Original Article

Initial Experience with Central Venous Line Insertion in a Tertiary Health Institution in Nigeria

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Abstract

Background: Central venous catheterization is an uncommon procedure in most hospitals in the West African subregion. This article presents our initial experience with central line insertion. **Materials and Methods:** Catheter sizes ranged from 5 fr for children and 7 fr for adult for intravenous therapy, while size 7 fr polyurethane catheters were used for children requiring hemodialysis and sizes 12–14 fr silicone catheters for adolescents and adults requiring hemodialysis'. Data were collected prospectively using a structured pro forma over a 2-year period (June 2010–May 2012) and analyzed with SPSS 15. **Results:** A total of 77 lines were inserted four as tunneled lines and 73 as nontunneled lines. Forty-seven (61.0%) patients were male, 30 (39.0%) were female, with age range of 1–80 years. The success rate was 97.4%. The overall complication rate was 16.9%. **Conclusion:** Our initial experience with the use of central venous lines, was marked by a high success rate, few manageable complications and no mortality over the study period. Majority of insertions were done by the bedside under local anesthesia lending credence to the assertion that it is a relatively safe procedure that can be done by any adequately trained doctor and should, therefore, be encouraged in our hospitals.

Keywords: Central venous catheters, complications, insertion

Introduction

A central line is an indwelling catheter in any vein that ends up in the superior or inferior vena cava (derivatives of the "cardinal system" or their direct tributaries) or the right atrium. These include catheters inserted via the subclavian, internal jugular, femoral, the umbilical vein or "long lines" through the forearm veins. Central venous catheterization was first described by Aubaniac in 1952. Today, millions of central venous catheters are inserted annually in the United States.[1,2] Central venous catheterization was made possible by two important medical landmarks (LMs); first was the daring experiment in 1929 by the German Werner Forssmann a medical intern who carried out the first central venous catheterization on himself and the description of the catheter over guidewire technique ("Seldinger's technique") by the Swedish Radiologist Sven-Ivar Seldinger in 1952.[1,3] Today, the uses and advantages of central venous access are so immense that intensive care management of the critically ill patient would be practically impossible, invasive cardiology and interventional procedures would be inconceivable without central venous catheterization.[1,4] It allows for frequent access to the central circulation while avoiding the trauma of frequent needle pricks due to the longer indwelling time compared to peripheral lines. Some of the uses of central venous access include therapeutic procedures such as administration of fluids (including parenteral nutrition, blood, and blood products), drug administration (including cytotoxics), exchange blood transfusion, hemodialysis and plasmapheresis, interventional procedures on coronary vascular anatomy and related pathologies, cardiac morphology and function including complex congenital anomalies, and insertion of transvenous pacemakers.[1] The procedure is not without complications which include septic complications such as thrombophlebitis, endocarditis and septicemia and mechanical complications such as catheter embolism, cardiac arrhythmias and cardiac perforation, deep venous thrombosis, hemothorax, pneumothorax, and hemorrhage.[5] Although a

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basic clinical tool, despite its advantages and long history, the insertion of central venous catheter is an uncommon procedure in most Nigeria hospitals. There are, however, publications, suggestingthe utilization of central venous lines in some tertiary health institutions in the country.[6-9] In these institutions, however, these are usually case reports or activities centered around a single unit; the nephrology or dialysis units. In the index institution, a concerted effort is been made to reverse this trend by in-house seminars and workshops and hands-on instruction of resident doctors who rotate through the cardiothoracic surgery unit, with the aim of making it a common practice across all clinical units and departments of the hospital.

This article presents the initial experience with central line insertion in an attempt to make it a routine clinical procedure in our institution.

Materials and Methods

The study was necessitated by the increased demand for vascular access and the need to document the outcome in a center with no previous experience. The decision to insert venous catheter was based on the need for hemodialysis, prolonged intravenous (IV) therapy and/or patients who had difficult peripheral venous access. The procedures were done by consultants when anticipated to be difficult, especially in children or when attempt at insertion by a less experienced hand had failed. Catheter sizes ranged from 5 fr for children and 7 fr for adult for IV therapy, while size 7 fr polyurethane catheters were used for children requiring hemodialysis and sizes 12–14 fr silicone catheters for adolescents and adults requiring hemodialysis. When available, tunneled lines were inserted for patients requiring prolonged cytotoxic chemotherapy on outpatient basis. Catheters were chosen based on sizes appropriate for age. The need to avoid venous occlusion in children necessitated the use of 5 fr for IV Fluid and 7 fr (polyurethane) for hemodialysis to allow for adequate flow. Polyurethane rather than silicone catheters were used for dialysis in children because we do not have access to smaller sizes of silicone catheters appropriate for children. The order of preference was subclavian site as the first choice and when this failed the internal jugular before the femoral. Each consecutive case was documented with no attempt at randomization. The study was approved by the Health Research Ethics Committee of the institution.

Technique description

The procedures were done under general anesthesia in theater for children and under local anesthesia with 1% xylocaine, for adults on the wards and under general anesthesia preoperatively in the theater. Patients are placed supine (20°–30°), head down for the subclavian and internal jugular sites to distend the veins and flat for the femoral vein after adequate explanation of the procedure is done and consent obtained. The head is turned to the contralateral side for the cranial sites. The site is cleaned and draped, and the procedure is done under strict aseptic techniques.

Internal jugular vein approach

The internal jugular vein is sought for at the apex of the triangle formed by the two heads of the sternocleidomastoid. A 22G finder needle is inserted at 45°–60° to the skin and directed toward the ipsilateral nipple with intermittent aspiration. Entry into the vein is confirmed by aspiration of dark blood. If several unsuccessful attempts are made, another site or route is tried. If the carotid artery is punctured, the needle is withdrawn and a gentle pressure is applied for a few minutes before proceeding. If venous blood is aspirated, the site is memorized, the needle is withdrawn and an 18G needle with a syringe containing heparinized saline (1 unit/1 ml) is inserted at the same site and direction as the finder needle. A J-flexible-tipped guidewire is introduced with a sliding motion through the hub of the 18G needle. When over half the length of the guidewire has been introduced, the 18G needle is removed, leaving the guidewire *in situ* in the vein. A small puncture is made beside the guidewire with a size 11 blade to allow for the introduction of the dilator sheet. The dilator is then introduced into the vein over the guidewire to dilate the track with an inward and outward rotatory motion. The dilator is removed to allow for the passage of adequate length of the catheter over the guidewire following which the guidewire is removed. The catheter is aspirated to ensure the free flow of blood and to remove air. The catheter is flushed with heparinized saline (1 unit/ml) and clipped, and then, it is sutured to the skin and sterile dressing is applied at the puncture site. It is now ready for use. The procedure is documented in the case note and instructions (Dos and Don'ts) on the treatment sheet.[10,11]

Subclavian vein approach

The LM for the subclavian site is at the point where the clavicle makes a curve (two-third of the way between the sternal notch and the acromial prominence). The index finger of the left hand is placed at the sternal notch and the thumb at the intersection of the clavicle and the first rib. At this point, the needle is inserted about 0.5 cm below the clavicle and advanced toward the sternal notch at 20°–30°, aspirating intermittently. The rest of the procedure is as described under the internal jugular vein approach; however, the use of 22G finder needle is avoided, while the 18G needle is used to find the vein as well as to introduce the guidewire.[10]

Tunneled central venous line technique

The technique for insertion of a tunneled central line is practically the same as that for the internal jugular and subclavian veins as described above. The only addition is in the tunneling of the line which is usually longer (Hickman Catheter®) than the regular central venous catheter and also has a Dacron or Fibrin cuff attached to the catheter and positioned 2–3 cm before the exit point [Figures 1 and 2]. The technique requires making a small incision (≤1 cm) at the very point where the finder needle is introduced (entry point) and the point where the catheter finally exits (exit point), usually 3–4 inches

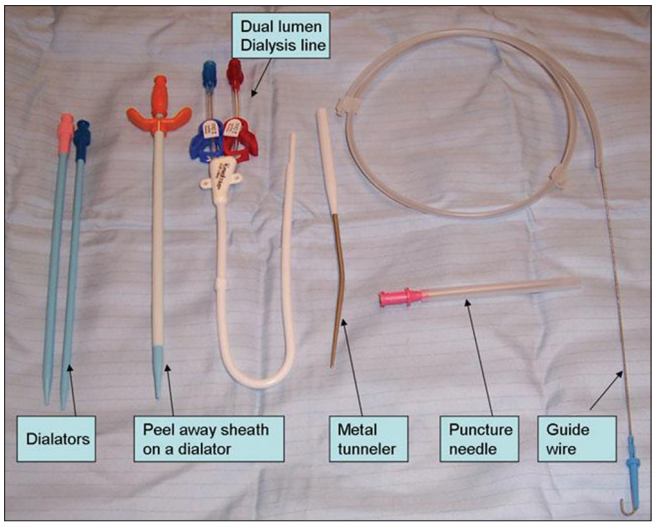

Figure 1: Key components of the central venous catheter kit (with tunneled-type catheter)

below the clavicle and away from the nipple and breast tissues. The line connecting the two points is infiltrated with xylocaine. For children, apprehensive and uncooperative patients, this may be done under mild sedation with midazolam by the bedside or under general anesthesia in the theatre. Following insertion of the guidewire into the vein at the entry point, the plastic or metal tunneled is used to create a subcutaneous tunnel connecting both points. The guide-wire is now pulled through from the entry point and out through the exit point. The catheter is now threaded along the wire into the vein. A few stitches are placed at the entry and exit points to narrow the opening and to firmly secure the line. The Dacron of fibrin cuff induces fibroses around it that not only stabilizes the catheter but also acts as a barrier to infection from the skin.[12]

Femoral vein approach

The LM for the femoral site is to palpate the femoral pulse at the midpoint between the pubic symphysis and the anterior-superior iliac spine. The femoral vein is located just medial to the artery. The needle is directed at 45° to the skin. The rest of the procedure is as for the internal jugular and subclavian sites described above.[10]

Data collection

This was done prospectively using a structured pro forma over a 2-year period (June 2010–May 2012) and analyzed with SPSS version 15.0 software program (SPSS 2006, Inc., Chicago, IL, USA).

Results

A total of 77 lines were inserted, four as tunneled lines [Figure 3] and 73 as nontunneled lines. Ten lines were inserted in 2010 (June–December), 34 in 2011 (January–December), and 33 in 2012 (January–May). Forty-seven (61.0%) patients were male and 30 (39.0%) were female with age range of 1–80 years [Figure 4]. Fifty-nine (76.6%) were done on the ward, 18 (23.4%) in the theater. Sixty (77.9%) and 17 (22.1%)

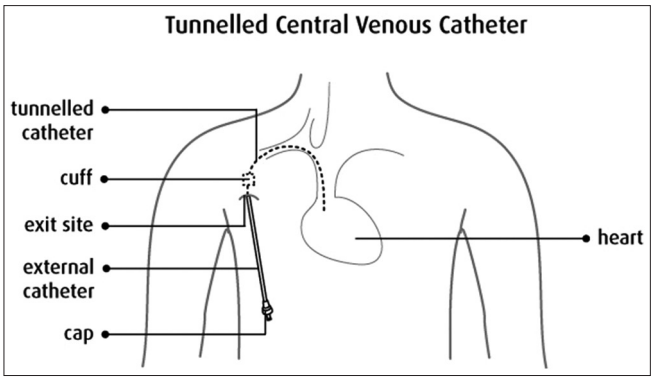

Figure 2: Tunneled line in position indicating the exit point and the position of the cuff

were done under local and general anesthesia, respectively. The indications included hemodialysis 30 (39%), parenteral nutrition 3 (3.9%), hydration 15 (19.5%), perioperative 15 (19.5%), cytotoxic 6 (7.8%), and exchange blood transfusion 8 (10.4%). Fifty-one (66.2%) were inserted by consultants and19 (24.7%) and 7 (9.1%) were inserted by senior (>2 years in training) and junior residents (<2 years in training), respectively [Figure 5]. The number of central lines inserted by residents over the period per year was 1 (3.8%) in 2010, 8 (30.8%) in 2011, and 17 (65.4) in 2012 [Figure 6]. The procedure was performed on the right side in 65 (84.4%) cases, in the internal jugular 6 (7.8%), subclavian 69 (89.6%), and femoral veins 2 (2.6%). The success rate was 75 (97.4%). The duration of stay was <72 h 7 (9.1%), 3–7 days 15 (19.5%), and >1 week 54 (70.1%) of cases. The overall complication rate was 16.9%; sepsis 3 (3.9%), hemorrhage 3 (3.9%), dislodgement 3 (3.9%), hematoma 2 (2.6%), and malposition 2 (2.6%) [Figure 7].

Discussion

Central venous access has become a routine procedure performed by all cadres of doctors, including medical interns in all advanced and standard hospitals world over. In the United States, specially trained nurses (IV therapists) are engaged in the insertion and care of these lines.[13] This is, however, not the case in most Nigerian hospitals where there is both extensive dearth of knowledge and gross underutilization of central venous lines.[14]

Central venous catheterization is a routine procedure in India and many Asian countries and thus the numerous publications on catheter-related complications from this region.[15] In Africa, the routine use of central lines is more in Southern and Northern African regions, and publications on catheter-related complications, particularly infections, are not difficult to find.[16,17] In the index institution, insertion of central venous lines commenced with the activation of the cardiothoracic unit in 2008. The rate of insertion was, however, limited due to lack of awareness by clinicians and accessibility to central venous line kits. A concerted effort is on, to reverse this trend by regular in-house seminars (at unit and departmental levels)

and hands-on instructions of resident doctors who rotate through the cardiothoracic surgery unit. This has impacted positively on the previously unimpressive state of affairs, as shown by the result [Figure 8]. More than thrice the number of procedures was done in 2012 for an equivalent duration in 2010 and almost equaling the number done in 2011 for half the duration in 2012. There was an increase in the number of procedures done by residents in successive months. The month of March 2012 saw a relative increase in the rate of insertion

Figure 3: The insertion of a tunneled central line for a pediatric patient in the theatre

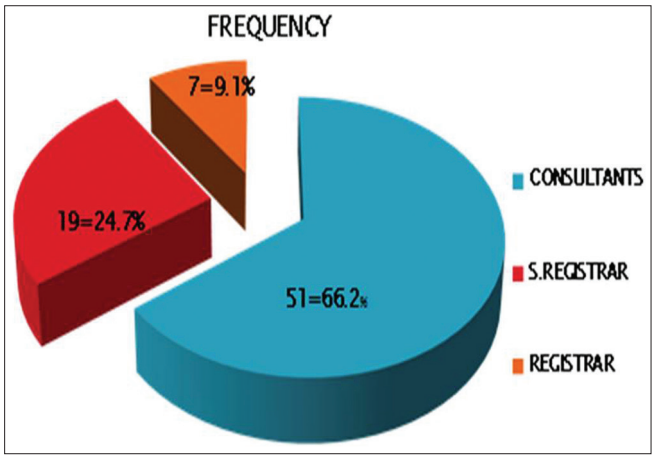

Figure 5: Pie chart of number of central lines inserted by different level of surgeons

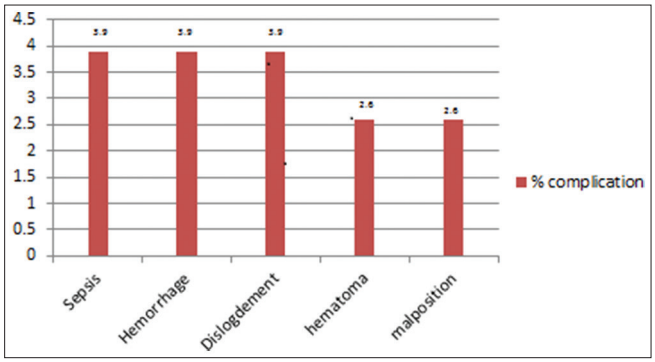

Figure 7: Bar chart showing different complications and their relative frequencies

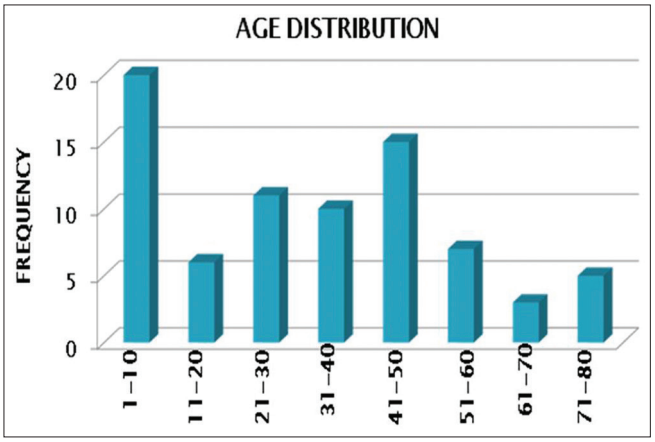

Figure 4: Bar chart of frequency of central lines inserted according to age

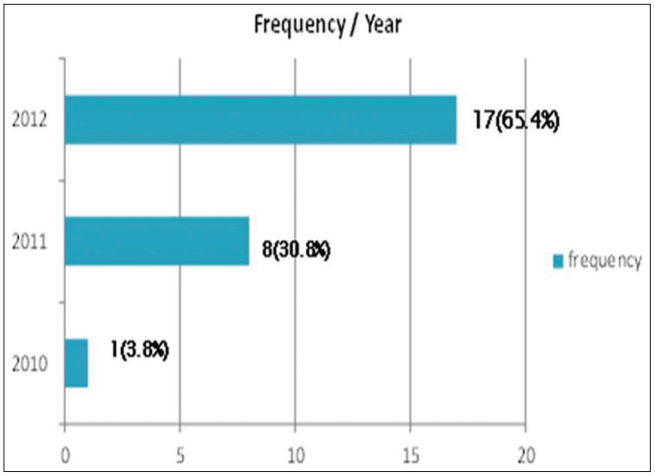

Figure 6: Bar chart of number of central lines inserted by residents per year

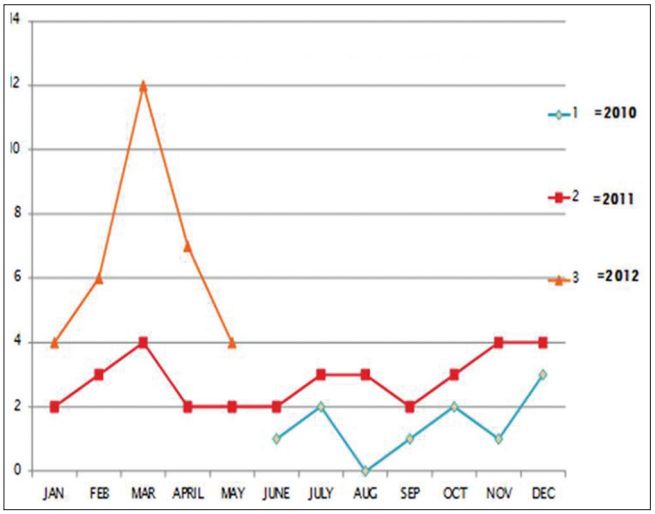

Figure 8: Number of central lines inserted by resident doctors per month per year

as a result of a hands-on workshop on central line organized by the department of surgery to mark its annual surgery day. Unfortunately, similar workshops could not be organized due to resource constraint and lack of support or sponsorship. As expected, a higher percentage of the procedures were done on the ward (76.6%) and under local anesthesia, to score home the point that it is essentially a bedside procedure except in children in whom cooperation may not be obtained. More procedures were done on the right side to preserve the left for future arteriovenous fistula creation in patients requiring dialysis. The subclavian route was a more preferred site, as it is more convenient to the patient while the femoral is less preferred due to its proximity to the perineum and greater risk for infection.[18] Some studies, however, did not find any statistical difference in infection rate between the femoral and other sites.[15,19] A higher percentage of patients had their catheter *in situ* for more than a week, and most of the patients are those who were on hemodialysis. A cursory look at the overall complication rate of 16.9% may give an impression of a rather high rate, but this compares favorably with works done by other researchers, e.g., Vanholders *et al*. reported overall rate of 27.2% for haemodialysis catheters.[20] Furthermore, the specific complications agree comfortably with those in the literature, e.g., infection rate of 9.7% and 1.5% for hematoma.[21] Although the hematoma reported by Akmal *et al*. were seen in femoral procedures, we observed 2.6% hematoma (equally for subclavian and internal jugular procedures). Symptomatic thrombotic complications may be as high as 1.2%–34.1%, while asymptomatic thrombosis may be as high as 1.5%–34.1%.[22] We had no case of catheter-induced thrombosis, though we did not rule out asymptomatic thromboses with the aid of ultrasound (US). The use of US to guide catheter placement has significantly reduced not only the complication rate but also the time to successful placement and number of attempts.[5,23,24] We adopted the traditional LM technique because we had neither the tool nor the technical skill. Improvement on our experience will require the adoption of the US technique which would further reduce our complication rate. This would indeed provide a basis for a comparative study (between US and LM) in our environment which for now does not exist. This study when conducted would help support or refute the arguments for and against the use of US given that some studies have found no advantage of US over the LM technique, especially with the subclavian approach.[25] This, in addition to preference by patients, formed the basis for our adoption of the subclavian approach as the default (thus constituting 89.6%) approach and the use of alternative routes when the former fails.[18] Furthermore, the finding of Brass *et al*. can be used as a benchmark for competency assessment when compared with local study when the US technique is commenced.[24] The absence of mortality in our study is in keeping with the reported mortality of 0–1.25/1000 catheterizations, which may result from septicemia, cardiac or major vessel perforation, and air embolism.[20] Indeed, any possible complication could lead directly or indirectly to death. Although we had initial anxiety regarding the care of central venous catheters given that most of the clinical staff were unfamiliar with the device, the relatively low incidence of complications and the complete absence of mortality gives us the confidence to encourage more clinicians to insert central venous catheters routinely because of its numerous advantages.

Conclusion

Our initial experience with the use of central venous lines, was marked by a high success rate, few manageable complications and no mortality even in the hands of resident doctors over the study period. Majority of insertions were done by the bedside under local anesthesia lending credence to the assertion that it is a relatively safe procedure that can be done by any adequately trained doctor and should, therefore, be encouraged in our hospitals.

Study limitations

The authors wish to acknowledge some limitations; the small sample size resulting from the fact that it is a single-unit activity in an institution without previous experience. That the study is limited to a single institution is also a limitation which can be made better by collaborating with another institution with similar setting. The study was carried out without institutional sponsorship and the cost borne by patients in a resource-poor setting which is a contributory factor to the sample size as some indigent patients could not afford the cost of the catheter.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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