Original Research Article

Incidence and Aetiology of Bloodstream Infections in Intensive Care Unit Patients at National Medical College, Birgunj, Nepal

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A B S T R A C T

Bloodstream infection (BSI) is among the most common acquired illnesses in intensive care unit (ICU) patients and remains one of the most important causes of morbidity and mortality. The current study was aimed to evaluate the incidence of central line‑associated bloodstream infections (CLA-BSIs) and bacterial aetiology among the patients admitted at ICU. This study was conducted on randomly selected 1030 patients admitted in the ICU of National Medical College and Teaching Hospital Birgunj, Nepal, from 15th April 2023 to 14th March 2024. The incidence of bloodstream infection and bacteriological profile were done by following standard technique and precautions. This study revealed that the incidence of CLA-BSI was 12.04 per 1000 catheter days. The current study revealed that Gram-negative organisms (66.67%) were the most common organisms associated with the incidence of CLA-BSI in ICU patients which followed by gram-positive organisms (27.08%) and fungal organisms (6.25%). The current study findings also reveal that *Salmonella enterica, Escherichia coli*, *Staphylococcus aureus* and *Enterococcus spp.* were the most common causative agents for CLA-BSI episodes in the ICU patients. It may be prudent to turn our attention to infections caused by these pathogens that may require different approaches to prevention, *e.g.*, optimizing central line maintenance practices.

Introduction

Bloodstream infection (BSI) is defined by positive blood cultures in a patient with systemic signs of infection and may be either secondary to a documented source or primary, without identified origin (Chaturvedi *et al.,* 2021). The term bacteraemia and bloodstream infection are synonymously used which generally refer to significant growth of a microorganism in a blood culture obtained from the patient with clinical signs of infection (Parajuli *et al.,* 2017). BSI is among the most common acquired illnesses in intensive care unit (ICU) patients

and remains one of the most important causes of increased duration of hospitalisation, antimicrobial resistance, additional medical costs and resulting in significant morbidity and mortality (Chaturvedi *et al.,* 2021). BSIs might be the result of bacterial bloodstream diffusion from a localized illness (secondary BSI) or the only recognized infectious process (primary BSI). Therefore, BSI is among the most difficult problems confronting clinicians managing intensive care unit patients. Central venous catheters/line (CVCs/CVL) are integral part of current‑day intensive care practice for monitoring of haemodynamic variables, delivery of

intravenous medications, nutritional support, blood products, and collection of blood samples, etc. BSI's usually occur after the patient undergoes intravascular catheterization (Singhal *et al.,* 2019). The two terms commonly used to describe these BSIs are central line‑related bloodstream infections (CR-BSIs) and central line‑associated bloodstream infections (CLA-BSIs) (O'Grady *et al.,* 2011; Rosenthal, 2016). The occurrence of CLA-BSI depends on infection control practices of health care system. The developed countries have strict infection control practices and good nurse–patient ratios, therefore; they succeeded to reduce the incidence of CLA-BSI to very low rates. However, in developing countries the incidence of CLA-BSI often high due to lack of resources, trained staff, frequent attrition and unfavourable nurse-patient ratio (Rosenthal, 2016).

In clinical practice, BSI may range from self-limiting infections to life threatening septicaemia that requires prompt and rational antimicrobial treatment. However, in the developing countries, changing epidemiology, lack of standard antimicrobial guidelines in locality, emergence of antimicrobial resistance, and paucity of good diagnostic facilities are major denominators for surge in BSI associated morbidity and mortality (Chaturvedi *et al.,* 2021). Wide spectrums of organisms have been described to cause BSI, and this spectrum is subject to geographical differences. The International Nosocomial Infection Control Consortium (INICC) has evaluated incidence rate of CLA-BSI extensively in developing countries through multicentric studies (Singhal *et al.,* 2019).

However, such data from developing countries are very limited. It is important to have reliable data from developing countries on the incidence of CLA-BSI which adhere to a comprehensive infection control policy. Thus, the microbiological profile of bacteria causing these infections is essential to formulate their own regimens. The present study was undertaken evaluate the incidence of central line‑associated bloodstream infections (CLA-BSIs) and to identify the various organisms causing CLA-BSIs in intensive care unit of National Medical College of Nepal.

Materials and Methods

This prospective study was conducted over a period of one year from 15th April 2023 to 14th March 2024 at National Medical College and Teaching Hospital, Birgunj, Nepal for determining the incidence and bacteriological profile of bloodstream infection in patients admitted in the ICU's.

Ethical approval

Ethical approval for the study was taken from the Institutional Ethics Committee National Medical college & Teaching Hospital, Birgunj, Nepal on 31st March 2023. (Ref. F-NMC/647/079-080). and the experiment was performed in accordance with the ethical standards of the committee and with the Helsinki Declaration.

The study was conducted on the blood culture samples received in the department of microbiology at National Medical college & Teaching Hospital, Birgunj, Nepal. Patients admitted to the ICU of National Medical College and Teaching Hospital with several health complications during the study period were approached and the purpose of the study, procedures of data collection and importance of this study were explained to ensure their comprehension and cooperation and informed consent obtained from them.

Inclusion criteria for the samples included patients admitted to the ICU with several health complications during the study period.

Patients less than 18 years old were excluded from the study. In the present study, blood sample was taken from randomly selected 1030 patients for blood culture following standard aseptic technique and precautions. 10mL of blood specimen was collected from each patient and they were transferred into previously prepared blood culture bottles containing brain heart infusion (BHI) broth at the blood to broth ratio of 1:10 and transported to the Department of Microbiology with minimal delay. After incubation, at 37∘C for 24, 48, and 72 hours, blind subcultures were made on nutrient agar, blood agar, chocolate agar and MacConkey agar to look for any growth.

The plates were observed for bacterial growth after 24 hrs of aerobic incubation at 37∘C with the help of colony morphology, gram staining and relevant standard biochemical test such as coagulase test, catalase test, oxidase, triple sugar iron, urease production test, citrate utilization test, methyl red test, Vogues Proskauer test, indole production (Watt *et al.,* 1996; Isenberg, 2004). Blood culture bottles showing no signs of any growth after 5 days of incubation were noted as negative report.

CLA-BSI rate was calculated by the formula, total number of reported CLABSI/number of central line days multiplied by 1000 (Center for Disease Control and Prevention, 2020).

Descriptive statistics were performed for all studied variables. Some were then categorized according to frequency analysis. Chi-square test was performed to assess difference of categorical variables. The level of statistical significance adopted was p<0.05.

Results and Discussion

Total1030 patients admitted in the ICU during study period were participated in the present study. Among them; 652(63.3%) were male and 378 (36.7%) were female respectively. The age of the studied patients was ranged from 18-84 years. The average hospital stay in ICU was 6.35 days.

Of the 1030 blood cultures which were sent with suspected cases of BSIs, 96 (9.32%) were bacteriologically positive. The incidence rate of central line-associated bloodstream infection (CLA-BSI) was 12.04 per 1000 catheter days. The incidence of CLA-BSI was significantly higher ($\chi2$:4.328; p<0.05) among male patients (11.35%) as compared to females (5.82%). The results reported that there was significant variation ($\chi2$: 27.125; p<0.001) in bacteriologically positive cultures. Among the pathogens which were isolated, gram-negative isolates were more predominant 64 (66.67%); which followed by gram-positive isolates 26 (27.08%) and fungal isolates 6 (6.25%).

Among the gram-negative isolates; two most common microorganisms isolated these were *Escherichia coli* (37.5%) and *Salmonella enterica* (16.67%) (Table 1). Among the gram-positive isolates, *Staphylococcus aureus* (16.67%) and *Enterococcus* spp. (10.42%) were isolated. Besides the bacterial isolates, there was 6.25% fungal isolates which belonged to *Candida tropicalis*.

Bloodstream infections remained a challenge for the health care professionals due to the changing bacterial aetiology and emergence of antimicrobial resistance. Therefore; early detection of causative organism are necessary to help clinicians decide appropriate empirical therapy (Parajuli *et al.,* 2017). Our study evaluates the incidences of bloodstream infections and bacterial aetiology among the patients admitted at ICU of National Medical College and Teaching Hospital, Nepal. This

study revealed that the incidence of CLA-BSI was 12.04 per 1000 catheter days at ICU of National Medical College and Teaching Hospital. Comparing with the results of other studies by Parajuli *et al.,* (2017) and Yadav *et al.,* (2017) at intensive care unit of different hospital of Nepal showed that, the incidence rate of CLA-BSIin the present study was lower than those studies. Yadav *et al.,* (2017) determine the hospital acquired bloodstream infections (HAI) in neonatal intensive care unit of B.P. Koirala Institute of Health Sciences, Nepal and reported that the incidence rate of HAI was 39.3 infections per 1000 patient-days. In another studies by Parajuli *et al.,* (2017) on device-associated health care-acquired infections (DA-HAIs) in an intensive care unit of a teaching hospital in Nepal, stated that incidence rate of DA-HAIs was 27.3 per 1,000 patient-days which was far higher than the present study. Singhal *et al.,* (2019) studied the incidence rate of central line associated bloodstream infections in intensive care unit patients of a tertiary care multi‑specialty hospital in Mumbai, India and reported that the incidence of CLA-BSI was 5 per 1000 catheter days. A recent study by Maqbool and Sharma (2023) in a Tertiary Care Hospital in Northern India showed the incidence of CLA-BSI was 9.3 per 1000 catheter days. Malek *et al.,* (2018) showed the incidence of CLA-BSI in ICU in a private hospital of Cairo, Egypt was 6 cases per 1000 central line-days. Lee *et al.,* (2020) evaluated the incidence of peripherally inserted central venous catheter associated BSI in cancer patients of four hospitals of Korea and the results showed that the infection rate was 2.31 per 1000 catheter days. The exact figures of CLA-BSI among the intensive care unit patients was vary from study to study, but there is no doubt that CLA-BSI is an extremely serious public health problem among the critically ill ICU patients. The higher incidence rate of CLA-BSI in the present study than in developed countries may be due to the fact that ICU patients in developing countries are at an increased risk for infection. Several factors associated with high CLA-BSI rates in ICU patients in limited-resource countries have been identified. Nurse-to-patient ratio is a major factor contributing to higher CLA-BSI rates considering the higher ratio between nursing staff and patients in limited-resource countries than in health care facilities in developed countries (Rosenthal, 2016). CLA-BSI rates in the present study may be higher than those in developed countries because the ICU in our center admits many patients who were critically ill with advanced chronic illnesses and who were referred from other hospitals; received multiple courses of antibiotics; and were may be infected with multidrug-resistant pathogens.

The present study showed that among the pathogens which were isolated, gram-negative isolates were more predominant which followed by gram-positive and fungal isolates. Among the gram-negative isolates; two most common microorganisms isolated were *Escherichia coli* and *Salmonella enterica*.

Among the gram-positive isolates, *Staphylococcus aureus* and *Enterococcus spp.* were isolated. Our results were also consistent with several studies (Singhal *et al.,* 2019; Parajuli *et al.,* 2017; Al-Yousafi *et al.,* 2023;

Chaturvedi *et al.,* 2021). However in Europe and USA gram-positive isolates was predominant (Siefert and Wisplinghoff, 2005).

A high prevalence of the *Salmonella* spp was seen in another study by Pandey *et al.,* (2013) which were done in Nepal. In another study done by Yadav *et al.,* (2017) on HAI in neonatal intensive care unit of B.P. Koirala Institute of Health Sciences, Nepal and reported that *Staphylococcus aureus* was the most commonly isolated agent in haemocultures of patients with BSI.

Table.1 Microbial aetiology of patients with central line-associated bloodstream infection

Isolates	*f*	%
Gram negative isolates	64	66.67
Escherichia coli	36	37.50
Salmonella enterica	16	16.67
Acinetobacter **spp.**	8	8.33
Klebsiella pneumoniae	2	2.08
Pseudomonas aeruginosa	2	2.08
Gram positive isolates	26	27.08
Staphylococcus aureus	16	16.67
Enterococcus **spp.**	10	10.42
Fungal isolates	6	6.25
Candida tropicalis	6	6.25

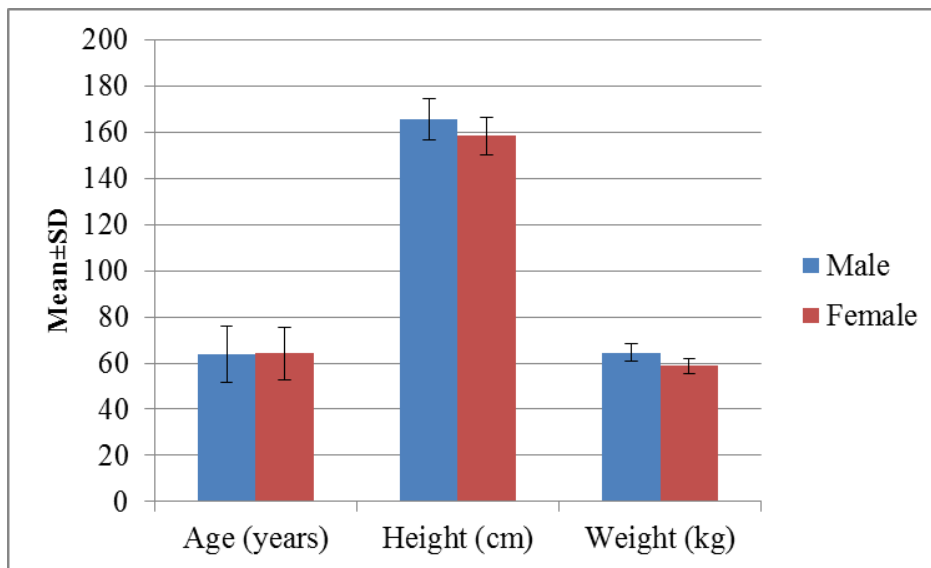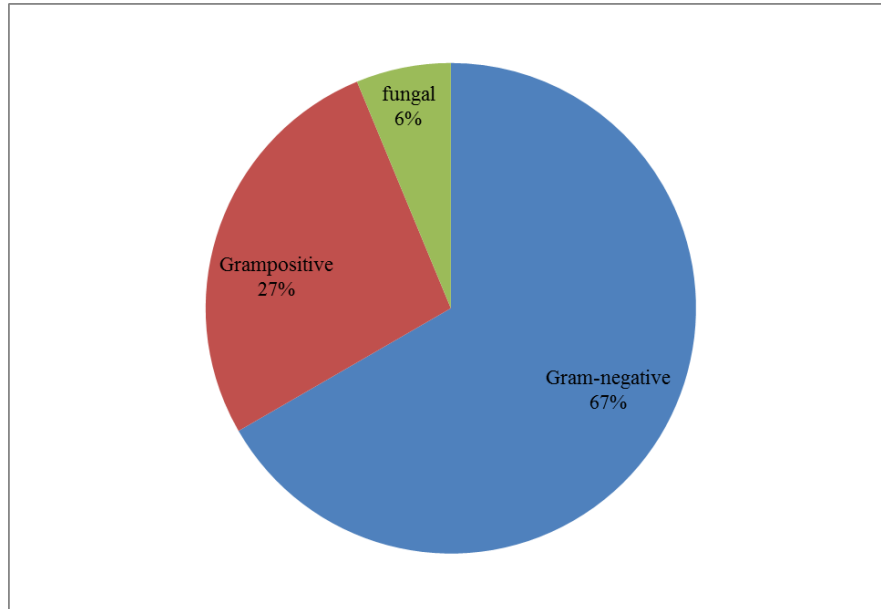**Figure.1** Age and physical measures of the patients

Figure.2 Microbiological profile of blood specimen

The incidence rate of CLA-BSI in the present study was 12.04 per 1000 catheter days at ICU of National Medical College and Teaching Hospital. Comparing with the results of other studies done at ICU of different hospital of Nepal, the incidence rate of CLA-BSI in the present study was lower than those studies. The current study revealed that Gram-negative organisms are the most common organisms associated with the incidence of CLA-BSI in ICU patients. The current study findings also reveal that *Salmonella enterica, Escherichia coli*, *Staphylococcus aureus* and *Enterococcus spp.* were the most common causative agents for CLA-BSI episodes in the ICU patients. It may be prudent to turn our attention to infections caused by these pathogens that may require different approaches to prevention, *e.g.*, optimizing central line maintenance practices.

Author Contributions

Ravi Shankar Gupta: Investigation, formal analysis, writing—original draft. Shisir Pokhrel: Validation, methodology, writing—reviewing. Chandana Jha:— Formal analysis, writing—review and editing. Naval Kishor Karn: Investigation, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.
Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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