Original Article

Use of central venous access devices and its complications in neonates

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ABSTRACT

Background: Intravenous therapy is a major component in the health care and appropriate research-based knowledge is essential to ensure positive patient outcomes. **Objective:** The objective of the study was to study the use of Central Venous Access Devices (CVADs) and their complications in neonates in routine practice. **Methods:** A prospective observational study was conducted at a tertiary care neonatal intensive care unit (NICU) on 40 newborns. CVADs were inserted in neonates, who had been anticipated to have intravenous access for >7 days. CVADs used in the study included Peripherally Inserted Central Catheters (PICCs) and umbilical venous catheters. CVADs were inserted under strict aseptic precautions as per international guidelines, and maintenance protocols followed. Monitoring for complications was done daily. Central Line Associated Blood Stream Infection (CLABSI) was established by a combination of suggestive clinical signs and blood culture reports as per Centre for Disease Control and prevention definition. **Results:** Extremely low birth weight neonates contributed 40% of the patients. PICC insertions formed the 85% of the devices used. Basilic vein was the preferred site of the insertion in almost one-half of the patients. 80% of the PICCs in neonates were used to administer total parenteral nutrition. CLABSI was the most common complication occurring at a rate of 7.5/1000 catheter days. Other complications were occlusion, suspected infection, accidental displacement, and thromboembolism. **Conclusion:** Central venous catheterization is a safe and efficient procedure with minimal complication in neonates. This study emphasizes its use whenever prolonged intravenous access requirement is expected.

Key words: *Central line-associated bloodstream infections, Central venous access devices, Neonates*

Central venous access device (CVAD) is defined as an intravascular catheter that terminates at or close to the heart or in one of the great vessels which is used for infusion, withdrawal of blood or hemodynamic monitoring [1]. The options of IV access in neonates available to clinicians have increased over the years. CVADs include peripherally inserted central catheters (PICCs), central venous catheters (CVCs), and umbilical venous catheters (UVCs).

Strict asepsis has to be maintained during insertion as well as maintenance of the catheter. Complications of inserting a CVAD including pneumothorax, hemothorax, hematoma, infections, and thrombosis are frequently reported in literature [2]. This study looks at the use of CVADs in neonates to determine their efficacy and complications in this population. The aim was to study the use of CVADs and their complications in neonates.

METHODOLOGY

This was a prospective observational study conducted in a tertiary care institution. The study group comprised 40 newborns over a period of 2 years. Prior approval from the Institutional Ethical Committee was obtained, and consent was taken from the parents or legal guardians before recruitment. All the newborn assessed to be requiring intravenous access for >7 days were eligible for inclusion in the study. This included neonates with prematurity, low birth weight, respiratory distress, congenital malformations, surgical conditions, etc. as shown in Fig. 1. Neonates with a central venous catheter placed at an outside facility and then referred to this hospital were excluded from the study.

Data collection included demographic profile of the patient (gestational age, sex, birth weight, and diagnosis of neonates); type of catheter (CVAD) used, size of lumen, site of insertion, number of attempts, type of fluids and medications administered (IV fluids, antibiotics, total parenteral nutrition [TPN], and blood and blood products), duration while the catheter was *in situ*, reason for removal, and details of events taking place while the catheter was *in situ* and complications of the catheters. Insertion of each CVAD even in the same patient was counted as a separate event. CVADs used in the study included PICCs and UVCs. The common types of catheters which were used included 1 Fr catheter with splitting needle (28G) with flow rate 0.7–1.6 ml/min for preterm neonates, 2 Fr catheters with splitting needle (24G) with flow rates 4–9 ml/min for term neonates, and Umbilical catheters (5Fr and 3.5 Fr).

CVADs were inserted by resident with the guidance of a consultant under strict aseptic precautions as per Centre for Disease Control and Prevention (CDC) guidelines [3]. An appropriate catheter was chosen on the basis of gestational age of the patient. Only single lumen catheters were used. Catheter placement within a vein was confirmed by aspirating blood and irrigating with normal saline. No heparin was used during the procedure. Check X-ray was taken for catheter tip site confirmation in all the cases before using it. Monitoring for complications was done daily by inspection and/or by palpation. Catheter insertion site and dressing were not touched unless it was displaced. However, cleaning of part outside dressing was done with alcohol-based antiseptic twice daily. Care and maintenance of all catheters were done uniformly. Cultures were sent under aseptic conditions as per protocol at the time of suspicion of infection and at the time of removal of the catheter.

Central line-associated bloodstream infection (CLABSI) was established as per CDC definition which is a laboratory-confirmed bloodstream infection in a patient where the central line was in place for >2 calendar days (48 h) on the date of the event, with a day of device placement being day 1. The diagnosis of CLABSI was made when they meet one of the following criteria: (a) Criterion 1: Patient has a recognized pathogen cultured from one or more blood cultures and organism cultured from blood is not related to an infection at another site. (b) Criterion 2: Patient <1 year of age has at least one of the following signs or symptoms: Fever (>38°C core), hypothermia (<36°C core), and apnea or bradycardia and organism cultured from blood is not related to an infection at another site, and the same (matching) potential contaminant organism is cultured from two or more blood cultures drawn on separate occasions [1].

Colonization was considered when CVAD tip culture was positive, and criteria for CLABSI were not fulfilled. In cases of proven CLABSI, catheter was removed, and appropriate antibiotics were initiated. In cases of occlusion of the catheter, heparin flush was given, and an attempt was made to salvage the catheter, but in cases of failed attempt to salvage the catheter, it was removed. Catheter fracture was defined as a separation or cracking of catheter line components during use [4]. If the catheter was found to be fractured, it was removed. Accidental displacement of the catheter was also an indication for catheter removal. Catheter tip was sent for culture and sensitivity in all cases on removal. Results obtained were analyzed statistically.

RESULTS

A total of 40 CVADs were inserted in 32 neonates. This was due to more than one CVAD being used in a few patients. Patient characteristics are shown in Table 1. Mean birth weight of neonates was 1.63±0.92 kg, and the weight of the smallest baby was 570 g. PICCs insertions formed the bulk (85%) of devices used. UVCs were used in rest of the 6 (15%) cases, where, emergency intravenous access was required during resuscitation in 4 cases and for exchange transfusion in 2 cases. Most of the preterm neonates required 1 Fr PICC, and term neonates required 2 Fr. UVCs 3.5 Fr was used for preterm and 5 Fr for term babies. Characteristics of the catheter used are shown in Table 2.

Basilic vein was the preferred site of insertion in almost half of the patients as majority of the cases had PICC in the upper limb. Other sites of insertion were saphenous vein, cephalic vein, and

Table 1: Demographic profile of patients

Parameters	n (%)
Sex	
Male	30 (75)
Female	10 (25)
Weight (kg)	
<1	16 (40)
1–<1.5	6 (15)
1.5–<2.0	6 (15)
2.0–<2.5	3 (7.5)
2.5 or more	9 (22.5)
Gestational age	
Preterm	30 (75)
Term	10 (25)

Table 2: Characteristics of catheter and duration of insertion

Characteristics	n (%)
Type of catheters	
PICC	34 (85)
UVC	6 (15)
Number of attempts	
One	27 (67.5)
Two	10 (25)
Three	3 (7.5)
Duration (weeks)	
<1	15 (37.5)
<2	12 (30)
<3	12 (30)
<4	0
<5	1 (2.5)

PICC: Peripherally Inserted Central Catheters, UVC: Umbilical venous catheter

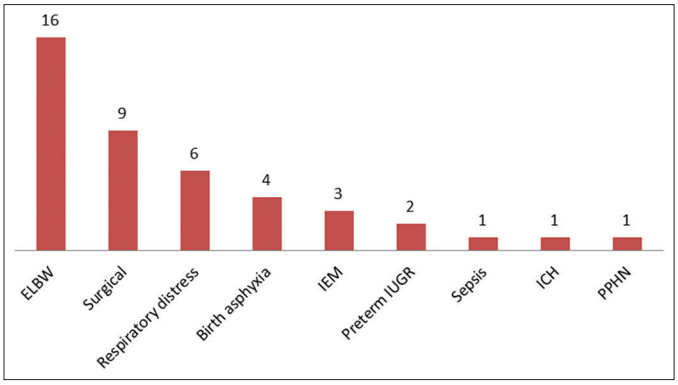

Figure 1: Indications of Central Venous Access Devices in neonates. ELBW: Extremely low birth weight, IEM: Inborn Error of metabolism, ICH: Intracranial hemorrhage, and PPHN: Persistent pulmonary hypertension of newborn

Table 3: Distribution of complications in neonates

Complications	Preterm neonates	Term neonates	Total neonates (%)
CLABSI	2	1	3 (7.5)
Occlusion	2	-	2 (5.0)
Suspected infection	1	1	2 (5.0)
Accidental displacement	-	1	1 (2.5)
Thromboembolism	1	-	1 (2.5)
Total	6	3	9 (22.5)

CLABSI: Central Line-Associated Bloodstream Infection

umbilical vein. All the CVADs used were single lumen catheters. Regarding the number of attempts, single attempt at catheterization was successful in 67.5% of the neonates. All the CVADs (PICCs and UVCs) were used for giving IV fluids. 80% of the PICCs were used to administer TPN. In neonates, duration of the catheter was in the range of 2–32 days with a total period on the catheter of 395 days with a mean duration of 9.9 days per patient.

CLABSI was the most common complication occurring in 7.5% of the total CVADs. Other complications are shown in Table 3 which conclude that two-third of the complications occurred in preterm and CLABSI rate was 7.5/1000 catheter days. Blood culture showed growth in 3 cases and the organisms grown were coagulase-negative Staphylococcus, *E. coli,* and Acinetobacter.

DISCUSSION

Placement of a CVAD is a potentially life-saving measure for neonates with poor peripheral venous access and gastrointestinal tract intolerance of adequate nutrition. In our study, we have inserted CVADs for prolonged administration of intravenous fluids, antibiotics, and TPN, and blood products. Overall, complication rates were low, occurring in only 22.5% of patients. Of these, infections were the most common comprising 34% of all complications, the majority of which occurred in preterm patients. Other complications included occlusion, fracture, and accidental displacement of the catheter.

In a study by Dheer *et al*., the most common indication of CVADs was failure of peripheral venous access in neonates (63.1%) [5]. In our study, however, neonates assessed to require a prolonged duration of intravenous access were subjected to CVADs. A single attempt at catheterization was successful in 67.5% of neonates in our study. Almost identical results were seen in a study by Dheer *et al*., in which a single attempt was successful in 70.7% of the neonates.

CLABSI occurred in 7.5% of our patients, and the isolates were coagulase-negative staphylococcus, E.coli, and Acinetobacter. This is in accordance with published literature showing a similar organism. In 2010, a study by Sengupta *et al*. had shown coagulase-negative staphylococcus (n=7, 32%) in majority of the cases [6]. It was found that the duration of catheter use was critical for the occurrence of infections. One of the largest studies by Sengupta *et al*. had median time from line insertion to CLABSI in neonates of 18 days (9–22 days); while in our study, it was 11 days (4–18 days). This may be explained by the post-operative neonates in our study which forms a known high-risk group for complications. When catheters are in place for extended periods, the catheter hub probably plays a major role in providing access for the microorganism to the bloodstream by migrating endoluminally [7]. Therefore, the catheter should always be removed as soon as possible when not required.

CLABSI rate in our study was 7.5/1000 catheter days for neonates. These results reinforce the results of published data on the CLABSI. In a prospective study of 111 PICCs used for TPN in hospitalized children, Yeung *et al*. reported a rate of 6.4/1,000 catheter days [8]. The incidence of PICC associated CLABSI over the 3-year period was 2.01/1000 catheter-days (95% confidence interval: 1.24-3.06) in a study by Sengupta *et al*. [6]. CVADs occlusion was a common problem, especially with the smaller gauge catheters. CVADs that did not flush or allowed flow were considered to be occluded. Whenever it did not resolve, CVAD was considered occluded (n=2, 5.0%), and it was removed. Occlusion was the second most common complication after the infections. In a large study by Thiagarajan *et al*., occlusion occurred in 7% of cases [9].

CVADs increase the risk of central venous thrombosis, with the concomitant potential risk of venous thromboembolism. Thrombotic clots can form if the venous wall is damaged during catheter insertion. Cochrane Database Systematic Review (2005) concluded that thrombosis occurs in 2–67% of CVADs [10]. Most of the thrombosis due to CVADs is asymptomatic [11]. Therefore, ultrasound follow-up that would reveal asymptomatic thrombosis should be performed regularly [12]. In our study, there was only one case of thromboembolism. Ultrasound was not routinely performed to look for thrombosis. However, in suspected cases where the ultrasound was performed, only one case of thrombosis was seen.

Sengupta *et al*. suggested that catheter duration was an important risk factor for PICC associated CLABSI in the neonatal intensive care unit (NICU). A significant daily increase in the risk of CLABSI may warrant replacement of a PICC if intravascular access is necessary beyond 35 days [6]. This study showed that the maximum number of the days PICC remain inserted in neonates in our NICU was 32 days. Either it was not required beyond this time or removed due to complication. Serious complications reported in the literature by Darling *et al*. include cardiac perforation, arteriovenous fistulas, nerve injuries (mostly brachial plexus injuries), cardiac tamponade, tension pneumothoraces, significant hemothoraces, delayed pneumothoraces, life-threatening arrhythmias, and thoracic duct

injuries and death [13]. None of our patients had any of these serious complications which denote proper insertion and care as per protocol. Limitations of the study were small sample size; study considered for neonates only can be extended to uses and complications of CVADs in pediatric age group.

CONCLUSION

We conclude that central venous catheterization is a safe and efficient procedure with minimal complication in neonates. It is recommended to use CVADs whenever prolonged intravenous access requirement is expected. This study is extremely important to emphasize the uses and complications of CVADs in neonates in Indian practice and to encourage its use even in smaller neonatal centers also.

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