

CENTRAL VENOUS CATHETERIZATION IN THE CRITICALLY ILL: INDICATIONS AND COMPLICATIONS.

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Abstract

Background: Central venous catheterization is frequently indicated in critically ill patients such as for rapid large volume resuscitation, administration of vaso-active drugs, poor peripheral venous access, amongst others. It is life saving and associated with some complications.

Methodology: We documented all the central venous catheterizations performed for patients in the ICU during a 3-month period. The total number of patients admitted into the unit, the total number of patients who required central venous catheterization and the total number of patients who had the procedure were collected and studied. The indications, route of central venous access and complications following the procedure were also documented.

Results: Ninety six (96) patients were admitted into the unit during study duration out of which 44.8% required central venous catheterization. However, less than half of the total number of patients requiring central venous catheterization (48.5%) was cannulated. The right internal jugular vein was the most used route and the only complication detected was pneumothorax with a complication rate of 12%. The common primary indications were drug and fluid administration and poor peripheral access.

Conclusion: Central venous catheterization is easy to perform and it is associated with few complications which are operator and catheter type dependent. The issue of availability of central line kits and training of personnel should therefore be addressed.

Introduction

Establishing and maintaining a good and functioning vascular access is a necessary skill for the critical care physician¹. Often, peripheral venous access is usually attempted first because of ready accessibility. However, central venous catheterization (CVC) is frequently indicated in the critically ill patient. Some of the common indications for CVC are rapid large fluid resuscitation, administration of vaso-active drugs, frequent venous blood sampling, poor

peripheral venous access and monitoring of central venous pressure among others².

In addition, central venous catheters are longer and stay longer than peripheral venous catheters³. They also come with two or three separate infusion ports which provide additional advantage in the setting of multiple drug administration. In the early 1950s, the Seldinger technique⁴ was introduced for central venous catheterization, also known as catheter-over-guide-wire technique.

However, cannulation of central veins is associated with some complications^{5,6}. Some of these complications include venous air embolism which is considered one of the most feared complications of the

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procedure. Others are pneumothorax which is commoner during subclavian venous cannulation, although can still occur with internal jugular venous catheterization. Cardiac arrhythmias and cardiac perforations are some of the other complications. These occur when the tip of the catheter longer than 15cm is advanced into the walls of the right atrium².

Careful and skillful placement of central venous catheters reduce the risk of these complications. In addition, multiple attempts increase the complication rate to about 6 times greater than after a single attempt⁴.

Despite the advantages of central venous catheterization, many centres in Nigeria are yet to make this a routine practice. We documented all central venous line placements in the Intensive Care Unit of the University of Benin Teaching Hospital over a three month period to evaluate the indications, sites and complications of the procedure.

Methodology

Study area: The study was conducted in the Intensive Care Unit of the University of Benin Teaching Hospital, a 7-bed open facility.

Study design: This was a prospective procedure based study conducted between July to September 2013.

Inclusion: All central venous catheterization procedures performed during the three month period were included.

Exclusion: All abandoned procedures due to difficulty with accessing a central vein.

Intervention: Informed consent for the procedure was obtained from each eligible patient and/or their relatives. A multi-parameter monitor was attached to the

patient to monitor the pulse rate, the blood pressure, arterial oxygen saturation and more importantly the electrocardiography (ECG). The patients were each positioned supine in Trendelenburg position and the site of catheterization was cleaned with antiseptic lotion (chlorhexidine and alcohol) and draped. A triple lumen central venous catheter was opened and each infusion port was flushed with heparinized saline. Anatomical landmarks, in the case of the right internal jugular vein, the two heads of the sterno-cleidomastoid muscle were identified and the apex of the triangle formed with the clavicle was located. A finder needle was inserted lateral to the pulsation of carotid artery until the internal jugular vein was entered. For the subclavian route, the sterna notch and the junction of the lateral third and the medial two-thirds of the clavicle were identified. In the case of the femoral route, the femoral artery pulsation was located and 1cm medial to this, inferior to the inguinal ligament the femoral vein was cannulated. A 20 gauge needle was inserted close to the finder needle and a free flow of dark venous blood confirmed correct placement. A guide-wire was then introduced through the needle which was subsequently withdrawn. Afterwards, a dilator was used to dilate the subcutaneous route of the vein. The triple lumen catheter was passed over the guide-wire and each port was aspirated for dark venous blood and flushed with 1ml heparinized saline. The catheter was sutured in place and a sterile, transparent dressing applied. A mobile X-ray machine obtained a chest-X-ray to confirm placement and to rule out haemo- or pneumothorax. The presence of inadvertent arterial puncture, haemothorax or pneumothorax was recorded

Data collection and analysis: The total number of patients admitted into the ICU over the three month period of the study was recorded. Also documented were the number of patients who required central

venous catheterization and those who were cannulated. Central venous access sites, indications and complications of the procedure were all recorded and analyzed using SPSS version 16.0. P value < 0.05 was considered significant.

Results

A total of 96 patients were admitted into the Intensive Care Unit during the study period. Less than half of the total number of patients requiring central venous catheterization, 43 in number representing 46.5% was cannulated. Twenty five (25) procedures were performed and analyzed. The male to female ratio was 1.5:1. Seventy six percent (76%) of the patients were between the ages of 31-40 and > 61 years. Table 1

The commonest primary indication for central venous catheterization was fluid administration (44%) followed by poor peripheral venous access (28%). Drug administration viz. dobutamine, noradrenaline accounted for 24% of the indications while one patient (4%) required central venous catheterization for total parenteral nutrition. Table II.

Table III shows that three (3) sites were used for central venous cannulation in this study. The right internal jugular vein was the commoner of the two accounting for 88%. The right femoral vein was used in 8% and the subclavian vein was used in 4% of cases. Close monitoring of patients' vital signs (50%) was the commonest indication for ICU admission of patients who had central line placement. Cardiac and ventilatory support accounted for 40% of the indications for ICU admission. Only 10% of these patients were admitted for ventilatory support. Figure II. Table IV shows that pneumothorax occurred thrice (12%) and was the only complication seen during the period.

The relationship between indications for ICU admission and indications for central venous catheterization is as shown in table V. More patients were admitted into the unit for monitoring and cardiac support necessitating the need for central venous catheterization for fluid and drug administration for these patients as shown in table V. $p=0.043$

Table I: Socio-demographic characteristics of patients

Age	Frequency	Percentage
<20	2	08
20-30	4	16
31-40	6	24
41-50	3	12
51-60	4	16
>61	6	24
Sex		
M	18	72
F	07	38

Table II: Indications for central venous catheterization

Indications	Frequency	Percentage
Fluid administration	11	44
Drug administration	6	24
Poor peripheral access	7	28
Total parenteral nutrition	1	04

Table III: Sites for central venous catheterization

Sites	Frequency	Percentage
Right IJV	22	88
Right Femoral vein	02	08
Right subclavian vein	01	04
Total	25	100

Table IV: Complications of central venous catheterization

Complications	Frequency	Percentage
Pneumothorax	3	12
None	22	88

Table V: Relationship between indications for ICU admission and indication for CVC

Indications for CVC	Indications for admission			
	Cardiac support	Ventilatory support	Monitoring	Cardiac +Ventilatory support
Fluid administration	0	2	6	4
Drug administration	1	0	1	0
Poor peripheral access	1	1	3	6
TPN	0	4	0	4

P=0.043

Figure 1: Sex distribution of patients

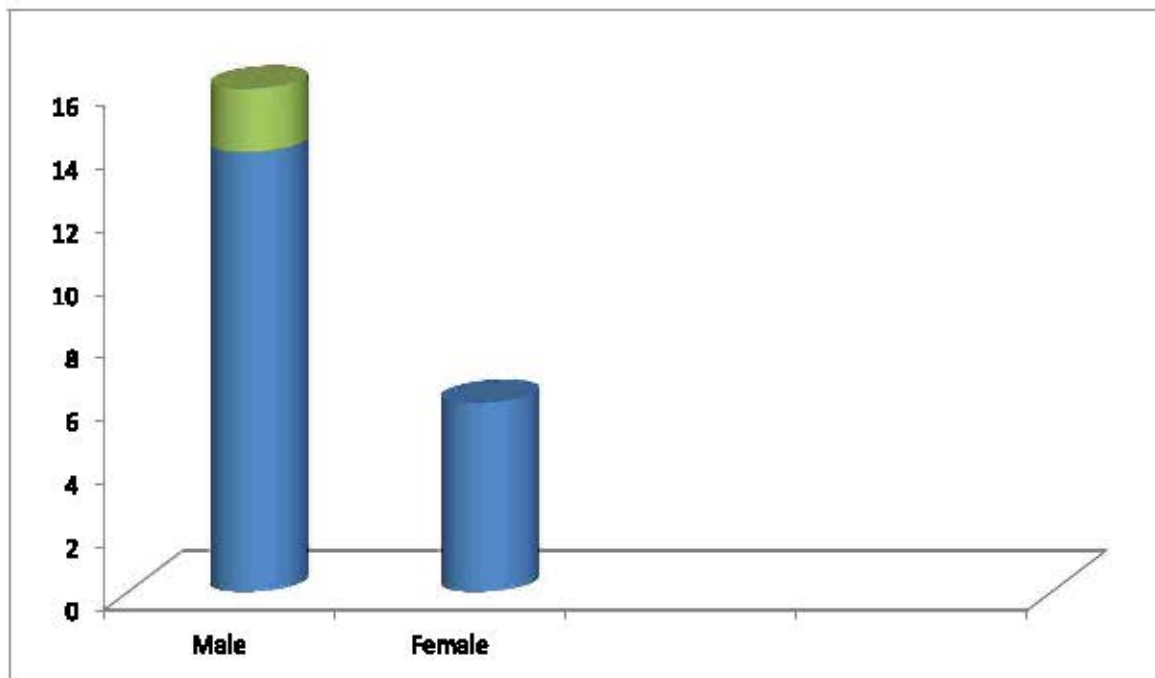
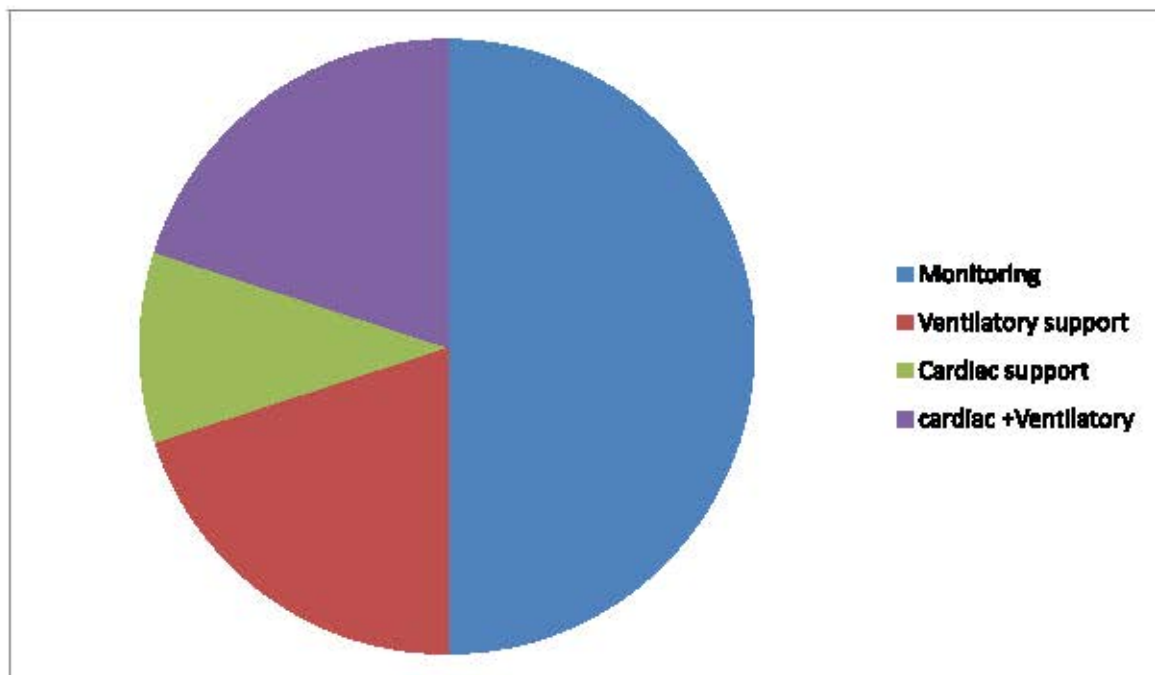


Figure II: Indications for ICU admission



Discussion

The commonest primary indication for central venous catheterization in this study was fluid administration (44%). Rapid fluid infusion is commonly required in the critically ill patients and it is the commonest indications for CVC⁴ as seen in our study. This was followed by poor peripheral venous access such as in severe burns and generalized oedema. The need for infusion of vasoactive drug administration such as dobutamine, dopamine was another common indication for central venous catheterization in this study

The study showed that less than 50% of our patients who required CVC were eventually cannulated. Many reasons could be adduced for this finding. Being relatively a new practice in our ICU, epileptic availability of central venous catheters made it difficult to cannulate all the patients who required it. In addition, lack of trained personnel at all times in the ICU could be responsible for this. It is imperative therefore that training of personnel and availability of central venous catheters be vigorously pursued.

The commonest indication for ICU admission was monitoring and cardiac support which necessitated the need for central venous catheterization for fluid and drug administration. This shows a relationship between indications for ICU admission and central venous catheterization. In other words, the placement of CVC in the ICU should be individualized with risk: benefit assessment. Although the administration of total parenteral nutrition (TPN) is one of the indications for CVC, it's scarcity in our environment accounted for the reason it was administered for only one patient during the 3 months of this study.

Furthermore, central venous pressure monitoring is a known indication for central venous catheterization. The unavailability of pressure transducers for the

measurement of CVP in our centre accounted for the reason it was an indication in this study.

Multiple sites for CVC have been described in the literature namely internal jugular, subclavian, and femoral veins^{7,8,9}. The most frequent site used for central venous catheterization in this study was the right internal jugular vein. It is often the most preferred route because of its straighter course to the superior vena cava⁷. Also, the risk of injury to the thoracic duct is lesser compared with the left internal jugular vein. The right and left femoral veins may be used for CVC but the risk of venous thrombosis is higher than the other sites⁴. Difficulty with accessing the other routes due to anatomical distortion and infections at these sites may necessitate the use of femoral route.

The complication rate in our study was 12 % which is comparable to other centres^{10,11}. The only complication observed in this study was pneumothorax as diagnosed on chest radiograph. Interestingly, this was observed among patients who were on ventilatory support. Although, this is commoner during cannulation of the subclavian vein, the right internal jugular vein was the most frequent site used. It is therefore important to look for this complication when the right jugular vein is being used for CVC. Complication rates following CVC have been associated with operator training and experience. Operators who have passed more than 50 central venous catheters were observed to have half the complication rates compared to those who have passed less than 50¹². In addition, multiple attempts at CVC increase the complication rate to about 6 times greater than after a single attempt⁴

Other complications include venous air embolism which is considered one of the most feared, cardiac arrhythmias and cardiac perforations¹³⁻¹⁴. These occur when

the tip of the catheter is advanced into the walls of the right atrium. Perforations of the superior vena cava and the innominate veins and venous air embolism have been associated with stiff introducers and the type of catheter used¹⁵⁻¹⁸. The catheter used for this study had soft introducers which minimized the risk of perforation of vascular structures. Furthermore, electrocardiography (ECG) and pulse oximetry monitoring were instituted for all our patients during the procedure which would help in diagnosing cardiac arrhythmias. Stable cardiovascular status pre- and post-CVC was used to rule out these feared complications.

Conclusion

Central venous catheterization is commonly indicated in the critically ill patient. Indication for ICU admission is a significant determinant for central venous placement in the critically ill patients. It is easy to perform and associated with few complications which are operator and catheter type dependent. The issue of availability of central line kits and training of personnel should therefore be addressed

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