Central Venous Catheter Insertion Complications in Pediatric Intensive Unit: A Report of a Tertiary Center in the South of Iran

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Abstract:

Background and Objective: **Central venous catheterization (CVC) is a frequently performed procedure in intensive care units, particularly in pediatric patients. However, it carries potential risks and complications. This study aimed to determine the frequency of application, indications, success rate, and complications associated with central venous catheters at different sites in the Pediatric Intensive Care Unit (PICU).**

Materials & Methods: **This retrospective study was conducted on pediatric patients admitted to the PICU of Namazi Hospital in Shiraz, Iran. CVCs were inserted for various reasons from April 2018 to September 2019 (18 months). Data were extracted from medical records and analyzed using SPSS.**

Results: **A total of 184 CVCs were inserted in 156 patients, with a cumulative duration of 1842 days. The majority of patients requiring CVC insertion were children under 2 years old (114; 62%). The most frequent insertion site was the jugular vein (51.8%), followed by the femoral vein (41.2%) and the subclavian vein (7%). In 114 patients (61.9%), the primary reason for CVC insertion was the failure of peripheral venous access. The average catheter dwell time was 10.8 days, ranging from 1 to 42 days. Out of the 184 CVCs placed, 52 (28%) were associated with complications, with catheter occlusion being the most common, occurring in 44 patients (25.8%). Of these, 14 cases (8.2%) occurred in the PICU.**

Conclusion: **Catheter occlusion was identified as the most common and significant complication in this study. This risk could be reduced through the development and strict adherence to CVC guidelines for PICU nursing staff.**

Keywords:* *Central Venous Catheter, Pediatric Intensive Care Unit, Pediatric Patients

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Background and Objective

Central venous catheter (CVC) insertion is one of the most common procedures used in intensive care units. It has become an essential route of venous access in management of critically ill patients. There are many indications for CVC insertion: parenteral nutrition, long-term antibiotics, chemotherapy, intravenous fluids, inotrope and blood components, frequent blood sampling, invasive hemodynamic monitoring, hemodialysis, and plasmapheresis. In addition to the benefits of its applications in adult critical care, CVC use in children minimizes the risk of vein puncturing from multiple attempts. It saves the vein for future use as opposed to instances in which cut down is done.[1,2] There are three common sites for CVC insertion: femoral vein, jugular vein and subclavian vein; the rate of complications differ in each site.[3]

Since 1953 that CVC was inserted with seldinger technique by using anatomical landmarks;[4,5] but as time passed ultrasonography was used for this procedure ,and replaced the old method; ultrasonography decreased complications due to catheterization ,and increased the success rate of CVC insertion.[6]

Many complications have been reported after widespread use of CVC; although they could be rarely lethal, they negatively affect the length of hospital stay.[4] The complications occur during or a short time after the procedure, such as cardiac arrhythmia, pneumothorax, arterial puncture, bleeding and hematoma formation that are related to CVC insertion and is called “immediate and early” complications; these occur in days to weeks that are due to device management, such as thrombotic events or infection.

In recent years, most guidelines emphasize the use of ultrasound in the placement of central venous catheters due to the reduction of complications and benefits.[4,7]

The aim of this study was to determine the frequency of CVC insertion, indications, failure rate, and complication rate of CVC insertion of different sites in the Pediatric Intensive Care Unit (PICU) of the Namazi Hospital. Also, we aimed to determine the rate of complication of each site.

Materials and Methods

This is a prospective study on all pediatric patients under 18 years of age; percutaneous CVC was inserted for them by seldinger technique, for any reason through different sites, in the pediatric intensive care unit (PICU) of Namazi Hospital (the main tertiary referral center located in Shiraz in the south of Iran which has 18 bed general PICU) over 18 months (2018-2019) were enrolled in this study.

The total number of inserted CVCs, indications for CVC placement, the most frequent insertion place, the average and catheter stay time, occlusion time, and the most frequent complications related to CVCs were recorded. All CVCs were inserted by pediatric intensive care fellowships.

After taking informed consent, the procedures were performed in aseptic conditions with continuous EKG and oxygen saturation monitoring. An appropriate catheter was chosen based on the size and age of the patients. Then, appropriate analgesia catheters were inserted percutaneously with the Seldinger technique. The preferred site for primary attempts was chosen according to the clinical condition and indication of the procedure.

After central line insertion, the site of insertion and patient’s condition were closely observed for potential immediate complication (e.g. bleeding, pneumothorax), and the patients were also checked daily for other complications such as thrombosis, malfunction, and infection (they all had been written in medical record by nurses). After CVC insertion, chest X-rays were taken to confirm the position of the tip of the catheter, and to detect potential complications of the internal jugular and subclavian routes (pneumothorax).The catheters were maintained by flushing the CVC by 10 units/ml heparin at least three times a day. We utilized the SPSS version 21.0 (SPSS Software, CA, USA) to code, enter,

and analyze the data. For the analysis of normally distributed numeric data and non-normally distributed parametric data, we used the student's t-test and the Mann-Whitney U test, respectively. Mean ± SD was presented for symmetric data.

Results

A total of 184 CVCs were inserted in156 patients for a total of 1842 catheter days (The difference between the number of patients and number of inserted CVCs is caused by multiple insertions of CVCs in some patients due to accidental removal, occlusion). Of all patients, 94 patients (51.1%) were female and 90 (48.9%) were male. Children under 2 years of age were the largest age group who required CVC insertion (62%) (Table 1).

In 114 patients (61.9%), failure of peripheral venous access was the main reason for CVC insertion (Table 2). The most frequent insertion site was jugular vein (51.8%) followed by femoral vein (41.2%) and subclavian vein (7%). The right side of the body was the most frequent insertion site for CVCs (68%) (Table 3). In four patients, two catheters were inserted at the same time because of the need to dialysis or plasmapheresis.

The total indwelling time was 1842 days and the average catheter stay time was 10.8 days (with a range of 1-42 days). Of a total of 184 CVCs placed, 52patients (28%) had one of the complications related to CVC insertion. In our study, catheter insertion success rate was 92.4%, and the overall complications were 24.1%, as shown in Table 4 (it should be mentioned that in some patients, more than one complication were seen in one patient). The most common complication was occlusion of the catheter which occurred in 14 patients (7.6%), and the mean time of occlusion was 11.9 days (table 4).

Table 1- Demographic data

	Variable	*NO.*	*Percent (%)*
Sex	*Male*	*90*	*48.9*
	Female	*94*	*51.1*
Age	*Less than 2 years old*	*114*	*62*
	More than 2 years old	*70*	*38*

Table 2- Indications for CVC insertion

Reason	*NO.*	*Percent (%)*
Failure of peripheral line insertion	*114*	*61.9*
Central venous pressure (CVP) monitoring	*24*	*13*
Need inotrope	*38*	*20.6*
Dialysis	*6*	*3.2*
Plasmapheresis	*2*	*1.1*
Total	*184*	*100*

Table 3- site of CVC insertion

Site	*NO.*	*Percent (%)*
Femoral vein	*76*	*41.3*
Jugular vein	*96*	*52.1*
Subclavian vein	*12*	*6.5*
Total	*184*	*100*

Pneumothorax was observed in 6 patients (3.2%), four with CVC insertion into the subclavian vein and two cases into the jugular vein. It was well correlated with multiple attempts and >30 minute time of procedure. Arterial puncture occurred in 3.2% (two cases into jugular artery and in one patient during subclavian cannulation); hematoma was seen in 3.8% of patients, both of which occurred in those aged less than 2 years. Thrombosis occurred in six patients (3.2%) (Day: 6, 18 and 33), all being in the femoral vein. The incidence of catheter-related blood stream infection (CRBSI) was 1.08/1,000 catheter-days (1.16%), which all occurred in the femoral vein with Coagulase negative staphylococcus. None of patients died during catheterization nor due to its complications.

Table 4- Complications related to CVC insertion and stay

Complication	*Frequency*	*Percent (%)*
Occlusion	*14*	*7.6*
CRBSI[3]*	*2*	*1.08*
Thrombosis	*6*	*3.2*
Pneumothorax	*6*	*3.2*
Arterial puncture	*6*	*3.2*
Hematoma formation	*7*	*3.8*
Accidental removal	*4*	*2.1*
Total	*45*	*24.1*

**CRBSI: catheter related blood stream infection*

Discussion

Most complications of CVC insertion are minimal, but some of them could be life-threatening; even minor complications can lead to prolonged hospital stays and can increase the healthcare costs. The most frequent requirement for CVC insertion in our study was the failure of peripheral venous access (61.9%). In other studies, the range of this indication is 10 to 70%.[6,8]

In our study, cannulation of CV was according to anatomical landmark and the success rate of CVC insertion was 92.4%. Other studies reported the same success rate between 51% to over 90%.[7-9] In a study conducted on 282 children admitted to the pediatric ICU, the success rate of catheterization was 99.3% and pneumothorax was seen in two patients (0.7%) (all catheterizations were performed in the subclavian vein).[10] The total complication rate was 24.1% in our study. The complication rates of other studies were between 5%[7] to 28%.[6,11] In our study, pneumothorax was an incidental finding found in chest X-rays in 6 patients (3.2%). Other studies reported theincidence between 0.9% and 2.4%.[6,12] In our study, arterial puncture occurred in 3.2% and hematoma in 3.8% of patients; in other studies, the arterial puncture rate was between 1.9%-12.8%, and the rate of hematoma formation was between 1.4% to 5.2%.[2,13-15]

There are some serious complications reported in some studies including cardiac perforation, cardiac tamponade, hemothorax, thoracic duct injuries, and death;[1] none of these complications was seen in our patients. In our study, the accidental removal rate was 2.3%; it was 3.8% in Karapinar et al.'s study[9] and 3% in Bhatt et al.'s research.[11]

Occlusion of the CVCs was the most common complication in our study (6.7%). The expected range was between 0-7%. In Mestrovic et al.'s study, it was 3.4%.[6] Thrombosis was seen in 3.5% of our patients, while it has been reported 5-18% in other studies.[16] The incidence of catheter related

blood stream infection (CRBSI) was 1.08/1000 catheter-days in our study. However, Mestrovic et al. reported 4% in one study,[4] and Mahieu et al. reported 4.9/1000 catheter-days.[17]

Limitations

The main limitation in our study was that we did not appropriate size of ultra sonography probe for small children so we could not compare the landmark-based central line insertion with ultrasound guided CVC insertion.

Conclusions

CVC is necessary for monitoring and treatment of critically ill children in pediatric intensive care units. Major complications in our patients were rare, indicating that central venous catheterization is safe and can be recommended for use in critically ills patients in PICUs. Our study revealed that, while not common, the most serious complication of CVC was occlusion. This risk could be minimized with the development of and strict adherence to CVC guidelines for nursing staff monitoring CVCs.

Authors' contributions

AS designed the study and drafted and submitted the manuscript, gathered patients' data and write the manuscript.

Conflict of Interest Disclosures

None.

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Ethics approval and consent to participate

This study was approved by the ethics committee of Shiraz University of Medical sciences with approval ID: IR.sums.med.rec.1398.131. Written informed consent was obtained from the parents and sent to the ethics committee.

Consent for publication

Obtained.

Competing interests

The authors declare that they have no competing interest.

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