Background/Purpose: The use of central venous catheters has brought enormous benefits in neonatal care. They have been used extensively in neonatal intensive care units for administration of intravenous fluids, parenteral nutrition as well as antibiotic therapy. Tunneling the catheter through the subcutaneous tissue has been used to reduce the incidence of systemic sepsis, as the skin exit site is away from the vein puncture site. Tunneled central venous catheters have been routinely inserted in the operating room, few centers performing the technique in the neonatal intensive care unit (NICU). The aim of this study was to evaluate the feasibility and safety of their insertion in the NICU.

Patients and Methods: Over a period of two years, fourteen tunneled single lumen silicone catheters have been inserted by the author in 12 neonates. They were inserted using a cut-down technique either through the internal jugular vein or the femoral vein. Cases performed in the operating room received general anesthesia, while sedation and local anesthesia were used for cases performed in the NICUs. Postoperatively, X-ray was performed to verify the catheter position. Catheters inserted in the NICU were compared to those inserted in the operative room. Indications, complications and outcomes were reviewed.

Result: The patients’ weight ranged from 590 gm to 3.3 kg. The youngest was 7 days old. Six catheters were inserted in the operating room (43%), and eight (57%) in the NICU. The internal jugular vein was used in 12 cases (86%) and the femoral vein in two (14%). Of the twelve babies, ten (83%) required the catheter for hyperalimentation, and two (17%) for both antibiotic therapy and intravenous fluid administration. Septic complications occurred in two cases (14%); local wound sepsis in one patient (7%); and septicemia in another (7%). Both of them were inserted in the operative room. Tube dislodgement occurred in one case (7%) and thrombus formation in one occasion (7%).

Conclusion: Tunneled insertion of central venous catheters is a valuable technique in the neonates. Line insertion in the NICU was not associated with increased risk of line sepsis. Therefore, performing the technique in the NICU is not only feasible but safe as well. However, large-numbered studies are still needed.

Index Words: Central venous lines, tunneled lines, neonates, Broviac

INTRODUCTION

The use of central venous catheters (CVC) has become an essential component of both medical and surgical practice in the pediatric population. They obviate the need for multiple peripheral venous punctures. These catheters have been used extensively in the neonatal intensive care units (NICUs) for administration of intravenous fluids (IVF), parenteral nutrition, antibiotic therapy as well as frequent blood sampling. CVC can be inserted either percutaneously, with or without fluoroscopy control, or by the open,
cut-down technique.3 Percutaneous insertion could be done either directly into a central vein or through a peripheral one (peripherally inserted central catheter (PICC)).4

Tunneled CVC have been used in the neonates. Tunneling the catheter through the subcutaneous tissue reduces the incidence of systemic septic complications as the exit site from the skin is away from the vein puncture site. This also leads to tissue growth around the tube, which means better fixation and less incidence of accidental tube dislodgement.4,5 Traditionally, these tubes used to be inserted in the operative room (OR), however, critically ill patients in the NICU carry a higher risk during transportation, and insertion in the NICU is currently gaining popularity.

The aim of this study was to evaluate the feasibility and safety of their insertion in the neonatal intensive care unit.

PATIENTS AND METHODS
Over two years (between February 2003 and January 2005), 14 tunneled, single lumen silicone CVCs have been inserted by the author in 12 neonates. They were inserted using a cut-down technique6 either through the internal jugular vein (IJV) or the femoral vein (FV). Cases performed in the OR received general anesthesia, while sedation and local anesthesia were used for cases performed in the NICU. After dissection of the chosen vein with proximal and distal control, a venotomy was performed using fine vascular scissors and the already tunneled silicone tube was passed inside the vein’s lumen. The venotomy site was sutured snug over the tube without encroaching upon the vein lumen and the wound was closed. In all cases, the catheters were tunneled through the subcutaneous tissue with a remote exit from the site of venotomy. Exit was placed over the chest wall for the IJV lines and the abdominal wall for the FV lines.

Postoperatively, X-ray was done as a routine to verify the catheter position. Cases received it in the ICU were compared to the OR ones. Indications, complication rates and outcomes were reviewed.

RESULTS
The weights of the patients ranged between 590 gm and 3.3 kg. The youngest patient was 7 days of age. The procedure was performed in the OR on 6 occasions (43%) and in the NICU on 8 (57%). Twelve internal jugular veins were cannulated (86%) versus two femoral veins (14%). One of the two babies of FV lines had ventriculo-peritoneal shunt already inserted and tunneled for hydrocephalus. In the second case, one of the inserted IJV catheters had to be taken out for suspected line-related septicemia, and the replacement was inserted in the FV instead. Of the twelve babies, 10 cases (83%) required the CVC for hyperalimentation and 2 (17%) for both antibiotic therapy and IVF. One line (7%) developed local wound sepsis and another (7%) had signs of septicemia, presumably line-related. Both lines were inserted in the OR. In both cases, the lines were pulled out without further sequelae (one reinserted in the FV as mentioned before). In one patient the catheter had to be replaced in the left IJV after being accidentally pulled out from the right IJV during routine nursing care. Right atrial thrombus occurred following one line (7%). This was proved by echocardiography. Fibrinolytic agents were given to dissolve it.

DISCUSSION
In 1973, after unsuccessful efforts with arteriovenous shunts, John Broviac designed an intravenous catheter that afforded prolonged access for hyperalimentation.7 In 1979, Robert Hickman made modifications to the Broviac’s prototype, to make it more suitable for leukemia chemotherapy administration.8 His tunneled, cuffed and bigger lumen catheter facilitated blood collection as well as infusion of chemotherapeutic agents, blood, and IV solutions.

In our series, a cut-down insertion technique was employed, where the catheter was passed into the vein under direct vision. This technique was performed in both the OR and the NICU. In this series, the eight cases performed in the NICU were so ill that transportation to the OR was thought too risky. In one of these cases, the catheter came out during routine nursing care and had to be replaced. This occurred in the first postoperative day, where enough time for tissue growth (essential for catheter fixation) did not take place.

In the literature, the total complication rate of CVC ranges from 30-35%.9,12 Early complications include pneumothorax, arterial puncture, and failure of placement. Late complications include sepsis.
(superficial and systemic), venous thrombosis, line displacement, catheter blockage and nerve injury.\textsuperscript{13-19}

Klein et al\textsuperscript{2} examined CVC sepsis in the newborn surgical patients. During a 3-years period, 79 patients required a tunneled, cuffed, CVC. Nineteen patients (24\%) had proven sepsis and 8 (10\%) had suspected sepsis. Risk factors for the line-related sepsis included younger gestational age, repeated operations, and the presence of intestinal stoma.

In our study, septic complications (14\%) occurred in the premature children. One of them developed frank septicemia. The baby weighed 1.3 kg and suffered right lung collapse, for which mechanical ventilation was necessary. Screening for sepsis was inconclusive, and line-related sepsis was the only possible explanation. The line was, accordingly, pulled out of the IJV and a new one was inserted in the FV. Insertion of the lines in the NICU was not associated with increased risk of line sepsis in our study (both cases were inserted in the OR).

The incidence of CVC-associated thrombus formation ranges between 10- 12 \%.\textsuperscript{15,16} This is usually asymptomatic and is confirmed when an abnormal mass, consistent with a thrombus, is detected in the right atrium using echocardiography. The formation of these thrombi is associated with positioning the catheter tip in the right atrium (RA), instead of the superior vena cava (SVC) or its junction with the RA \textsuperscript{15}. In the single case with RA thrombus in our series, the tip was placed in the right side of the heart rather than the SVC. Again, this was detected by echocardiography and the case was originally performed in the OR. Based on the above, indications of insertion in the NICU did not differ from the OR. And this was not associated with higher complication or sepsis rate.

**CONCLUSION**

Tunneled insertion of the central venous catheter is a valuable technique in the neonates. It was helpful in providing hyperalimentation, intravenous fluids, antibiotics therapy as well as frequent blood sampling. Line insertion in the neonatal intensive care was not associated with increased risk of line sepsis. Therefore, performing the technique in the neonatal intensive care unit is not only feasible but safe as well. However, large-numbered studies are still needed to confirm our findings.

**REFERENCES**


