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ORIGINAL ARTICLE

Safety and efficacy of ultrasound-guided central venous catheter insertion in critically ill children.

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ABSTRACT… Objective: to evaluate safety and efficacy of ultrasound guided cvc insertion in picu of resource-limited, public-sector children hospital. **Study Design:** Prospective Observational study. **Setting:** National Institute of Child Health. **Period:** March 2020 to September 2020. **Material & Methods:** We prospectively conducted this study after the IRB approval. Parental consent was obtained. All procedures were done under aseptic precautions with central line insertion checklist according to guidelines of ultrasound guided CVC insertion. We use 8hz linear probe of ultrasound to localize internal jugular vein or femoral veins and needle insertion done under real-time us. The data was collected on structured proforma, including age, gender, weight, admitting diagnosis, size of CVC, success rate. **Results:** Out of 360,72 (20.20%) required CVC placement during study period of 06 months. The mean age was 7.0±3.53 years with range of (1-15 years). We categorized the patients into three groups 0.1-3 (infant & toddler group) 3-10 (school aged group) 10-15 (adolescent group%). Out of 72 cannulations, 68 (94.4%) were successful in 1st prick, while other 04 (5.6%) were in 2nd prick. **Conclusion:** Ultrasound guided CVC insertion is easy to perform, safe and highly effective in critically ill children.

Key words: Critically Ill Children, Complications, Ultrasound, Venous Cannulation.

INTRODUCTION

Accessing the vascular line in critically ill children is challenging because of anatomical sites, small vessels size, large subcutaneous fat and less cooperation.[1] In addition to peripheral access, central venous catheter insertion are frequently required in pediatric intensive care unit (picu) for management like of fluid infusion, hemodynamic monitoring, administration of blood products, medication parenteral nutrition, hemodialysis and blood sampling.[2]

CVC associated complications among both children and adults are well documented which include thrombosis, trauma, infection, vascular erosion with extravasation, bleeding, malfunction and systemic or pulmonary embolic events. Infants and young children are more vulnerable to these complications.[3] Patient's condition, family preferences, treatment duration and frequency and the characteristics of infusions are key factors to choose type of vascular access device.[4] It is crucial to anticipate the aptitude requirements because poor plan for management may lead to therapy disruption, collapse of the peripheral vasculature, mental and physical burden due to repetition of procedure.[5] Ultrasonography presents real-time images at the bedside which is helpful for procedure and reduces medical errors as compared to land-mark technique.[6]

To our knowledge, our study would be the first to affirm the effectiveness and safety of central venous access in critically ill children. It would add the literature evidence from our region and improve the physician knowledge and clinical practice towards the management of children in picu.

MATERIAL & METHODS

This was a prospective observational study performed after clearance from Institutional

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review board and written informed consent from patient's guardians. All consecutive pediatric patients aged 11 month to 15 years admitted and ventilated in Pediatric intensive care unit of National institute of child health from March 2020 to September 2020 were enrolled into the study. The exclusion criteria included patient's guardian refusal, bleeding disorder, clotting abnormalities (platelets < 75000, international normalized ratio >2) or a local site of infection.

The patient's age, weight were documented and appropriate size of CVC was selected. As already, the patients were on ventilator support with proper sedation and relaxation, so there was no need to give another medication for this procedure. An ultrasound scanner (Mindray) with a cordless linear probe 8Hz frequency was used that was covered with sterile sheet after putting the ultrasonic gel. The patient was supine positioned with slightly extended neck and turned to other side (if to put the CVC in right IJV, then neck directed towards left as shown here. The transducer was placed perpendicular to the vessel at the apex of the triangle formed by the two heads of the sternocleidomastoid muscle and clavicle. The internal jugular vein (IJV) was identified as an oval thin walled hypoechoic compressible structure lying lateral and superficial to a noncompressible, pulsating carotid artery. The internal jugular vein can also be identified by applying the color doppler imaging view on ultrasound machine. An introducer needle with an attached syringe was inserted under the probe at an angle of 45 degree. The tip of needle was directed towards the right shoulder to avoid the puncture of carotid artery. When the tip of the needle clearly visualized inside the IJV on ultrasound image, blood was aspirated by pulling the plunger while holding the needle at place. If it was freely coming, hold the needle firmly, detach the syringe and advanced the guidewire. After removing the needle, keeping the guide wire in place, dilator was inserted on wire, make a free passage and finally CVC CATHETER was introduced and stitched with skin.

The procedure was considered as failure if the physician was unable to do the procedure in three attempts. Successful cannulation in the study was the skin puncture to blood aspiration through the catheter immediately following the guidewire removal. Unsuccessful cannulation was complete withdrawal of the puncturing needle out of the skin surface was required.

RESULTS

Among the 360 admissions in 6 months, we enrolled the 72 patients consecutively who fulfilled the inclusion criteria and underwent the CVC insertion. The mean age was 7.0±3.53 years with range of (1-15 years). We categorized the patients into three groups 0.1-3 (infant & toddler group) 3-10 (school aged group) 10-15 (adolescent group). The percentage in middle group was more as 42 (58.3%). Mean weight was 19.2±6.15 kilograms with range (8.5-31.0 kilograms). Gender distribution was observed as 44:28 (61.1%:38.9%) male to female. 5Fr CVC Size was used in maximum cases 46 (63.9%) while 4Fr was used 26 (36.1%). Out of 72 cannulations, 68 (94.4%) were successful in 1st prick, while other 04 (5.6%) were in 2nd prick. (Table-I) Out of four 2nd prick cases, three were done in infant & toddler group. Among the patients in which 2nd prick was needed to place the line, insertion site was intrajugular in 3 cases and femoral site in one case.

Variables	N=72
Age (years)	7.0±3.53 (1-15)
Age groups 0.1-3 3-10 10-15	 15 (20.8%) 42 (58.3%) 15 (20.8%)
Weight(kilograms)	19.2±6.15 (8.5-31)
Gender Male; female	 44:28 (61.1%:38.9%)
Size of CVC 4Fr 5Fr	 26 (36.1%) 46 (63.9%)
CVC insertion sites Right IJV Right Femoral Left IJV Left femoral	 60 (83.3%) 09 (12.5%) 02 (2.8%) 01 (1.4%)
Number of pricks First prick Second prick	(n=72 subjects) 68 (94.4%) 04 (5.6%)
Complications Yes: No	 5:67 (6.9:93.1%)

Table-I. Demographic and clinical variables.

DISCUSSION

With advancements in management protocols, emergency and critical care is rapidly progressing in children. So, the insertion of cvc has become a necessary part in emergency or in pediatric ICU for the ease of therapy and sampling. To our knowledge, our study is the first in our country to analyze the use of cvc in children in pediatric ICU.

In different studies, the success rate has been found around 90-98%.[7,8] In younger age groups, there is more chances of increase number of pricks and failure. In our study 3/4 2nd pricks were in infants and toddlers. ($P < 0.02$) Likewise the success rate is also decreased as also explained by hayashi et al.[9]

We have used two central catheters of different sizes in our population and find them easy to handle. Up to 3 years, 4 fr was used commonly and for children and adolescent, 5fr was selected. Although, up to 7 fr cvc size has been used in children safely without major complication, but we have not tried because of resource limitations.[10]

We preferably choose the right sided intrajugular vein as 1st priority, right femoral as 2nd and then other opposite sites if there is any contraindication in former sites. We did not do any attempt for subclavian vein cannulation. In many studies, it has been shown to have more risk of infections in femoral lines as compared to other sites.[11]

Major complication in our study was arterial prick (2.8%) and hematoma formation (2.8%). But there was no incidence of pneumothorax, hydrothorax, or subcutaneous emphysema in any case. There is possibility to puncture the carotid if needle traversed the IJV and enter the CA. It may happens because of anatomical differences as occurred in around 54% cases in a study by troianos et al.[12]

There are few limitations in our study. We have counted the short term complications but could not enlist the infection rate in CVC. For this, there is need to involve the more resources, for that another study is continued on this.

CONCLUSION

Ultrasound-guided intravascular catheter insertion is easy, safe, and effective. It has higher success rate with very negligible short-term complications. This technique should be universally carried out in all pediatric cardiac intensive care units.

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