https://doi.org/10.29309/TPMJ/2023.30.11.7740

The Professional Medical Journal
www.theprofesional.com
2023, Volume, 30 Issue, 11

ORIGINAL ARTICLE

Complications associated with central venous catheterization in pediatric ICU of a tertiary care hospital of Pakistan.

Humaira Rafiq[1], Ata Ullah Khan[2], Seema Sakina[3], Hafiz Asim Ali Qaisar[4]

Article Citation: Rafiq H, Khan A, Sakina S, Qaisar HAA. Complications associated with central venous catheterization in pediatric ICU of a tertiary care hospital of Pakistan. Professional Med J 2023; 30(11):1398-1403. https://doi.org/10.29309/TPMJ/2023.30.11.7740

ABSTRACT… Objective: To determine the frequency of complications of central venous line insertion among children admitted in Pediatric Intensive Care Unit (PICU). **Study Design:** Cross-sectional study. **Setting:** PICU of Shifa International Hospital, Islamabad, Pakistan. **Period:** March 2022 to February 2023. **Material & Methods:** Children of either gender aged between 2 months to 16 years admitted in PICU during study period and underwent central venous catheterization(CVC) during admission were analysed. The patients were observed for immediate and late complications of CVC. **Results:** In a total of 160 children, 89 (55.6%) were boys. The mean age at the time of admission was 6.00±4.87 years. Immediate complications occurred among 9 (5.6%) children including catheter malposition, pneumothorax, hematoma, and arterial puncture observed in 4 (2.5%), 2 (1.3%), 2 (1.3%) and 1 (0.6%) children respectively. The CLABSI rate was 16.8 per 1,000 catheter days. The most common micro-organisms causing CLABSI were Methicillin Resistant Staph Epidermidis (MRSE), and Klebsiella, reported in 3 (21.4%) cases each. Younger age ($p<0.001$), relatively low body weight ($p<0.001$), and increased duration of central venous line placed ($p<0.001$) were found to be significantly associated with CLABSI. **Conclusion:** In this study, CLABSI rate was found to be 16.8 per 1,000 catheter days which is comparable to the regional data. Common immediate complications of CVC were catheter malposition, pneumothorax, hematoma, and arterial puncture. Younger age and increased duration of CVC were associated with CLABSI.

Key words: Central Venous Catheter, Complications, Infection, Pediatrics, Pneumothorax.

INTRODUCTION

Paediatric critical care medicine is a newly evolving speciality in Pakistan and only few centres have dedicated Paediatric Intensive Care Units (PICU). In PICU settings, central venous catheter (CVC) insertion is a frequently carried out practice.[1] Over 5 million CVC insertions are performed annually in USA alone, accounting for 15 million CVC days.[2] Like any other procedure central line insertion is also not without risks. Complications associated with central venous catheter can be immediate or delayed. Immediate complications can be pneumothorax, haemothorax, pnemomediastinum, arterial injury, cardiac arrhythmias and malposition. Delayed complications can be central line blockage, thrombosis and infections.[3]

Current practices of Ultrasound guided catheter insertion have decreased the burden of immediate complications linked to CVC which have been recorded to be between 4-11.8%.[4] According to a study done in Pakistan 11.1% children developed immediate complications after passing CVC under USG guidance, with pneumothorax to be the commonest, noted in 2% children.[5] Catheter related blood stream infection is one of the dreadful complication causing mortality in 12 to 25% of cases.[6] Variation in the incidence of CVC related infections have been reported in different countries.[7,8]

Previously, multiple studies have been done on central venous line associated infections and their microbiological profile but there is paucity of data in paediatric population especially in our part of

1. MBBS, FCPS (Pediatric Medicine), Fellow Pediatric Critical care Medicine Pediatric ICU, Shifa International Hospital, Islamabad
2. MBBS, MCPS, FCPS (Pediatric Medicine), Consultant Pediatric ICU, Shifa International Hospital, Islamabad.
3. MBBS, FCPS (Pediatric Medicine), Fellow Pediatric Critical Care Medicine Pediatric ICU, Shifa International Hospital, Islamabad.
4. MBBS, FCPS (Pediatric Medicine), MRCPCH, Consultant Pediatric ICU, Shifa International Hospital, Islamabad.

Correspondence Address:
Dr. Humaira Rafiq
Department of Pediatric ICU
Shifa International Hospital, Islamabad.
humairarafiq88@gmail.com

Article received on: 15/06/2023
Accepted for publication: 21/08/2023

the country. This research study was carried out to determine the frequency of complications of central venous line among children admitted in PICU.

MATERIAL & METHODS

This cross-sectional study was conducted in the Pediatric Intensive Care Unit (PICU) of Shifa International Hospital, Islamabad, Pakistan from March 2022 to February 2023. Shifa international hospital is accredited by Joint commission international. Our PICU is closed unit with 9 beds. Study was approved by Institution of Review Board and Ethical committee of our hospital (IRB#0185-23) and exemption from consent was obtained. Inclusion criteria were children of either gender aged between 2 months to 16 years admitted in PICU and centrally cannulated during admission as a part of their management. Children who were shifted to another healthcare facility with central line in place were excluded.

At the time of enrolment, demographic information like age, gender and weight and admitting diagnosis were noted. Insertion of central venous catheter was decided by the on-duty PICU physician. Written/informed consent was obtained from parents/guardians of all children undergoing CVC placement. The central venous catheterization was done using standard seldinger technique under ultrasound guidance while taking aseptic measures. Site of CVC was noted, and complications such as hematoma and arterial puncture were noted. Chest x rays were done after procedures as a routine and reviewed for mechanical complications which included pneumothorax, hemaothorax, pneumomediastinum, or malpositioned catheters. Relevant laboratory investigations aiding underlying diagnosis and management of all admitted children were performed. All patients were observed for developing signs and symptoms of infection as per institutional protocols. CLABSI was suspected if the patient developed the following signs; temperature $> 38\ ^0C$ or $< 36\ ^0C$, tachycardia, hypotension, poor perfusion, or altered mental status. Blood cultures of these patients were sent. Centre for disease control (CDC) definition of CLABSI was followed as "the recovery of a pathogen from a blood culture (a single blood culture for an organism not commonly present on the skin and two or more blood cultures for organism commonly present on the skin) in a patient who had a central line at the time of infection or within 48 hours before the development of infection and infection is not related to another site".[9] In cultures positive cases, frequencies of microorganisms were recorded. A pre-designed format was developed to record study information.

The CLABSI rate per 1000 catheter days was calculated by:
(Number of CLABSI cases x 1000) / sum of days for which CVC placed

Data analysis was performed employing "Statistical Package for Social Sciences (SPSS)", version 26.0. Mean and standard deviation (SD) were calculated for numerical variables whereas frequencies and percentage were calculated for categorical data. Data was stratified with respect to central line-associated bloodstream infection (CLABSI) and post-stratification chi-square or independent sample t-test were applied considering $p<0.05$ as significant.

RESULTS

From March 2022 to February 2023, a total of 750 children were admitted to PICU. Out of these 750 children, central venous line was placed in 164 (21.9%) children. Four children were referred to other healthcare facilities so we could not follow them, hence, those 4 children were excluded from the final analysis.

Total number of central venous catheter days were 835 days with mean duration of 5.22 ± 4.69 days. Out of a total of 160 children, 89 (55.6%) were boys. The mean age at the time of admission was 6.00 ± 4.87 years ranging between 2 months to 16. The mean body weight was 18.79 ± 12.30 kg ranging between 2 to 60 kg. Most common types of underlying diagnosis were related to cardiovascular disorders, renal disorders and neuromuscular disorders recorded in 37 (23.1%), 28 (17.5%) and 27 (16.9%) children respectively. Site of central venous line insertion was right

internal jugular vein in 136 (85.0%) children. The mean number of pricks for performing central venous line placement were 1.20±0.57 while the central venous line was place in the first prick in 136 (85.0%) children. Immediate complications occurred among 9 (5.6%) children including catheter malposition, pneumothorax, hematoma, and arterial puncture observed in 4 (2.5%), 2 (1.3%), 2 (1.3%) and 1 (0.6%) children respectively.

Central line associated blood stream infections (CLABSI) were reported in 14 (8.8%) children. The CLABSI rate was calculated to be 16.8 per 1,000 catheter days considering total CVC days as 835 and number of children who had CLABSI as 14. In these 14 children, the most common micro-organisms identified were Methicillin Resistent Staph Epidermidis (MRSE) in 3 (21.4%), Klebsiella 3 (21.4%), candida 2 (14.3%), enterococcus 2 (14.3%), acinetobacter 1 (7.1%), E. coli 1 (7.1%), MRSA 1 (7.1%) and, serratia 1 (7.1%).

The mean duration of PICU stay was 5.84±6.33 days. Younger age (p<0.001), relatively low body weight (p<0.001), and increased duration of central venous line placed (p<0.001) were found to be significantly associated with CLABSI (Table-I).

Characteristics		CLABSI		P-Value
		Yes (n=14)	No (n=146)	
Gender	Boys	7 (50.0%)	82 (56.2%)	0.657
	Girls	7 (50.0%)	64 (43.8%)	
Age (years)	<1	10 (71.4%)	17 (9.6%)	<0.001
	1-5	2 (14.3%)	56 (38.4%)	
	6-12	2 (14.3%)	52 (35.6%)	
	13-16	-	21 (14.4%)	
Weight (kg)	<10	9	23 (15.8%)	<0.001
	10-20	3	69 (47.3%)	
	>20	2	54 (37.0%)	
Underlying diagnosis	Cardiovascular disorders	2 (14.3%)	35 (24.0%)	0.784
	Immunological disorders	-	10 (6.8%)	
	GI disorders	2 (14.3%)	8 (3.4%)	
	Hematological disorders	1 (14.3%)	2 (1.4%)	
	Hepatic disorders	1 (7.1%)	9 (6.2%)	
	Malignancy	1 (7.1%)	10 (6.8%)	
	Metabolic disorders	1 (7.1%)	6 (4.1%)	
	Neurological disorders	2 (21.4%)	25 (17.1%)	
	Renal disorders	2 (7.1%)	26 (17.8%)	
	Respiratory disorders	2 (21.4%)	13 (8.9%)	
	Trauma	-	2 (1.4%)	
Site of central venous line placement	Right internal jugular vein	12 985.7%)	124 (84.9%)	0.834
	Left internal jugular vein	2 (14.3%)	15 (10.3%)	
	Right femoral	-	6 (4.1%)	
	Left femoral	-	1 (0.7%)	
Duration of CVC placed (days)	<3	-	54 (37.0%)	<0.001
	3-7	3 (21.4%)	69 (47.3%)	
	>7	11 (78.6%)	23 (15.8%)	
Outcome	Discharged	10 (71.4%)	112 (76.7%)	0.657
	Died	4 (28.6%)	34 (23.3%)	

Table-I. Stratification of study variables with respect to Central line associated blood stream infections

DISCUSSION

CVC is one of the most frequent procedures performed in PICU for various indications such as difficult venous access, repeated sampling, administration of drugs, blood products, parenteral nutrition and chemotherapy, haemodialysis, and monitoring of central venous pressure.[10] According to the present study, the CVC was passed in 21.9% patients admitted in PICU.

Several complications are associated with central venous line use that can occur during or after the procedure. Mechanical and infectious complications are some of the most significant and potentially life-threatening complications associated with CVCs.[16] In our study immediate complications were noted in 5.6% cases. The literature reports pneumothorax to be the most common mechanical complication of CVC.[17] A study from Columbia reported pneumothorax in 1.2% patients who had CVC placed in a tertiary care hospital.[18] Kaur et al showed overall incidence of pneumothorax to be 2.2 %.[15] Our study revealed pneumothorax in 1.3% which is comparable to international figures.

The present study revealed that CLABSI rate was 16.8 per 1000 catheter days. A study performed in Aga khan university Hospital Karachi showed the incidence of CLABSI 13.3 per 1000 central line days.[11] Abdelmoneim et al from Egypt reported CLABSI rate to be 14.1 per 1000 catheter days which is close to what we found.[12] Regional data has reported CLABSI rates to be ranging between 2.8 to 24.6 per 1000 catheter days.[7,13-15] Data from USA calculate 30,100 CLABSI cases annually among ICUs.[9] The literature reports variation in CLABSI rates from various parts of the world. Different results can be related to technique, site of catheter insertion, experience of individual performing procedure, central line care and co morbidities of patient. Higher rates of CLABSI among developing countries can be due to higher central line usage, rapid staff turnover, a lack of on-going training, and staffing shortages.

According to CDC guidelines of 2011 the most commonly reported causative organisms are coagulase-negative staphylococci, Staphylococcus aureus, enterococci, and Candida spp.[9] Based on the "National Healthcare Safety Network (NHSN)" data, Gram-positive organisms (coagulase-negative staphylococci, 34.1%; enterococci, 16%; and Staphylococcus aureus, 9.9%) are the most common, followed by gram negatives (Klebsiella, 5.8%; Enterobacter, 3.9%; Pseudomonas, 3.1%; E.coli, 2.7%; Acinetobacter, 2.2%), Candida species (11.8%), and others (10.5%).[19,20] Our study revealed the most common organism being MRSE and klebsiella responsible for 21.4% cases each. Study performed in Egypt showed the frequency of Klebsiella to be 63.6%, Candida albicans 13.6%, Proteus 9.1%, and MRSA 9.1% which is different to the present findings.[12] As it is a single-center study, our results cannot be generalised. Further multicentric studies involving large set of patients should be conducted with prospective design to further add what is known about the burden and associated factors of CLABSI in this region.

CONCLUSION

In this study, CLABSI rate was found to be 16.8 per 1,000 catheter days which is comparable to the regional data. Common mechanical complications of CVC were catheter malposition, pneumothorax, hematoma, and arterial puncture. Methicillin Resistant Staph Epidermidis and Klebsiella were the most common micro-organisms identified. Younger age and increased duration of CVC were associated with CLABSI.

REFERENCES

1. Safety Committee of Japanese Society of Anesthesiologists. **Practical guide for safe central venous catheterization and management 2017.** J Anesth. 2020; 34(2):167-186. doi:10.1007/s00540-019-02702-9

2. McGee DC, Gould MK. **Preventing complications of central venous catheterization.** N Engl J Med. 2003; 348(12):1123-33. doi: 10.1056/NEJMra011883

3. Patel AR, Patel AR, Singh S, Singh S, Khawaja I. **Central line catheters and associated complications: A review.** Cureus. 2019; 11(5):e4717. doi:10.7759/cureus.4717

4. Bhutta ST, Culp WC. **Evaluation and management of central venous access complications.** Tech Vasc Interv Radiol. 2011; 14(4):217-224. doi:10.1053/j.tvir.2011.05.003

5. Rasheed A, Basheer F, Iqbal T, Hassan SK. **Real Time Ultrasound guided practice in passing central venous pressure line in pediatric population.** J Dow Uni Health Sci. 2021; 15(3):149-154. doi: 0.36570/jduhs.2021.3.1190J Dow Univ Health Sci 2021, Vol. 15 (3): 149-154149

6. Gahlot R, Nigam C, Kumar V, Yadav G, Anupurba S. **Catheter-related bloodstream infections.** Int J Crit Illn Inj Sci. 2014; 4(2):162-167. doi:10.4103/2229-5151.134184

7. Kaur M, Gupta V, Gombar S, Chander J, Sahoo T. **Incidence, risk factors, microbiology of venous catheter associated bloodstream infections--a prospective study from a tertiary care hospital.** Indian J Med Microbiol. 2015; 33(2):248-254. doi:10.4103/0255-0857.153572

8. Ahmed B, Khan BA, Khan M, Beg MA. **Frequency of Central Venous Catheter Related Infections and their Culture and Sensitivity Pattern.** J Islamabad Med Dent Coll. 2016; 5(2):63-66.

9. Centers of Disease Control and Prevention. **Bloodstream Infection Event (Central Line-Associated Bloodstream Infection and Non-central line-associated Bloodstream Infection).** 2015. www.cdc.gov/nhsn/PDFs/pscManual/4PSC_ CLABScurrent.pdf. Accessed 27 Jun 2016.

10. Timsit JF, Baleine J, Bernard L, Silvia C, Darmon M, Dellamonica J, et al. **Expert consensus-based clinical practice guidelines management of intravascular catheters in the intensive care unit. Ann Intensive Care.** 2020; 10(1):118. doi:10.1186/s13613-020-00713-4

11. Ahmed SA, Haque A, Abbas Q, Jurair H, Qamar ud Din Z, Afroze B. **Device associated infections in a pediatric intensive care unit of a tertiary care hospital, Pakistan.** Professional Med J. 2021; 28(3):338-343. doi: 10.29309/TPMJ/2021.28.03.5241

12. Abdelmoneim HM, Ibrahim HM, Ahmed AR, Mohammed KA. **Incidence of central line-associated blood steam infection in Pediatric Intensive Care Unit (PICU).** Egypt J Hosp Med. 2020; 78(1):136-141.

13. Mehta A, Rosenthal VD, Mehta Y, Chakravarthy M, Todi SK, Sen N, et al. **Device-associated nosocomial infection rates in intensive care units of seven Indian cities. Findings of the International Nosocomial Infection Control Consortium (INICC).** J Hosp Infect. 2007; 67(2):168-174. doi:10.1016/j.jhin.2007.07.008

14. Patil HV, Patil VC, Ramteerthkar MN, Kulkarni RD. **Central venous catheter-related bloodstream infections in the intensive care unit.** Indian J Crit Care Med. 2011; 15(4):213-223. doi:10.4103/0972-5229.92074

15. Kaur R, Mathai AS, Abraham J. **Mechanical and infectious complications of central venous catheterizations in a tertiary-level intensive care unit in northern India.** Indian J Anaesth. 2012; 56(4):376-381. doi:10.4103/0019-5049.100823

16. Odendaal J, Kong VY, Sartorius B, Liu TY, Liu YY, Clarke DL. **Mechanical complications of central venous catheterisation in trauma patients.** Ann R Coll Surg Engl. 2017; 99(5):390-393. doi:10.1308/rcsann.2017.0022

17. Tsotsolis N, Tsirgogianni K, Kioumis I, et al. **Pneumothorax as a complication of central venous catheter insertion.** Ann Transl Med. 2015; 3(3):40. doi:10.3978/j.issn.2305-5839.2015.02.11

18. Devia Jaramillo G, Torres Castillo J, Lozano F, Ramírez A. **Ultrasound-guided central venous catheter placement in the emergency department: Experience in a hospital in Bogotá, Colombia.** Open Access Emerg Med. 2018; 10:61-65. doi:10.2147/OAEM.S150966

19. 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(2):646-652. doi:10.3906/sag-1511-29

20. 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(5):577-578. doi:10.1016/j.ajic.2017.12.012

AUTHORSHIP AND CONTRIBUTION DECLARATION

No.	Author(s) Full Name	Contribution to the paper	Author(s) Signature
1	Humaira Rafiq	Data collection, Drafting.	
2	Ata Ullah Khan	Study concept, Methodology,	
3	Seema Sakina	Data collection, Literature review.	
4	Hafiz Asim Ali Qaisar	Proof reading, Revisions.	