 14 patients developed CRBSI, corresponding to an incidence of 35.7% (95% CI: 12.8%–64.9%). Among the 7 confirmed CRBSI cases, 4 patients had central venous catheters inserted for ICU indications and 3 for surgical indications (Table 4). Among these infected patients, 4 were female and 3 were male. The 7 CRBSI cases were distributed across different age groups, with no meaningful pattern observed due to the small number of events. The likelihood of CRBSI increased with increasing catheter duration. A high proportion of patients with CRBSI had concurrent indwelling devices; however, due to the small number of events and limited variability, no statistically robust association could be established. [Table 5]

Table 1: Comorbidities

	Yes n(%)	No n(%)
DM	60(46.2)	70(53.8)
HTN	63(48.5)	67(51.5)
CAD	62(47.6)	68(52.3)
BA/COPD	25(19.2)	105(80.8)
CVA	28(21.5)	102(78.5)
CKD	22(16.9)	108(83.1)
CLD	13(10)	117(90)
OTHERS	14(10.8)	116(89.2)

Majority of the study subjects had Hypertension (48.5), Coronary Artery Disease (47.6) and Diabetes Mellitus (46.2) respectively.

Table 2: Relationship Between Indication and Signs of Infection Among Study Population

	Present n (%)	Absent n (%)	Chi square Value	P value
Surgical	7(8)	80(92)	10.88	0.001
ICU	13(30.2)	30(69.8)		

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Table 3: Comparison of Confirmed CRBSI Incidence Between Surgical and ICU Patients

Group	CRBSI Positive n (%)	CRBSI Negative n (%)	Statistical Test	P value
Surgical	3 (3.45)	84 (96.55)	Fisher's Exact Test	0.23
ICU	4 (9.30)	39 (90.70)		

Table 4: Distribution of Patients Meeting IDSA Criteria for Catheter-Related Bloodstream Infection (CRBSI)

	n	%
Positive	7	5.4
Negative	123	94.6

Table 5: Distribution of presence of other devices among study population

	Present n (%)	Absent n (%)
Endotracheal Tube	88 (67.7)	42 (32.3)
Epidural Catheter	46 (35.4)	84 (64.6)
Ryles Tube	58 (44.6)	72 (55.4)
Urinary Foleys Catheter	127 (97.7)	3 (2.3)
Others	8 (6.2)	122 (93.8)

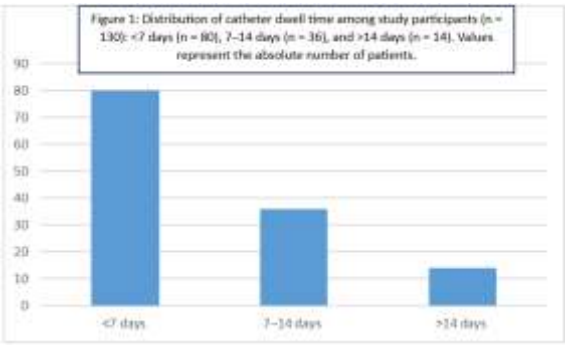

Figure 1: Distribution of catheter dwell time among study participants (n = 130): <7 days (n = 80), 7–14 days (n = 36), and >14 days (n = 14). Values represent the absolute number of patients

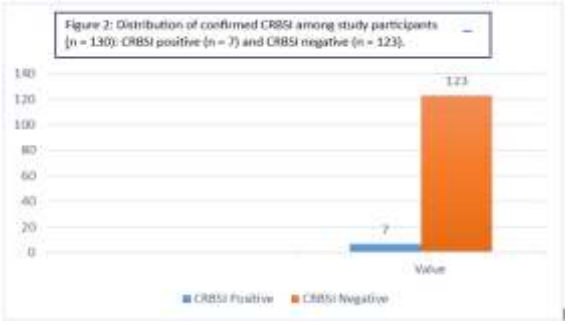

Figure 2: Distribution of confirmed CRBSI among study participants (n = 130): CRBSI positive (n = 7) and CRBSI negative (n = 123).

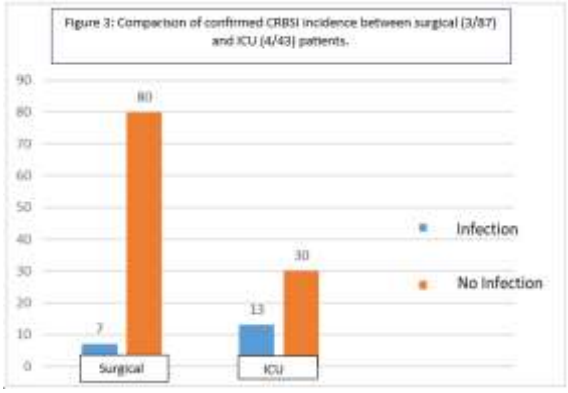

Figure 3: Comparison of confirmed CRBSI incidence between surgical (3/87) and ICU (4/43) patients

DISCUSSION

Central line-related bloodstream infections are a major cause of mortality in critically ill patients. A total of 130 patients with central venous catheters for surgical and ICU indications were included, revealing an overall CRBSI incidence of 5.38% (7 out of 130 patients). The wide global range in reported incidence rates of CRBSI spans from 2.75% to 60%, influenced by patient populations, health care settings, and infection control practices. Our observed CRBSI incidence of 5.38% was numerically similar to the 5.3% CLABSI rate reported by He et al. However, this comparison should be interpreted cautiously because CLABSI is a surveillance definition, whereas CRBSI requires stricter clinical and microbiological confirmation. Therefore, the two measures are not directly equivalent and should not be directly compared. Shrivastava et al. reported a confirmed CRBSI rate of 6%, while Maqbool et al. observed an overall incidence of 6.95% .[5,8] The seven CRBSI cases were distributed across older age groups; however, no statistically robust association between age and CRBSI could be established. The predominance of older patients in our cohort likely reflects the greater burden of comorbid illnesses, increased need for major surgical procedures, and higher frequency of critical illness requiring central venous catheterisation in this age group. Similar age distributions have been reported in previous studies evaluating catheter-related bloodstream infections. Females (n=4) were slightly more affected than males (n=3). Many patients had comorbid conditions such as diabetes, hypertension and cardiovascular disease, which may increase susceptibility to infection. Duration of Catheterization and Concurrent Devices Infection rates escalated dramatically with longer catheterization periods. Catheters placed for <7 days (n=80) had a 1.25% infection rate, and 7-14 days (n=36) had a 2.78% rate. However, for catheters staying >14 days (n=14), 5 were infected, representing a 35.7% infection rate. This highlights a critical need for vigilant monitoring beyond the 14-day mark, supported by Pitiriga et al,[6] who proved

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that CRBSI rates increase with duration. A high proportion of patients with CRBSI had concurrent indwelling devices such as endotracheal tubes and Foley catheters. This observation should be interpreted cautiously, as the presence of multiple invasive devices may reflect greater severity of illness and increased exposure to invasive procedures rather than an independent causal relationship with CRBSI. Given the limited number of infection events in our cohort, an independent association between concurrent devices and CRBSI could not be established. Although the observed CRBSI incidence was numerically higher in ICU patients (9.30%) compared to surgical patients (3.45%), this difference was not statistically significant in our cohort due to the small number of events. Therefore, the observed difference between ICU and surgical patients should be interpreted as a descriptive trend only and should not be considered evidence of a statistically significant difference in CRBSI incidence. The confidence intervals around the incidence estimates were wide and overlapping, reflecting the small number of CRBSI events in this cohort. Therefore, subgroup comparisons and observed trends should be interpreted cautiously and considered exploratory rather than confirmatory. Nevertheless, the descriptive trend is comparable to incidences reported in ICU-focused studies such as that by Maqbool et al.

It is important to distinguish the observed clinical signs of infection from microbiologically confirmed CRBSI. Although clinical signs suggestive of infection were significantly more frequent among ICU patients in our study, these findings were nonspecific and may reflect a variety of infectious and non-infectious conditions commonly encountered in critically ill patients, including pneumonia, urinary tract infection, surgical site infection, systemic inflammatory response, or other concurrent illnesses. Therefore, the higher frequency of clinical signs in ICU patients should not be interpreted as evidence of an increased incidence of catheter-related bloodstream infection. In contrast, microbiologically confirmed CRBSI did not differ significantly between ICU and surgical patients in our cohort. Regarding insertion sites, 80% were subclavian and 20% internal jugular vein (IJV). Of the 7 infected, 4 were subclavian (57.1%) and 3 were IJV (42.8%), yielding no statistically significant difference between sites. Lorente et al,[7] reported lower infection rates with the subclavian route, possibly due to reduced local bacterial colonization and less contamination compared to other sites. In contrast, Shrivastava et al. and Ruesch et al,[8,9] favored the internal jugular route, which may reflect differences in patient population, operator expertise, and institutional practices. Additionally, the subclavian route, while associated with lower infection rates, carries a higher risk of mechanical complications such as pneumothorax, which may influence site selection. Femoral venous catheters, which are associated with a higher risk of infection, were not included in this study.[2] Regarding catheter site dressing, all patients in this study were managed using a uniform institutional protocol. However, individual variations in adherence or dressing changes were not evaluated, which may have influenced outcomes.

Microbiological Profile Seven microorganisms alongside mixed bacterial growths were isolated from cultures. Staphylococcus aureus (28.6%) and Pseudomonas aeruginosa (28.6%) were the primary pathogens, while the remaining 42.8% were attributed to multidrug-resistant (MDR) Klebsiella, Candida spp., and Chryseobacterium indologenes. This diverse profile echoes existing literature. Pitiriga et al identified high rates of MDR Klebsiella pneumoniae, while He et al predominantly found Gram-negative bacteria like Pseudomonas. Rehab Nasser Al-Shukri et al frequently isolated Staphylococcus aureus.[10] The isolation of Candida spp. in our cohort aligns with historical findings by Maki,[11] and Widmer.[12]

Limitations of the study

The inclusion of both ICU and post-surgical patients introduces heterogeneity, as these groups differ in illness severity, exposure to invasive procedures, and baseline infection risk. This may have influenced the observed incidence rates, and direct comparisons between these groups should be interpreted cautiously. Another key limitation of this study is the low number of CRBSI events (n=7), which restricts the statistical power to detect significant associations with multiple risk factors. As a result, subgroup analyses and observed associations should be interpreted with caution and considered exploratory rather than definitive. Exclusion of femoral venous site may have led to an underestimation of the overall incidence of CRBSI and limits the generalizability of the findings to all central venous access sites. The study did not account for several potential confounding variables, including severity of illness, underlying comorbidities, prior antibiotic use, and immunological status. These factors may have influenced the risk of infection and limit the ability to draw definitive conclusions regarding associations.

CONCLUSION

This study demonstrated an overall CRBSI incidence of 5.38%. Although nonspecific clinical signs of infection were significantly more frequent among ICU patients, confirmed CRBSI incidence did not differ significantly between ICU and surgical patients. The higher frequency of clinical signs in ICU patients should therefore not be interpreted as evidence of increased catheter-related infection. The highest observed CRBSI incidence occurred among patients with catheter duration exceeding 14 days. The microbial profile was dominated by Staphylococcus aureus and Pseudomonas aeruginosa, while remaining infections were attributed to MDR Klebsiella, Candida spp. and

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Chryseobacterium indologenes. While external evidence, including the study by Lorente et al., suggests that subclavian access may be associated with a lower infection risk, our data did not demonstrate a statistically significant difference between subclavian and internal jugular venous access sites. Therefore, the choice of insertion site should be individualized based on patient factors, operator expertise, and procedural considerations. Older age, comorbidities, and the presence of additional indwelling devices were frequently observed among patients who developed CRBSI; however, independent associations could not be established because of the limited number of infection events.

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