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RESEARCH ARTICLE

INCIDENCE AND RISK FACTORS OF CENTRAL VENOUS LINE ASSOCIATED BLOODSTREAM INFECTIONS IN THE PAEDIATRIC INTENSIVE CARE UNIT OF A TERTIARY CARE HOSPITAL: A PROSPECTIVE STUDY

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ABSTRACT

Introduction: Hospital acquired infections have caused high morbidity and mortality, of which central line associated blood stream infections (CLABSI) account for high costs and prolonged hospital stay. As per CDC guidelines CLABSI is defined as "a laboratory confirmed blood stream infection in a patient who had a central line within the 48 hours before the development of the blood stream infection and that is not related to an infection at another site". ***Objectives:*** To determine the incidence of CLABSI in the PICU and the risk factors associated with it. ***Material and methods:*** Among 72 children with central venous catheters in the PICU, with new onset sepsis, two sets of blood samples, one percutaneously and other from catheter hub were collected. The samples were cultured by Bactec method. Catheter tips were sent for culture at the time of removal. Data collection was done and analyzed using SPSS version 21. ***Results:*** 4 children (5.6%) had CLABSI. The incidence density of CLABSI was 6.6 per 1000 central line days. Of the 4 CLABSIs, 2 cases grew Candida and 1 each grew Staphylococcus aureus and E coli. The mean duration of hospital stay in CLABSI and no CLABSI cases was 15.25+7.2 and 11.78+3.48 days respectively. The length of hospital stay was found to be statistically significant with the incidence of CLABSI. ***Conclusion:*** The incidence density of CLABSI was 6.6 per 1000 central line days. The duration of hospital stay was found to have statistically significant association with CLABSI incidence.

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INTRODUCTION

Hospital acquired infections (HAI) have emerged as a global concern worldwide in the health department due to its association with high morbidity and mortality and also alarmingly high added costs to health care system, although significant efforts are being made towards prevention. Amongst the HAIs, CLABSI account for the highest rate of morbidity, mortality, prolonged hospital stay and cost, nearly $46000 per case.(1) Assessing the overall burden of HAI is challenging and a tedious process. "Central line associated blood stream infection (CLABSI) is defined as a laboratory confirmed blood stream infection in a patient who has had a central line within the 48 hour period before the development of the blood stream infection and that is not related to an infection at another site; it is defined by the National Healthcare Safety Network (NHSN) for the purpose of surveillance of health care-associated infection."(2) Central venous catheters play an important role in modern critical health care. It is widely used in ICU patients for administration of intravenous fluids, delivery of medications, blood products, parenteral nutrition and providing access for hemodynamic monitoring and haemodialysis, but their use is associated with a high risk of developing bloodstream infection caused by microorganisms colonizing the extraluminal or intraluminal surface of the device.

In PICUs, the occurrence of central line associated bloodstream infections (CLABSI) is a common entity. Its occurrence is attributed to wrong technique of insertion and improper maintenance. Several evidence based protocols have been implemented through the PICUs aiming at prevention of CLABSI. The success rates for cutting down on CLABSI rates vary among hospitals. Some hospitals have managed to reduce CLABSI rates to a minimum, few have ensured zero rates for over a period of time and others have been inconsistent in their efforts. In developed countries, achieving a zero CLABSI rate is considered as a standard of health care facility and also a prime parameter for procuring accreditation of health management. Even in limited resource settings, CLABSI can be largely preventable by using simple evidence based catheter care bundle practices. The CDC has devised guidelines for catheter insertion, handling and maintenance of central line along with supplemental strategies such as antimicrobial impregnated catheters and caps. It also emphasizes on empowering and educating healthcare personnel. The present study was a prospective study monitoring the occurrence of CLABSI in the PICU of our hospital for a period of 18 months. The main purpose of the study was to obtain the incidence rates and epidemiology of CLABSI.

MATERIAL AND METHODS

A prospective observational study was conducted at paediatric Intensive Care Unit in a tertiary care teaching hospital, south India. Study duration was 1 year and 6 months. Sample size was calculated in reference to the incidence value of CLABSI in a previous study by Tomar *et al*[3] Formula used was S= z^2p*q/d^2, wherein z =1.96 (confidence interval), p=4.9, q = (100-4.9), d (marginal error) of 5% & S= 1.96*1.96*4.9*95.1/5*5 = 1790.14/25 = 71.60. Using this formula the sample size is estimated to be 71.60 rounded off to 72 and purposive sampling was adopted. Children aged >2 months to 18 years with central venous catheter inserted during the study period in situ for more than 48 hours were included in the study. Transferred in patients with indwelling central venous catheter inserted elsewhere were excluded from the study. After taking institutional ethical committee clearance & informed consent from the patient attenders, demographic details such as name, age, gender, address, in patient number and clinical details such as current diagnosis, co morbidities, indication for CVC insertion, site of CVC insertion, type of CVC used and method of placement, duration of CVC insertion, other invasive devices present, presence or absence of antimicrobial therapy at the time of inclusion, findings on general physical examination and systemic examination were noted and relevant investigations were sent depending upon the clinical profile of the patient. All patients enrolled in the study were followed up daily for the development of new onset sepsis 48 hours after the insertion of the CVC as per the criteria for CDC and until 48 hours after the removal of the catheter or discharge or death whichever was earlier. After 48 hours of CVC insertion, on development of features of new onset sepsis, two sets of blood cultures were drawn, one percutaneously and one through the CVC hub within a span of 24 hours and interpreted by differential time to positivity method. Other sources of infection were identified by focused physical examination and relevant investigations depending upon the clinical presentation of the patient and such patients were excluded if a source was found. In the absence of features of systemic or local sepsis, one sample of blood was taken percutaneously for culture routinely at the time of catheter removal along with the distal 5 cm of the catheter tip which was cut using a sterile blade, placed in a sterile transport container and cultured using the semi-quantitative roll plate method described by Maki *et al.* Approval was obtained from the Institutional Ethics Committee of the Faculty of Medicine, JSS Academy of higher education and research Mysore, India to collect data and review the records of included subjects. **Statistical analysis;** The data were encoded using SPSS software version 21. Descriptive statistics were used for all variables. For nominal data, frequencies and percentages were used. For numerical data, mean ± SD was used. Appropriate graphs and tables were used to summarize data.

RESULTS

A total of 72 children were included in the study of which 47(65.3%) were males and 25(34.7%) were females. More than half of them were between 1-5 years (39 – 54.2%). All the cases 72 (100%) had femoral site as site of insertion of central line catheter. Of the 72 central lines placed, 10 had single lumen catheters (13.90%), 44 had double lumen catheters (61.10%) and 18 had triple lumen catheters (25%).Out of the 72 cases, 54(75%) children had an underlying medical disease, 12(16.70%) had a surgical condition and 6 (8.3%) had neurosurgical problem. The overall incidence of Central line associated blood stream infection was 4/72 (5.60%). The mean duration of hospital stay in CLABSI and no CLABSI cases was 15.25±7.2 and 11.78±3.48 days respectively which was found to be statistically significant. The Incidence density of CLABSI cases is given by formula

$$\text{Incidence density of CLABSI} = \frac{\text{Number of CLABSIs}}{\text{Number of Central line days}}$$

$$= 4/\ 600 \times 1000$$

$$= 6.6 \text{ per } 1000 \text{ days}$$

Of the 4 CLABSIs, 2 cases grew Candida and 1 each grew Staphylococcus aureus and E.coli respectively.

DISCUSSION

This study involved surveying 72 patients admitted in the paediatric intensive care unit with central venous line. Various risk factors such as gender, age, site of CVC insertion, type of catheter lumen, type of CVC placement, number of attempts of insertion, underlying disease, duration of ICU and hospital stay and total duration of antibiotics were individually assessed to find association, if any with CLABSI rate. The results from this prospective observational study reflected a CLABSI incidence rate of 6.6 per 1000 central line (CL) days, which is comparable to various studies. However the rates are comparatively lower than the rates reported in developing countries as seen in a study done by "S.B Mishra *et al* who reported CLABSI incidence of 17.04/1000 CL days"[4] and higher than the rates in North America(1.2-2.15/1000 CL days)[5] and European countries (1.7-3.7/1000 CL days).[6] In this study, majority of the patients were in the age group between 1-5 years but adolescents between 11-15 years had the maximum incidence of CLABSI. "A systematic review by De Jonge *et al* found older children have similar risk of CLABSI as adults, while younger children may be at increased risk".[7] "This review cites several studies concluding that the risk of CLABSI decreases with increase in age, with a plateau levels in late childhood or adolescence". [8], [9], [10],[11] In contrast "a study done by Flores J *et al* found no association between age and risk of CLABSI".[12] Although the maximum numbers of central venous lines placed were double lumen catheters, the incidence of CLABSI was found to be more in triple lumen catheters with almost equal incidence in both percutaneous and cut down methods of insertion. "In a similar study done by KY Lin *et al*, higher rates of CLABSI was associated with the use of triple lumen catheters".[13] Multiple studies have shown increased risk of infection with the use of multi lumen catheters. [14], [15], [16] However guidelines recommend using a catheter with the minimal number of ports or lumens. [17] The general medical cases required maximum central line insertions followed by surgical cases.Of the 4 cases, Candida species were grown in 2 cases, 1 case grew *Staphylococcus aureus* and the other grew *E.coli.* "The most common causative pathogens for CLABSI in the US are coagulase-negative staphylococci, Staphylococcus aureus, Enterococci, and Candida spp. Gram negative bacilli (GNB) account for 19% of CLABSIs".[18]

"In a study done by Lakshmi *et al* in Chandigarh, India, they found a predominance of GNB pathogens."[19] "Also, a study done in PICU, AIIMS, New Delhi found 96.5% of bacterial isolates causing healthcare-associated infections to be gram-negative bacteria.[20] Thus, GNBs continue to dominate in developing countries where infection control practices are suboptimal". "Emerging multi-drug resistant gram-negative bacteria are a major challenge in treatment of these infections, as seen in a study done by Tomar *et al*".[21] In our study the number of cases were only 4, hence the predominant organisms causing CLABSI could not be determined, although it throws light on emergence of fungal pathogens as a causative agent of CLABSI. Amongst the CLABSI positive cases, the mean values of length of ICU stay, hospital stay and antibiotic days were 9.25, 15.25 and 12.5 days respectively. The duration of hospital stay was found to have statistically significant association with CLABSI rate, which is in accordance to "a study done by KY Lin *et al* at Taiwan where the length of hospital stay significantly contributed to the development of CLABSI".[13] "Also in a study done by Goudie A *et al* the mean duration of hospital stay was 19 days".[21] The mean duration of central line days did not show any significant association with CLABSI which is in contrast to "a study done by Torre *et al* where the chances of developing CLABSI was reported to be 7 fold when the duration of CVC use was prolonged by one day".[22] Achieving a very low rate of CLABSI is a quality indicator of any tertiary care hospital however, maintaining a zero CLABSI rate is challenging. Strict adherence to catheter care practices is the key to prevention of CLABSI.

Table 1. Factors associated with CLABSI

VARIABLE		CLABSI	NO CLABSI	TOTAL FREQUENCY (%)	p VALUE
Age	<1 year	1 (5.9%)	16 (94.1%)	17 (100%)	
	1-5 years	1 (2.6%)	38 (97.4%)	39 (100%)	
	6-10 years	0	5 (100%)	5(100%)	
	11-15 years	2 (18.2%)	9 (81.8%)	11 (100%)	0.197
Gender	Male	2 (4.3%)	45 (95.7%)	47 (100%)	
	Female	2 (8%)	23 (92%)	25 (100%)	0.606
Type of placement	Cutdown insertion	2 (6.7%)	28 (93.3%)	30 (100%)	
	Percutaneous insertion	2 (4.8%)	40 (95.2%)	42 (100%)	1.00
Type of catheter lumen	Single	1 (5.6%)	17(94.4%)	18 (100%)	
	Double	1 (2.3%)	43 (97.7%)	44 (100%)	
	Triple	2 (20%)	8 (80%)	10 (100%)	0.06
Number of attempt	1	2 (3.2%)	60 (96.8%)	62 (100%)	
	2	2 (20%)	8 (80%)	10 (100%)	0.09

Table 2. Distribution of mean length of ICU stay, hospital stay and duration of antibiotics

Group Statistics					
	CLABSI	N	Mean	Std. Deviation	Std. Error Mean
LENGTH OF ICU STAY	CLABSI	4	9.25	3.403	1.702
	NO CLABSI	68	7.66	3.079	.373
LENGTH OF HOSPITAL STAY	CLABSI	4	15.25	7.274	3.637
	NO CLABSI	68	11.78	3.489	.423
TOTAL DURATION OF ANTIBIOTICS IN DAYS	CLABSI	4	12.50	3.416	1.708
	NO CLABSI	68	10.15	3.168	.384

The lower incidence of CLABSI in our PICU reflects upon the standard of care and strategies devised based on standard protocol for infection control. All CVCs were placed with maximal barrier measures and aseptic technique. In this study, other variables did not show any causal association with development of CLABSI. Further studies are required to determine whether the pattern of CLABSI and the variable causative factors described in this study is generalizable to other PICUs. Till date, very few reports have been published on CLABSIs occurring in PICUs in India. Most of the available data is from the western countries. Multiple reports have been published focusing on specific interventions, comparing the results prior and after intervention. Incorporation of strategies to improvise teamwork and changing behaviors in sustaining quality performance in the PICU needs further study.

CONCLUSION

This study shows an incidence density of CLABSI of 6.6 per 1000 central line days. Of all the risk factors assessed, the duration of hospital stay was found to have statistically significant association with CLABSI incidence. The incidence of CLABSI is attributed to wrong technique of Central line insertion and improper maintenance
The study shows that duration of hospital stay has direct statistically significant association with CLABSI incidence.

What is already known?: Central line associated blood stream infections (CLABSI) is a known complication of Central line insertion.

What this study adds: The incidence of CLABSI, the risk factors which contribute for and the common organism patterns in various PICU

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