Research Article / Özgün Araştırma

DOI: 10.4274/cayd.galenos.2025.90377
J Pediatr Emerg Intensive Care Med

Central-line-associated Blood Stream Infections in Children Admitted to a South African Paediatric Intensive Care Unit

Güney Afrika Çocuk Yoğun Bakım Ünitesine Yatırılan Çocuklarda Santral Venöz Kateterle İlişkili Kan Dolaşımı Enfeksiyonları

Nompumelelo Victoria Bobotyana[1], Nombini Pinkie Zozi[2], Siyazi Mda[2]

[1]Walter Sisulu University Faculty of Medicine, Department of Paediatrics and Child Health, Eastern Cape, South Africa
[2]Nelson Mandela University Faculty of Medicine, Department of Paediatrics and Child Health, Port Elizabeth, South Africa

Abstract

Introduction: Central line associated bloodstream infection (CLABSI) is a common complication of venous access. Rates of CLABSI are reportedly higher in middle-income countries compared with high-income countries. There is a paucity of data concerning CLABSI in South Africa. In this study we aimed to assess the prevalence of CLABSI and its associated factors at Dora Nginza Hospital.

Methods: We conducted a retrospective review of medical and laboratory records of all paediatric intensive care unit (PICU) patients who had central lines placed between January 2019 to December 2019. The CLABSI was defined according to Centers for Disease Control and Prevention guidelines. Eligible patients had to have had a central line for two days prior to CLABSI. Information concerning the type of the central line, associated factors, septic markers, and the organisms that were cultured was obtained from the records. Ethics approval was granted by the Institutional Review Board of Walter Sisulu University.

Results: In all, 289 patients were admitted in PICU during the period of the study, and 131 had central lines. The files of 107 children were used for the study with a total of 598 catheter days. Among 107 participants 19 CLABSI were identified yielding a CLABSI rate of 31.7 per 1000 catheter days. Patients with CLABSI had more central line days than those who did not develop CLABSI ($p<0.01$). Blood transfusion was also a risk factor for CLABSI in this study. Other known risk factors like antibiotics, catheter site, total parenteral nutrition, malnutrition were not found to be significantly associated in this study. Causes of CLABSI were Gram-negative (n=10, 52%) being predominant, followed by fungal at (26%, n=5) and Gram-positive (n=3, 15.8%).

Öz

Giriş: Santral venöz kateterle ilişkili kan dolaşımı enfeksiyonu (SVKİ-KDE), venöz erişimin yaygın bir komplikasyonudur. SVKİ-KDE oranlarının, yüksek gelirli ülkelere kıyasla orta gelirli ülkelerde daha yüksek olduğu bildirilmektedir. Güney Afrika'da SVKİ-KDE ile ilgili veriler yetersizdir. Bu çalışmada, Dora Nginza Hastanesi'nde SVKİ-KDE prevalansını ve bununla ilişkili faktörleri değerlendirmeyi amaçladık.

Yöntemler: Ocak 2019 ile Aralık 2019 tarihleri arasında merkezi venöz kateter takılan tüm çocuk yoğun bakım ünitesi (ÇYBÜ) hastalarının tıbbi ve laboratuvar kayıtlarını retrospektif olarak inceledik. SVKİ-KDE, hastalık kontrol ve önleme merkezleri kılavuzlarına göre tanımlandı. Çalışmaya dahil edilme kritelerine göre uygun hastalara, SVKİ-KDE gelişiminden iki gün önce merkezi venöz kateter takılmış olmalıydı. Merkezi kateterin türü, ilişkili faktörler, septik belirteçler ve kültürlenen organizmalarla ilgili bilgiler kayıtlardan elde edildi. Etik onay, Walter Sisulu Üniversitesi Kurumsal İnceleme Kurulu tarafından verildi.

Bulgular: Çalışma süresince ÇYBÜ'ye toplam 289 hasta yatırıldı ve 131'inde santral venöz kateter kullanıldı. Çalışmada 107 çocuğun dosyaları kullanıldı ve toplam 598 kateter günü kaydedildi. 107 katılımcı arasında 19 SVKİ-KDE olgusu tespit edildi ve bu da 1000 kateter günü başına 31,7 SVKİ-KDE oranı anlamına geliyordu. SVKİ-KDE olan hastalar, SVKİ-KDE gelişmeyen hastalara göre daha fazla santral kateter ile gün geçirdiler ($p<0,01$). Kan transfüzyonu da bu çalışmada SVKİ-KDE için bir risk faktörüydü. Antibiyotikler, kateter bölgesi, total parenteral beslenme, malnütrisyon gibi diğer bilinen risk faktörlerinin bu çalışmada anlamlı bir ilişkisi bulunmamıştır. SVKİ-KDE'nin nedenleri arasında Gram-negatif (n=10, %52) en yaygın olanıydı, bunu mantar (n=5, %26) ve Gram-pozitif (n=3, %15,8) izledi.

Address for Correspondence/Yazışma Adresi: Assoc. Prof. Siyazi Mda, Nelson Mandela University Faculty of Medicine, Department of Paediatrics and Child Health, Port Elizabeth, South Africa
E-mail: siyazi.mda@gmail.com **ORCID ID:** orcid.org/0000-0002-5848-4138
Received/Geliş Tarihi: 25.12.2024 **Accepted/Kabul Tarihi:** 02.04.2025 **Epub:** 18.08.2025
Cite this article as: Bobotyana NV, Zozi NP, Mda S. Central-line-associated blood stream infections in children admitted to a South African paediatric intensive care unit. J Pediatr Emerg Intensive Care Med. [Epub Ahead of Print]

Conclusion: The prevalence of CLABSI at Dora Nginza Hospital is high compared to rates reported in middle-income countries. Strict adherence to prevention bundles is required reduce CLABSI prevalence.

Keywords: Central-line-associated blood stream infections, children, South Africa

Sonuç: Dora Nginza Hastanesi'nde SVKİ-KDE prevalansı, orta gelirli ülkelerde bildirilen oranlara kıyasla yüksektir. SVKİ-KDE prevalansını azaltmak için önleme paketlerine sıkı sıkıya uyulması gerekmektedir.

Anahtar Kelimeler: Santral venöz kateterine bağlı kan dolaşımı enfeksiyonları, çocuklar, Güney Afrika

Introduction

Central line catheters are essential vascular access devices that are commonly used in critically ill patients. The use of central lines in intensive care is often necessary for patients requiring multiple infusions such as intravenous fluids, blood products, antibiotics, and total parenteral nutrition (TPN).[1,2] However, the use of central lines is not without risks, as they can lead to bloodstream infections.[1]

World-wide, central line associated bloodstream infections were the commonest cause of hospital acquired infections in 2001, with a reported mortality rate of 12-15%.[3] Central line associated bloodstream infection (CLABSI) can lead to high mortality, morbidity, increased length of stay and increased hospital costs in intensive care unit.[4]

The Centers for Disease Control and Prevention (CDC) defines CLABSI as "a laboratory confirmed bloodstream infection that occurs when an eligible bloodstream infection organism is identified and an eligible central line is present when the bloodstream is laboratory confirmed".[5] An eligible central line is defined as a central line that has been in place for more than two consecutive calendar days. An eligible pathogen is defined as any pathogen that can be used to meet laboratory confirmed bloodstream infection criteria. The infection cannot be related to any other infection the patient might have and must not have been present or incubating when the patient was admitted to the facility.[6]

With good aseptic techniques, most cases of central line-associated bloodstream infections can be minimised.[7] Introduction of CLABSI prevention guidelines reduced the incidence of CLABSI between 2001 and 2009 by 58%.[1] Care bundles are a group of interventions used for patients with intravascular central catheters, that when implemented together, result in better outcomes than when implemented individually. Central line bundle elements include hand hygiene, maximal barrier protection, chlorhexidine skin antisepsis, optimal catheter site selection, and daily review of need for the central line.[8]

Data on CLABSI from low- and middle-income countries are limited,[2] but it is reported that in low-income countries CLABSI rates are 3-5 times higher than in high-income settings.[9] In South Africa (an upper middle-income country), the CLABSI rate in a tertiary neonatal intensive care unit was 5.9 per 1000-line days,[2] and this was similar to that noted in some low- and middle-income countries, but higher than CLABSI rates in high-income settings. The rate of CLABSI noted in Iran (upper middle-income) was 10 per 1000 catheter days.[10] In the United States of America, CLABSI rate in intensive care units is estimated to be 0.8 per 1000 central line days.[11]

The risk factors of CLABSI may be classified as host-related and catheter-related. Host related risk factors include malnutrition,[12] leukopenia,[13] administration of blood products,[14] and TPN,[15] haematological malignancies,[12] prolonged use of broad-spectrum antibiotics,[16] stem-cell transplantation,[17] and male gender.[18]

Catheter related risk factors encompass types of catheters, including non-tunnelled, and multi-lumen catheters, as these carry a greater risk of CLABSI than tunnelled ones.[19] Femoral catheterisation is associated with a higher risk of infection than internal jugular and subclavian access.[20] The number of days since central line insertion is also a predictor for CLABSI.[21]

There is a paucity of data on CLABSI in critically ill children from low- and middle-income countries, particularly from Africa.[2] Knowledge of the CLABSI rate in poorly resourced settings and of common organisms causing CLABSI and their sensitivity patterns will help improve management of central lines and assist in choosing the appropriate antibiotics to treat CLABSI. This will likely assist in reducing morbidity and mortality associated with CLABSI in these settings. This study aimed to determine the prevalence, aetiology and outcomes of CLABSI in children admitted to a paediatric intensive care unit (PICU) in the Eastern Cape Province of the Republic of South Africa.

Materials and Methods

A descriptive study, cross-sectional and retrospective review of records of patients who had central lines in the PICU from January 2019 to December 2019 was conducted at Dora Nginza Hospital. The hospital is based in Gqeberha (formerly Port Elizabeth), in the Eastern Cape province (the poorest province in the Republic of South Africa). The hospital is the only public health facility offering regional and tertiary level paediatric services for children in the Western Region of the Eastern Cape, which has a population of approximately 2 million people. The PICU potentially has 16 beds, but only 6 beds are functional due to a nursing staff shortage. The nurse-to-patient ratio in the unit is typically 1:2. All children

with medical or surgical conditions that require intensive care are admitted to the unit. The ages of patients eligible for admission into the PICU range from one week to 12 years. There is one pediatric intensivist who supervises the medical officers and pediatric residents rotating in the PICU. Central lines are usually inserted by the medical officer/resident rotating in the unit. The indications for central line insertion include venous access for blood transfusion, administration of TPN, and inotropes.

All children with an eligible central line (two consecutive days) with a recovery of an eligible pathogen from blood culture by the time of infection or within 24 hours after the removal of the central line were enrolled. Children who did not meet the criteria of CLABSI, and those whose blood cultures were assessed as contaminants were excluded. Children who died or were discharged within 48 hours of PICU admission were also excluded.

The study was time-bound, but a priori sample size calculations indicated that at least 40 participants were required.

Paediatric intensive care files from January 2019 to December 2019 that met the inclusion criteria were evaluated by the principal researcher. The procedure included scrutiny of the PICU register to note the number of admissions for each month, the number of admissions who had central lines, and how many of them developed infections . The files were then retrieved from records storage, and demographic data (age and gender) and information on the indications of the central line, type of the central line, associated factors, septic markers, and the organisms that were cultured were reviewed by the researcher.

Known risk factors of CLABSI, underlying diagnoses, complications, antibiotics used, the duration of antibiotics, and the clinical outcome of each patient were identified. A data collection sheet was used for each patient.

The chi-square test was used to test for the association between organisms and complications, and for assessing association between demographic data, complications, antibiotics administered, and clinical outcomes. P-value of less than 0.5 was statistically significant.

Ethical clearance was obtained from the Institutional Review Board of Walter Sisulu University (certificate number: 009/2022, date: 30.03.2022).

Statistical Analysis

Data were analysed using the Statistical Package for the Social Sciences version 29.0 software. Data were assessed for normality by visual examination of histograms, followed by normality tests. Continuous data (including age and duration of central line) were described using frequencies and means with standard deviations if normally distributed, median with interquartile range was used for data that are not normally distributed. Frequencies were used to describe categorical data. Prevalence and common pathogens were described using frequencies.

Results

During the 12-month study period, 289 children were admitted to the PICU. One hundred and thirty-one patients had central lines, but 24 of them were excluded. Therefore, 107 patient files were fully analysed for the study, and 19 of them had central line-associated bloodstream infection. The assessment for eligibility and enrolment procedures is summarised in Figure 1.

Demographics, Human Immunodeficiency Virus (HIV), and Nutritional Status of the Patients

The gender distribution of the 107 children was 63 (58.9%) males; and the median age was 5.3 months. In terms of age distribution, more than half (52.3%) of the children were 6 months of age or younger and 18.7% were older than 5 years of age (60 months). Forty-two percent of children were between 1-6 months, 18% were above 60 months, and the remaining 40% were between 6 and 60 months.

The HIV status of all the children was known, and 8 (7.5%) were HIV positive with the remaining 99 (92.5%) being HIV negative. Seventeen percent of the children were malnourished, 13.1% (n=14) were moderately malnourished, 4.7% (n=5) were severely malnourished, and 82% (n=88) were well nourished. The demographic data is summarised in Table 1.

Prevalence of CLABSI

Out of the 107 children who had central lines, 19 (17.8%) developed central line associated bloodstream infections; the rest did not. There were 19 patients with CLABSI and 598 catheter days. The overall CLABSI rate was calculated to be 31.7 per 1000 catheter days.

Admission Diagnosis of Study Population and of Children with CLABSI

The commonest admission diagnoses among the 107 enrolled children were pneumonia (30 children), congenital heart diseases (13 children), acute gastroenteritis (12 children), sepsis (11 children) and surgical conditions (10 children). The remaining 31 children had other conditions. Among the 19 children who developed CLABSI, the most common diagnoses were pneumonia (6, 32% of children), congenital heart diseases (3, 16%) and surgical conditions (3, 16%).

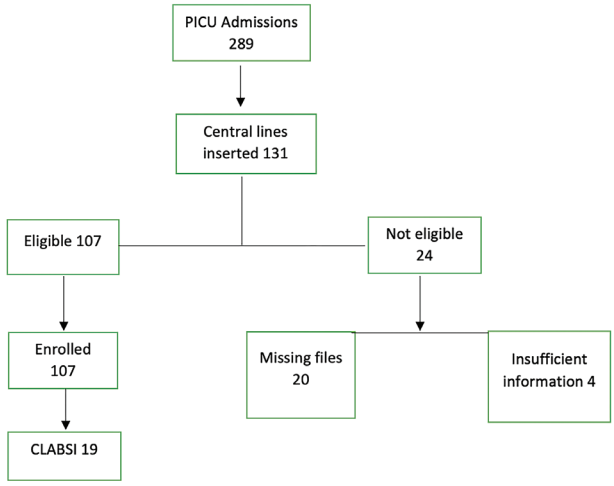

Figure 1. Consort diagram of the population
PICU: Paediatric intensive care unit, CLABSI: Central line associated bloodstream infection

Table 1. Demographics, HIV and nutritional status of the study population

Characteristics		Number	Percentage
Age in months	0-1	11	10.3%
	>1-6	45	42.0%
	>6-12	14	13.1%
	>12-24	9	8.4%
	>24-60	8	7.5%
	>60	20	18.7%
Sex	Male	63	58.9%
	Female	44	41.1%
Nutrition	Normal	88	82.2%

HIV: Human immunodeficiency virus

Risk Factors for CLABSI

Virtually all enrolled children (106/107) had non-tunneled central line catheters. All children who developed CLABSI had tunnelled central line catheters inserted in the femoral vein. There were 86 (97%) children who had femoral catheters, and 19 of these 86 children developed CLABSI (22%). With regard to duration of catheter days, 73 (83%) of the 88 children who did not have CLABSI had their central lines in situ for less than 7 days, while 9 (47%) of those who developed CLABSI had central lines in situ for less than 7 days. Findings related to catheter line days and other risk factors for CLABSI are summarised in Figure 2 and Table 2, respectively.

There were significantly more children with CLABSI who had central lines for more than 7 days (52.6%) compared to those children who did not develop CLABSI (16%), p<0.01. Eleven out of 19 patients who had CLABSI received a blood transfusion (57%), p<0.01.

All 19 patients who had CLABSI received antibiotics before the diagnosis of CLABSI, as opposed to 68 (77%) of those patients who received antibiotics on admission but did not develop CLABSI; however, this was not significant. There was also no difference in the prevalence of malnutrition and administration of TPN, between those who developed CLABSI and those who did not.

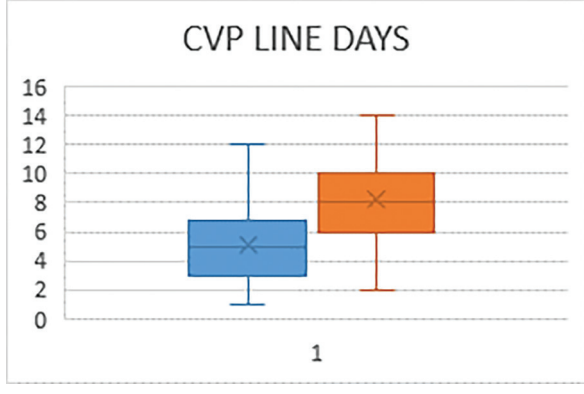

Figure 2. Association between catheter line days and development CLABSI
CLABSI: Central line associated bloodstream infection, Blue: No CLABSI, Orange: With CLABS

Laboratory Investigations on Non-CLABSI vs. CLABSI Patients

Most children with CLABSI (94.7%) had markedly or moderately elevated C-reactive proteins (CRPs). Only 5.3% had normal CRPs at the time of CLABSI diagnosis, and this was significantly different from children who did not have CLABSI. Fifty-two percent of all children with CLABSI had normal white cell counts. Of these, only 26.3% had low platelet counts, while 73.7% had normal or high platelet counts. This is shown in Table 2.

Organisms Causing CLABSI and Their Sensitivity

Out of the 19 children who developed CLABSI, 10 (52.6%) had Gram-negative bacilli responsible for the CLABSI. The Gram-negative bacilli were noted as follows: Five (26.3% of the CLABSI population) children had multidrug-resistant *Escherichia coli* (*E. coli*), which was sensitive to ertapenem and gentamicin; another two (10.5%) had *Klebsiella pneumoniae*, which was sensitive to meropenem, ertapenem, and gentamicin; and one (5%) who had *Chryseobacterium gleum* that was sensitive to ciprofloxacin.

The second most common organisms causing CLABSI were fungal infections, with 5 (26.3%) children having the following fungal infections: *Candida albicans* (two children), which was sensitive to fluconazole and amphotericin B; *Candida glabrata* (one child), which was only sensitive to amphotericin B; one child had *Candida parapsilosis*, which was sensitive to amphotericin B; and one child had *Candida tropicalis* (5% of CLABSI), sensitive to both fluconazole and amphotericin B.

The least common cause of CLABSI was Gram-positive organisms; 3 children (15.8% of CLABSI), and these were two children with *Staphylococcus epidermidis* (10%) and one with *Enterococcus faecium* (5%), both sensitive only to vancomycin (see Table 3).

Complications of CLABSI According to the Cultured Organisms

Out of 19 children who had CLABSI, 11 (59.9%) had septic shock as a complication. There was no evidence of other CLABSI complications. Fifty percent (n=5) of all the Gram-negative organisms had septic shock and needed inotropes, and the cultured organism was *Acinetobacter baumannii* in

Table 2. CLABSI risk factors

Catheter related		No CLABSI	CLABSI	p-value
Type of line*	Tunnelled	1	0	
	Non-tunnelled	87	19	
	Total	88	19	
Site*	Femoral	86	19	
	Subclavian	1	0	
	Other	1	0	
	Total	88	19	
Duration	1-7 days	73	9	
	>7 days	15	10	p<0.01
	Total	88	19	
Host related				
Antibiotics	No	20	0	
	Yes	68	19	p=0.21
	Total	88	19	
Blood transfusion	No	78	8	
	Yes	10	11	p<0.01
	Total	88	19	
TPN	No	85	16	
	Yes	3	3	p=0.62
	Total	88	19	
Nutrition	SAM	3	2	
	MAM	12	2	
	Normal	73	15	p=0.39
	Total	88	19	

TPN: Total parenteral nutrition, SAM: Severe acute malnutrition, MAM: Moderate acute malnutrition, *: P-value not calculated for type of line and site as some cells had zero as value, CLABSI: Central line associated bloodstream infection

Table 3. Organisms causing CLABSI and their sensitivity

Type	Organism	n (CLABSI%)	Sensitivity	
GNB	*Acinetobacter baumannii*	5 (26%)	Colistin only	
	Escherichia coli	2 (10.5%)	Ertapenem	Gentamicin
	Klebsiella pneumoniae	2 (10.5%)	Meropenem ertapenem	Gentamicin
	Chryseobacterium gleum	1 (5%)	Ciprofloxacin only	
GPC	*Staphylococcus epidermidis*	2 (10.5%)	Vancomycin only	
	Enterococcus faecium	1 (5%)	Vancomycin only	
Fungi	*Candida albicans*	2 (10.5%)	Fluconazole	Amphotericin B
	Candida glabrata	2 (10.5%)	Amphotericin B only	
	Candida parapsilosis	1 (5%)	Amphotericin B only	
	Candida tropicalis	1 (5%)	Fluconazole	Amphotericin B

GNB: Gram-negative bacilli, GPC: Gram-positive cocci, CLABSI: Central line associated bloodstream infection

80% of these cases. Thirty-three percent of the children in whom a Gram-positive organism was cultured developed septic shock, and the organism was *Staphylococcus epidermidis* in all cases. With respect to fungal infections, 5 (83%), children developed septic shock. Cerebrospinal fluid, hearing, eye, and bone assessments were not looked into in this study.

CLABSI Outcomes

Out of 19 children with CLABSI, 4 (21.1%) died, and all of them had a fungal infection. The fungal organisms cultured were *Candida albicans* (two children), *Candida glabrata* (one child), and *Candida tropicalis* (one child). The catheters were removed from all patients suspected to have CLABSI before organism identification. There was no use of antibiotic lock therapy for any of the patients due to its unavailability in the institution.

All 10 patients who had Gram-negative organisms cultured survived. Additionally, 3 patients who had Gram-positive organisms survived and were discharged from the intensive care unit. However, only two of the six children (33%) who had fungal infections survived.

Discussion

We conducted a descriptive study to determine the prevalence (rate) of CLABSI, identify common pathogens and sensitivity patterns, identify complications of CLABSI, and evaluate factors associated with CLABSI.

Out of the 289 patients admitted in PICU over the duration of the current study, only 131 (45%) had central lines inserted. The rate of central line insertion is lower than that in other intensive care units. A study conducted in the United States of America (USA) revealed that 50-80% of critically ill patients require central lines at some point during their stay in the intensive care unit (ICU). The lower rate may be because there is no paediatric high care unit at Dora Nginza Hospital. Consequently, some high care level patients are admitted to the ICU and these patients only need non-invasive ventilation and may not require central line insertion.

The ages of patients admitted to PICU in this study ranged between 0.1 months and 5 years of age. Young age has been shown to be a risk for developing CLABSI.[23] This was also observed in a Swiss study, where children between the ages of 2 months and 5 years had high incidence rates of CLABSI.[24] In the current study, 84% of the patients who developed CLABSI were younger than 5 years of age; this was in keeping with the above studies.

In the current study, there were only eight patients who were HIV positive (7.5% of the study population), and this was unlike the findings noted in an American study where HIV positive patients had increased risk of developing CLABSI compared with HIV negative patients.[25] Children with malnutrition are reported to have an increased risk of developing CLABSI,[23] but this was not the case in the current study. Children who are severely malnourished are not eligible for admission into the Dora Nginza Hospital PICU, and this probably reduced the expected effect of malnutrition on the development of CLABSI.

The study found a CLABSI rate of 31.7 per 1000 catheter days in a PICU, where both medical and surgical patients are admitted. This rate is higher than most studies that were previously done in Mumbai, India. For example, the rate was 4.3/1000-line days.[26] In a study conducted in Cape Town, South Africa, the rate was 5.9/1000-line days,[2] and in one conducted in Bloemfontein, South Africa, the rate was 26.3/1000-line days.[27] These two studies were conducted in South African provinces that are better resourced than the Eastern Cape province. The rate noted in the current study is higher than what is reported in low- and middle-income countries, as CLABSI rates are reported to be 3-4 times higher than those in high-income countries.[28] In Egypt (a middle-income country), CLABSI rates are reported to range between

2.9 and 14.3 per 1000 catheter days, with an overall rate of 9 per 1000 catheter days,[29] while in India (a middle-income country), the overall CLABSI rate was 17 per 1000 catheter days, which is 16-fold higher than that in the USA.[17] The rate of CLABSI noted in another middle-income country Iran, was 10 per 1000 catheter days.[10]

The possible explanation for very high CLABSI rates in our institution might be attributed to poor adherence to CLABSI reduction care bundles. The non-adherence might be due to a shortage of staff in the PICU, but the reasons for non-adherence were not assessed in the current study.

Males had a higher percentage of CLABSI compared to females, and this was in keeping with other observed findings where there was male predominance in patients with CLABSI.[30] Age distribution for children with CLABSI was not different from those who did not develop CLABSI in the current study, and this was similar to studies conducted in Türkiye and India.[17,31] where there was no difference in age and sex between children who had CLABSI and those who did not develop it.

The common PICU diagnoses were acute respiratory conditions, congenital heart disease, sepsis, surgical patients post-operatively, trauma, and others in that order. This was in keeping with a study done in Australia where most indications of admission were respiratory; cardiac; surgical; trauma; sepsis, etc., but not necessarily in the same order.[32]

With regard to risk factors, the known risk factors associated withfor CLABSI in the current study were blood transfusion and long duration of the central line. Blood transfusion is known to be a risk factor for development of CLABSI.[14] TPN and malnutrition are known to be independent risk factors for development of CLABSI.[12,15] However, in the current study, they were not significantly associated with the development of CLABSI.

All children who developed CLABSI had received broad spectrum antibiotics prior to developing CLABSI. However, there was no significant association when compared to the children who had also received broad spectrum antibiotics but did not develop CLABSI. This was not in keeping with studies conducted in India,[17] America,[11] and Japan,[33] which reported that the use of broad spectrum antibiotics is a risk for developing CLABSI.

Risk factors related to the catheter site and the type of catheter inserted could not be compared for risk assessment because almost all (99%) study children had non-tunnelled central line catheters, Furthermore, out of all the non-tunnelled catheters, only one child had a subclavian central line; the rest, had femoral catheters. It is known that non-tunnelled catheters carry a greater risk of CLABSI than tunnelled,[19] Femoral catheterisation is associated with a higher risk of CLABSI than internal jugular and subclavian access.[20]

Central line days since insertion is also a predictor for CLABSI, and this was also true in the current study. There were significantly more patients who had the lines *in situ* for more than 7 days among children with CLABSI compared with those who did not develop CLABSI. This was in keeping with a systematic review and meta-analysis which showed that prolonged catheterisation is a major risk factor for developing CLABSI.[34]

Ninety-four percent of all the patients with CLABSI had markedly and moderately elevated CRP levels, and only 5% had normal CRP levels at the time of CLABSI diagnosis. Only 47% of the CLABSI had elevated white cell count, while 53% had normal white cell count. CRP is an inflammatory protein used in clinical practice to guide antibiotic therapy, and the discrepancy between its increase and normal WCC in the current study might be due to the prior use of antibiotics before the diagnosis of CLABSI. This was not in keeping with a study done in Japan where patients with CLABSI showed a low white cell count and CRP compared to bloodstream infections without central line catheter.[35]

The most common causes of CLABSI in the current study were Gram-negative organisms like multi-resistant *Acinetobacter baumannii*, *E. coli* and *Klebsiella pneumoniae.*. Fungal infections were the second most common cause, and these were *Candida albicans*, *Candida glabrata*, *Candida parapsilosis*, and *Candida tropicalis*. The least common cause was Gram-positive organisms such as *Staphylococcus epidermidis* and *Enterococcus faecium*.

These findings were not consistent with findings from the CDC, where Gram-positive organisms like *Coagulase negative staphylococci*, *Enterococci*, and *Staphylococcus aureus* were the common causes of CLABSI, followed by Gram-negative organisms like *Klebsiella*, *Enterobacter*, *Pseudomonas, E. coli*, and *Acinetobacter*, with *Candida* species being the least common. It was however, in keeping with South African studies where Gram-negative organisms were found to be a common cause of bloodstream infections and CLABSI rather than Gram-positive organisms.[2,27] Multi-resistant *Acinetobacter baumannii,* requires that there be an emphasis on infection prevention measures and on strengthening antibiotic stewardship.

Complications of CLABSI include port pocket infections, endovascular infections such as endocarditis and thrombophlebitis, and metastatic infections such as osteomyelitis and liver, spleen, and brain abscesses. The only complication of CLABSI recorded in the current study was septic shock, and there was no evidence of other complications during the clinical examination.

Catheter tip cultures were not done routinely in all the

patients who had central lines; the positive tips did not help in the diagnosis of CLABSI. Although 63% of the patients had positive catheter tips, with negative blood cultures. Peterson and Smith[36] did not find any clinical significance of central line catheter tip cultures in the diagnosis of CLABSI. Huang et al.[37] noted that central line catheter cultures had no impact on antimicrobial therapy for CLABSI.

The CLABSI mortality rate was 21% in the current study. The mortality rate for CLABSI is estimated to be 20-25% globally by the CDC, and 12-15% in Southern California.[38] The cause of death among all the CLABSI patients was fungal infection. Fifty percent of them were HIV positive and malnourished, adding more risk of mortality, and the other two had cardiac issues. The cause for fungal CLABSI mortality is due to late diagnosis as most patients who deteriorate in the ICU are empirically commenced on antibiotic treatment for Gram-negative and Gram-positive organisms.

Study Limitations

This was a retrospective record review study in a hospital with no electronic filing system for patients, and approximately one fifth of the hospital files were either missing or had insufficient information. The findings of the study may not be generalizable to hospitals in well-resourced settings and may be compared to similarly resourced settings. Dora Nginza PICU only admits children 12 years, but in the studies used for comparison, the ages of participants were up to 18 years, and this should be considered a limitation.

Conclusion

This study found a very high CLABSI incidence of 31/1000 line days at Dora Nginza PICU; blood transfusion and long catheter line days were significant risk factors. The multi-drug resistant *Acinetobacter baumannii* was the most common cause of CLABSI, and fungal infection was associated with high mortality. Further studies focusing on fungal causes of CLABSI are recommended.

Ethics

Ethics Committee Approval: Ethical clearance was obtained from the Institutional Review Board of Walter Sisulu University (certificate number: 009/2022, date: 30.03.2022).

Informed Consent: It was not included because it was a descriptive study with a cross-sectional retrospective review of the records of patients with central catheters.

Footnotes

Authorship Contributions

Concept: N.V.B., N.P.Z., S.M., Design: N.V.B., N.P.Z., S.M., Data Collection or Processing: N.V.B., Analysis or Interpretation: N.V.B., S.M., Literature Search: N.V.B., N.P.Z., S.M., Writing: N.V.B., N.P.Z., S.M.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Bell T, O'Grady NP. Prevention of central line-associated bloodstream infections. Infect Dis Clin North Am. 2017;31:551-9.
2. Geldenhuys C, Dramowski A, Jenkins A, Bekker A. Central-line-associated bloodstream infections in a resource-limited South African neonatal intensive care unit. S Afr Med J. 2017 25;107:758-62.
3. Centers for Disease Control and Prevention (CDC). Vital signs: central line-associated blood stream infections–United States, 2001, 2008, and 2009. MMWR Morb Mortal Wkly Rep. 2011;60:243-8.
4. Lutwick L, Al-Maani AS, Mehtar S, Memish Z, Rosenthal VD, et al. Managing and preventing vascular catheter infections: a position paper of the international society for infectious diseases. Int J Infect Dis. 2019;84:22-9.
5. Gupta P, Thomas M, Patel A, George R, Mathews L, et al. Bundle approach used to achieve zero central line-associated bloodstream infections in an adult coronary intensive care unit. BMJ Open Qual. 2021;10:e001200.
6. Wright MO, Decker SG, Allen-Bridson K, Hebden JN, Leaptrot D. Healthcare-associated infections studies project: An American Journal of Infection Control and National Healthcare Safety Network data quality collaboration: location mapping. Am J Infect Control. 2018;46:577-8.
7. Han Z, Liang SY, Marschall J. Current strategies for the prevention and management of central line-associated bloodstream infections. Infect Drug Resist. 2010;3:147-63.
8. Ista E, van der Hoven B, Kornelisse RF, et al. Effectiveness of insertion and maintenance bundles to prevent central-line-associated bloodstream infections in critically ill patients of all ages: a systematic review and meta-analysis. Lancet Infect Dis. 2016;16:724-34.
9. Al-Abdely HM, Alshehri AD, Rosenthal VD, Mohammed YK, Banjar W, et al. Prospective multicentre study in intensive care units in five cities from the Kingdom of South Arabia: Impact of the International Nosocomial Infection control consortium multidimensional approach on rates of central line-associated bloodstream infection. J Infect Prev. 2017;18:25-34.
10. Afhami S, Seifi A, Hajiabdolbaghi M, Bazaz NE, Hadadi A, et al. Assessment of device-associated infection rates in teaching hospitals in Islamic Republic of Iran. East Mediterr Health J. 2019;25:90-7.
11. Haddadin Y, Annamaraju P, Regunath H. Central line–associated blood stream infections. [Updated 2022 Nov 26]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing. 2024-. Available at: https://www.ncbi.nlm.nih.gov/books/NBK430891/
12. Kelly M, Conway M, Wirth K, Potter-Bynoe G, Billett AL, et al. Moving CLABSI prevention beyond the intensive care unit: risk factors in pediatric oncology patients. Infect Control Hosp Epidemiol. 2011;32:1079-85.

13. Mollee P, Jones M, Stackelroth J, van Kuilenburg R, Joubert W, et al. Catheter-associated bloodstream infection incidence and risk factors in adults with cancer: a prospective cohort study. J Hosp Infect. 2011;78:26-30.

14. Alshahrani KM, Alhuwaishel AZ, Alangari NM, Asiri MA, Al-Shahrani NA, et al. Clinical Impacts and risk factors for central line-associated bloodstream infection: a systematic review. Cureus. 2023;15:e40954.

15. Fonseca G, Burgermaster M, Larson E, Seres DS. The Relationship Between parenteral nutrition and central line-associated bloodstream infections: 2009-2014. J Parenter Enteral Nutr. 2018;42:171-5.

16. Mathew R, Simms A, Wood M, Taylor K, Ferrari S, et al. Central line-associated bloodstream infection through focus on the mesosystem: standardization, data, and accountability. Pediatr Qual Saf. 2020;5:e272.

17. Mishra SB, Misra R, Azim A, Baronia AK, Prasad KN, et al. Incidence, risk factors and associated mortality of central line-associated bloodstream infections at an intensive care unit in northern India. Int J Qual Health Care. 2017;29:63-7.

18. Cohen B, Choi YJ, Hyman S, Furuya EY, Neidell M, et al. Gender differences in risk of bloodstream and surgical site infections. J Gen Intern Med. 2013;28:1318-25.

19. Maki DG, Kluger DM, Crnich CJ. The risk of bloodstream infection in adults with different intravascular devices: a systematic review of 200 published prospective studies. Mayo Clin Proc. 2006;81:1159-71.

20. O'Grady NP, Alexander M, Burns LA, Dellinger EP, Garland J, et al. Healthcare Infection Control Practices Advisory Committee (HICPAC). Guidelines for the prevention of intravascular catheter-related infections. Clin Infect Dis. 2011;52: e162-93.

21. Kovacs CS, Fatica C, Butler R, Gordon SM, Fraser TG. Hospital-acquired *Staphylococcus aureus* primary bloodstream infection: a comparison of events that do and do not meet the central line-associated bloodstream infection definition. Am J Infect Control. 2016;44:1252-5.

22. Govindan S, Prenovost K, Chopra V, Iwashyna TJ. A comprehension scale for central-line associated bloodstream infection: results of a preliminary survey and factor analysis. PLoS One. 2018;13:e0203431.

23. Sellamuthu R, Nair S, Chandrasekar J, Kesavan S, Shivam V. Risk factors of central line-associated bloodstream infection (CLABSI): a prospective study from a paediatric intensive care unit in South India. Cureus. 2023;15:e43349.

24. Paioni P, Kuhn S, Strässle Y, Seifert B, Berger C. Risk factors for central line-associated bloodstream infections in children with tunnelled central venous catheters. Am J Infect Control. 2020;48:33-9.

25. Rojas D, Wendel I D, Ferguson TF, Robinson, WT, Trepka MJ, et al. HIV-associated comorbidities as mediators of the association between people living with HIV and hospital-acquired infections. Am J Infect Control. 2019;47:1500-4.

26. Rosenthal VD, Udwadia FE, Kumar S, Poojary A, Sankar R, et al. Clinical impact and cost-effectiveness of split-septum and single-use prefilled flushing device vs 3-way stopcock on central line-associated bloodstream infection rates in India: a randomized clinical trial conducted by the International Nosocomial Infection Control Consortium (INICC). Am J Infect Control. 2015;43:1040-5.

27. Glover E, Abrahamson A, Adams J, Poken SR, Hainsworth SL, et al. Central line-associated bloodstream infections at the multidisciplinary intensive care unit of Universitas Academic Hospital, Bloemfontein, South Africa. Afr J Thorac Crit Care Med. 2022;28:10.7196/AJTCCM.2022.v28i1.175.

28. Dudeck MA, Edwards JR, Allen-Bridson K, Gross C, Malpiedi PJ, et al. National healthcare safety network report, data summary for 2013, device-associated module. Am J Infect Control. 2015;43:206-21.

29. El-Kholy A, Saied T, Gaber M, Younan MA, Haleim MM, et al. Device-associated nosocomial infection rates in intensive care units at Cairo University hospitals: first step toward initiating surveillance programs in a resource-limited country. Am J Infect Control 2012;40:e216-20.

30. van den Bosch CH, van der Bruggen JT, Frakking FNJ, Terwisscha van Scheltinga CEJ, van de Ven CP, et al. Incidence, severity and outcome of central line related complications in pediatric oncology patients; a single center study. J Pediatr Surg. 2019;54:1894-900.

31. Atilla A, Doğanay Z, Kefeli Çelik H, Demirağ MD, S Kiliç S. Central line-associated blood stream infections: characteristics and risk factors for mortality over a 5.5-year period. Turk J Med Sci. 2017;47:646-52.

32. Ibiebele I, Algert CS, Bowen JR, Roberts CL. Pediatric admissions that include intensive care: a population-based study. BMC Health Serv Res. 2018;18:264.

33. Nemoto T, Kunishima H, Shimizu G, Hirose M, Yamasaki Y, et al. Factors predicting the cause and prognosis of central line-associated bloodstream infections. J Infect Chemother. 2015;21:118-22.

34. Lafuente Cabrero E, Terradas Robledo R, Civit Cuñado A, García Sardelli D, Hidalgo López C, et al. Risk factors of catheter- associated bloodstream infection: systematic review and meta-analysis. PLoS One. 2023;18:e0282290.

35. Akaishi T, Tokuda K, Katsumi M, Fujimaki SI, Aoyagi T, et al. Blood culture result profile in patients with central line-associated bloodstream infection (CLABSI): a single-center experience. Cureus. 2023;15:e40202.

36. Peterson LR, Smith BA. Nonutility of catheter tip cultures for the diagnosis of central line-associated bloodstream infection. Clin Infect Dis. 2015;60:492-3.

37. Huang H, Chang Q, Zhou Y, Liao L. Risk factors of central catheter bloodstream infections in intensive care units: a systematic review and meta-analysis. PLoS One. 2024;19:e0296723.

38. Toor H, Farr S, Savla P, Kashyap S, Wang S, et al. Prevalence of central line-associated bloodstream infections (CLABSI) in intensive care and medical-surgical units. Cureus. 2022;14:e22809.