Predictors of Central Line Associated Blood Stream Infections (CLABSI) among patients admitted in Intensive Care Unit of a teaching hospital

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ABSTRACT

Introduction: Central venous catheters (CVCs) are commonly used in critically ill patients for various indications, including hemodynamic monitoring, administration of medications, and other therapeutic interventions. Central Line Associated Blood Stream Infections (CLABSI) are serious complications of CVCs, leading to increased morbidity, mortality, and healthcare costs due to immunosuppression, prolonged catheter use, and frequent access. The study was designed to explore the predictors of CLABSI among patients admitted in intensive care units (ICU). **Methods:** A prospective, observational study was conducted among 112 patients with CVCs from February 2023 to January 2024, recruited through consecutive sampling, using a structured proforma. The data was analyzed using descriptive and inferential statistics. **Results:** A total of nine episodes in 112 patients succumbed an incidence of CLABSI of approximately 8.03%, with a rate of 10.05 per 1,000 catheter days. Age, site of port, number of catheter days, and associated co-morbidities were significantly associated with the incidence, at the level of p-value <0.05 with gram-negative organisms being the most dominant causative organisms. **Conclusions:** The high incidence of gram-negative organisms suggests potential challenges in infection control, antimicrobial stewardship, and patient outcomes. These results emphasize the need for rigorous surveillance, early detection, tailored antimicrobial therapy and infection control protocols in ICUs.

Keywords: Antibiotic stewarsdhip, CLABSI, infection control.

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INTRODUCTION

The US Centers for Disease Control and Prevention (CDC)[1] defines Central Line-Associated Bloodstream Infections (CLABSI) as a laboratory-confirmed bloodstream infection not related to an infection at another site that develops within 48 hours of central line placement. CLABSIs are a significant concern in intensive care units (ICUs), contributing to increased morbidity, mortality, and healthcare costs and these infections are primarily caused by the introduction of bacteria or other microorganisms into the bloodstream through central venous catheters (CVCs).[2,3]

CLABSI occur through two mechanisms, including endogenous transmission (migration of the patient's skin flora, such as Staphylococcus spp. or Candida spp., into the bloodstream) or exogenous transmission particularly after ten days of insertion, often related to poor adherence to aseptic techniques during the procedure.[4] An estimated 2,50,000 bloodstream infections occur annually, and most are related to the presence of intravascular devices.[3] Globally, CLABSI rates vary significantly, with high-income countries reporting rates as low as 0.5–2.2 per 1,000 catheter days, while low- and middle-income countries (LMICs) experience substantially higher rates, ranging from 3.5 to 17.04 per 1,000

catheter days.[5] In spite of advancement in infection control protocols, CLABSI remain a significant cause of morbidity, prolonged hospitalization, mortality, increased health care associated costs, with a fatality rate that ranges from (12-25%).[6] In addition to this, a critical risk factor is catheter hub contamination, particularly after 10 days of insertion, often stemming from lapses in aseptic techniques during the procedure.[2]

In low-middle income countries, blood stream infection remains a significant challenge due to the variation in microbial etiology and emergence of antimicrobial resistance, thus early detection of significant predictors are required to assist clinicians to meticulously decide appropriate antimicrobial therapy and adoption of infection prevention protocols, which ultimately reduces the incidence of infection and resistance.[7] Understanding the key risk factors and implementation of preventive measures associated with CLABSI, including maximal aseptic precautions during procedure, timely catheter removal, and adherence to prevention bundles through protocol compliance, play a significant role in reducing morbidity and mortality associated with this infection.[8]

Therefore, this study aimed to identify the incidence and predictors of Central Line Associated Blood Stream Infections (CLABSI) among patients admitted in Intensive Care Unit (ICU) of a teaching hospital.

METHODS

This prospective observational study was conducted at a Tribhuwan University affiliated post graduate teaching hospital situated at Parsa district of Nepal, among adult patients admitted to the Intensive Care Unit (ICU) with a central venous catheter (CVC), between February 2023 to January 2024, recruited through consecutive sampling technique. All the eligible patients admitted in ICU during the period of data collection were included and a sample size of 112 were obtained.

The study population were all adult patients who were 18 years and above with a central venous catheter and admitted to the ICU more than 48 hours during the study period. All patients were followed up on until they were transferred out, were discharged from the ICU or had died in the ICU. Patients with preexisting bloodstream infections at CVC insertion and illness severity (evaluated using the Acute Physiology and Chronic Health Evaluation (APACHE) II score during the first 24 hours upon ICU admission) were excluded from the study. After enrollment, the Ultrasound guided Seldinger technique was adopted for the insertion of catheter, under aseptic conditions. Skin preparation was carried out using a 2% Chlorhexidine based antiseptic for skin preparation. Non antibiotic coated, double and triple lumen catheter was used. Sample for cultures were obtained by consultant Anesthesiologists using the roll-plate method by rolling a catheter tip back and forth on the surface of an agar plate. After rolling the plate was incubated under appropriate conditions for 72 hours in department of pathology. The number of microorganism colonies that grow was then counted to determine the level of contamination.

A structured checklist consisting of four sections were used to collect the data. The information collected included the patients' demographic characteristics (Section 1: age, gender), (Section 2: clinical diagnosis, duration of ICU stay), (Section 3: details of CVC site, insertion, indication and number of catheter days), (Section 4: reports of catheter culture and presence of diagnostic criteria:

a) Patient has a central line for >2 days (or removed ≤2 days before infection).

b) At least one positive blood culture with a recognized pathogen.

c) Fever (>38°C), chills, or hypotension without another cause)

d) Incidence of CLABSI was equated using the formula: (Number of CLABSI cases/ Total central line days) × 1,000

The collected data were transferred to the IBM Statistical Package on Social Sciences (SPSS) version 20.0. Descriptive statistics such as frequency, percentage, median and inter quartile range were applied to find out demographic, comorbidity related variables. The Kolmogorov-Smirnov test of the normality of data was done before analysis. Inferential statistics such as the chi-square test and multivariate analysis were applied to find the association between the prevalence of CLABSI with selected variables (age, port of entry, associated co-morbidity). A p-value of <0.05 was regarded as the appropriate level of statistical significance, and the strength of statistical association was assessed by adjusted odds ratios with 95% confidence intervals.

Ethical approval to conduct the study was obtained from the Institutional Review Committee of National Medical College Teaching Hospital (Ref. No. F-NMC/538/078-079) Birgunj, Nepal. Informed written consent was obtained from the conscious and oriented patients, whereas for unconscious

and mechanical ventilated patients, consent was obtained from legal guardians. Beneficence, confidentiality and efforts to minimize biasness were closely monitored throughout the study period.

RESULTS

The study included 112 participants aged 18 years and above. The median age of participants was 49 years. Among these 78(69.64%) were male. Regarding diagnosis, 1/4th of participants had respiratory failure. Similarly, 69(61.60%) patients had diabetes mellitus. Meanwhile, 62(55.35%) participants had hospital stays of more than 16 days. (Table 1)

Table 1: Patient's demographic, diagnosis and co-morbidities data (n=112)

Characteristics	Value	Numbers (%)
Age (Median. IQR)*	49(30-59)	
Gender	Male	78(69.64%)
	Female	34(30.36%)
Diagnosis	Severe sepsis & septic shock	29(25.89%)
	Tropical infectious disease	9(8.03%)
	Trauma & post-operative care	11(9.82%)
	Respiratory failure	25(22.32%)
	Renal & metabolic emergencies	13(11.60%)
	Cardiovascular conditions	18(16.07%)
	Neurological emergencies	8(7.14%)
Associated Co-morbidities	Diabetes Mellitus (DM)	69(61.60%)
	Hypertension (HTN)	58(51.71%)
	Malnutrition (clinically diagnosed)	12(10.71%)
	CKD	8(7.14%)
	DM+ HTN	31(27.67%)
	DM+CKD	23(20.53%)
	DM+CKD+HTN	6(5.35%)
Duration of ICU stay	>15 days	50(44.64%)
	<16 days	62(55.35%)

*IQR= Inter Quartile Range, CKD= Chronic Kidney Disease, DM= Diabetes Mellitus, HTN= Hypertension

Table 2: Patient's catheter-related data (n=112)

Characteristics	Sub-characteristics	n(%)
Site of insertion	Internal Jugular	103(91.96%)
	Femoral	9(8.04%)
Number of lumen	Two	106(94.64%)
	Three	6(5.35%)
Indication	Haemodialysis	6(5.35%)
	Total Parenteral Nutrition	42(37.5%)
	Fluids and medications	64(57.14%)
Number of catheter days (median , IQR)*	8 (6-13)	

* IQR= Inter Quartile Range

The median duration of catheter placement was eight days. Regarding the site of insertion, majority 103(91.96%) had their catheter at Jugular vein and the majority 106(94.64%) had two lumen catheter inserted. More than half of the participants 64(57.14%) had the requirement of fluid and medication as indication for catheter insertion. (Table 2)

Table 3: Multivariate analysis for determinants of CLABSI

Variable	All participants (n=112)	CLABSI (n=9)	Non-CLABSI (n=103)	Odds ratio	95%CI	p-value
Age(median, IQR)	49(30-59)	56(48-69)	47(29-58)	1.1	1.03-1.29	0.03*
Site of port						
Juglar	103(91.96%)	7(87.11)	83(73.45%)	0.39	0.21-1.34	0.04*
Femoral	9(8.04%)	2(12.89%)	20(26.55%)			
Co-morbidities						
DM	69(61.60%)	-	69			
HTN	58(51.71%)	-	58			
CKD	08(7.14%)	3	5	1.56	1.45-1.89	0.01*
DM+HTN+CKD	06(5.35%)	6	-			
CVC days (median. IQR)	8(6-13)	12(9-15)	7(6-11)	1.7	1.49-2.2	0.025*

CVC: Central venous catheter IQR Inter Quartile Range; *p<0.05 denotes statistical significance

A total of nine episodes in 112 patients succumbed an incidence of CLABSI of approximately 8.03%, with a rate of 10.05 per 1,000 catheter days. The multivariate analysis revealed, the age (OR=1.1, 95% CI: 1.03-1.29, p=0.03), site of port (OR=0.39, 95% CI: 0.21-1.34, p=0.04), Co-morbidity (OR=1.56, 95% CI: 1.45-1.89, p=0.01), and number of CVC days (OR=1.7. 95% CI: 1.49-2.2, p=0.025) were significantly associated with CLABSI. (Table 3)

Table 4: Microorganisms distribution among patients in ICU (n=9)

Characteristics	n(%)
Bacteria: Gram positive	2(22.22%)
Gram negative	6(66.66%)
Fungi	1(11.11%)

Among nine patients with CLABSI, the most common organism was Gram negative bacteria 6(66.66%). The presence of Fungi was 1(11.11%). (Table 4)

DISCUSSION

The incidence of CLABSI in present study was 10.05/1000 catheter days in general ICU. The rate is slightly higher than the findings from a multinational prospective cohort study of nine Asian countries, which reported an incidence of 5.08/1000 catheter days.[9] Additionally, a systematic review conducted in South East Asia revealed an incidence of 4.7/1000 catheter days.[10] In contrast, the findings from various studies conducted in developed countries revealed a lower incidence of CLABSI. For an instance, the incidence for Poland (1.83/1000 catheter days),[11] Australia (1.26/10000 catheter day),[12] France (1.23/1000 catheter days), Germany(1.5/1000 catheter days), Switzerland (1.69/1000 catheter days),[13] The United States (0.8/1000 catheter days).[3]

Another similar study[14] conducted in India revealed the overall rate of CLABSI as 17.04 per 1000 catheter -days which is higher than that of our setting. Whereas, the average incidence of CLABSI in China is (1.5/1000 catheter days),[15] which is considered similar to the rates documented in developed countries. This difference observed in between these countries may be associated with epidemiological estimates, antimicrobial stewardship and infection prevention practices. These findings warrant further investigations into the potential predictors of CLABSI.

In present study, a higher incidence (87.11%) was observed with the insertion site as Jugular vein, while femoral insertion had lower incidence (12.89%) of CLABSI. This finding is similar with a study conducted in a University teaching hospital at Palestine revealing the incidence of (81%) with Jugular vein insertion.[16] Nevertheless, CDC has recommended not to use femoral catheters whenever possible, due to high rates of CLABSI and recommended the use of subclavian catheters.[17] We adopted femoral catheters for patients with respiratory symptoms so as to minimize the risks of complications including pneumothorax. Another findings from present study revealed the average number of catheter days among patients with CLABSI was 12 with a range of nine to 15 days. This contrasted form the other study which found that patients with CLABSI had CVC insertion days ranging from five to 92 days.[18]

In our study, gram negative bacteria were predominant and this finding aligns with the findings from various similar studies as suggested by a systematic review.[19] The predictors of CLABSI among studied patients in our study were age, site of port, co-morbidities and number of catheter days. These factors are consistent with findings from similar previous studies.[19] Additionally, we found that co-morbidities associated with incidence of CLABSI were Diabetes Mellitus, Hypertension and Chronic Kidney Disease. Among those with CLABSI more than 1/2 (66.7%) had DM, HTN and CKD and remaining (33.33%) had CKD alone. In contrast, on a similar study, these factors were not determined as predictors of CLABSI.[16] Similar Findings from other studies[3,21] suggested that these co-morbid conditions can increase the risk of surgical site infections, which were not analyzed in our study. Similarly, duration of stay at ICU was not determined as a significant predictor of CLABSI, whereas findings from similar study[20] revealed a significant association between the length of hospital stays, with higher rates of CLABSI and a another similar study revealed a significant association between the length of hospital stays, with higher rates of CLABSI and a another similar study revealed the lack of association with these factors respectively.[16] Low middle income countries must have to adopt prevention strategies in the form of low cost, low technology measures that are feasible in nature to implement in resource limited settings.[9]

There are several limitations to our study. In this single centered study, we failed to study ICU bundle, nurse-patient ratio and adherence to infection prevention protocols including the antibiotic stewardship practices that are being adopted in our ICUs.

CONCLUSIONS

The study highlights age of patient, site of port insertion, number of catheter days and co-morbidities as predictors of CLABSI among ICU patients. Gram negative bacteria remains the dominant microorganism as a causative agent.

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AUTHORS' CONTRIBUTIONS

RG conceptualized the study. RG and AG contributed in literature review and development of study proforma. RG and AG collected data, performed statistical analysis and interpretation. RG prepared the initial draft of manuscript. RG and AG proofread the manuscript. Both authors approved the manuscript and RG corresponded with the journal for publication.

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