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RESEARCH

Comparison of Complication Rates Between Umbilical and Peripherally Inserted Central Venous Catheters in Newborns

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ABSTRACT

Objective: To compare the complication rates between umbilical central venous catheters and peripherally inserted central venous catheters in newborns and to investigate whether other variables might increase complication rates.

Design: A retrospective observational study.

Setting: A Level III neonatal intensive care unit (NICU).

Participants and Setting: Newborns (gestational age 24–42 weeks).

Methods: All central venous catheter–related complications were retrospectively analyzed in newborns. The differences in survival rates between the two types of central venous catheters were evaluated using a Kaplan-Meier survival analysis with removal because of complications as the event of interest.

Results: In total, 140 umbilical venous catheters and 63 peripherally inserted central catheters were included. There were no significant differences in removals due to complications between the two catheters. The central line–associated bloodstream infections had the highest complication incidence, followed by obstruction, dislocation, leakage, and extravasation. There were no influences of gestational age, birth weight, and the use of subsequent catheters on the complication incidence.

Conclusion: A high complication incidence resulted in removal of the catheters, but it was not significantly different between the two catheters. The prevention of complications should be an important goal in the daily care of infants in the NICU.

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For more than 40 years, central venous catheters (CVCs) have been commonly used in neonatal intensive care units (NICUs) to administer fluids, medications, and total parenteral nutrition (TPN) to critically ill newborns. The most commonly used CVCs in the NICU are umbilical central venous catheters (UVC) and peripherally inserted central venous catheters (PICC). An UVC is inserted in the umbilical vein. This access can be used in the first 2 days after birth. After 2 days, the umbilical stump is usually dried, which makes insertion difficult. Moreover, after 2 days, the umbilical stump becomes colonized by microorganisms, and therefore the insertion of a UVC at this time is not recommended (Mahieu et al., 2001). Our protocol prescribes the removal of an UVC before or at Day 7 when possible because we assume an increased risk of central line– associated bloodstream infections (CLABSI) related to longer UVC longevity as a result of this umbilical stump colonization. However, in practice, many UVCs frequently remain in longer than 7 days.

A PICC is inserted in one of the major peripheral veins. Insertion can occur in the first day after birth (when UVC insertion has failed) or at any point during the entire NICU stay. A PICC can be inserted after a UVC is (electively) removed or when a previous CVC is removed because of complications and continuous intravenous therapy or TPN is still necessary. Therefore, a PICC can be inserted as a second, third, or sometimes fourth subsequent CVC in a newborn.

Umbilical venous and peripherally inserted central venous catheters are widely used in the neonatal intensive care unit, although this use is not without risks.

The elective removal of a PICC occurs only when treatment is no longer necessary.

However, a CVC, whether it is a UVC or PICC, is not without risk. Complications, such as pleural effusion, obstruction, extravasation, thrombosis, leakage, and CLABSI can occur (Liu et al., 2009; Menon, 2003; Pettit, 2002 , 2003; Stocker & Berger, 2006).

In the literature, the complications of one type of CVC or even just one complication primarily are analyzed. This is understandable because a proper, balanced comparison cannot be made. Apart from the difference in the vascular access and postnatal age of the newborn when inserting a CVC, the sequential use of the CVC is another difference between the UVCs and PICCs. However, a comparison between the two types of CVCs, despite these differences, can improve our knowledge about the complication incidence, facilitating a more informed choice for using or continuing a CVC. Only then can improvements be made to reduce morbidity, mortality, and health care costs.

The primary aim of this study was to retrospectively compare the complication incidence between UVCs and PICCs in our NICU. The secondary aim was to determine whether other variables such as birth weight, gestational age, and the use of subsequent CVCs increase the complication rate. The knowledge of the incidence of CVC-related complications is important in the care of vulnerable newborns. If this information is known, measures can be developed to reduce the complications of CVCs in NICUs, such as for example CLABSI. CLABSI reduction would result in decreased mortality and a reduction in health care costs (Etchells et al., 2013).

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Methods

Sample

The study cohort was enrolled from a tertiary-level 17-bed NICU with an average of 500 admissions per year. Newborns were included if they 1) had a gestational age between 24 and 42 weeks and 2) had a CVC (UVC or PICC) inserted in our ward.

Newborns were excluded if their catheters were removed within 24 hours after insertion because it is expected that the complication rate would be very low in such a short in-situ duration. They also were excluded if they had a CVC inserted in another center because of possible differences in the insertion procedure that might affect the complication rate or had incomplete data. Lastly, newborns who underwent extracorporeal membrane oxygenation (ECMO) treatment were excluded because ECMO induces clotting activities that results in an increased risk for thrombi formation. Therefore, these newborns were treated with continuous heparinization to reduce the thrombi formation risk. (Oliver, 2009; Short, 2008). Thrombi formation can also increase the risk of CLABSI (Shah & Shah, 2011).

Design

In this retrospective observational study, clinical characteristics, catheter type, insertion site, complications, CVC longevity, and the reason for removal were collected by two investigators (IJJA & LMB) from the patient data management system and medical records for a 16-month (2005–2006) period. The investigators checked each other's work to increase reliability. CVCs were followed until their removal or when a newborn died or was transferred.

The reasons for CVC removal were grouped into elective (end of therapy, death, transfer to other hospital) and nonelective reasons. Nonelective reasons included obstruction of the CVC (i.e., difficulty or inability to flush the catheter or inability to administer fluid in three seconds), leakage from the CVC insertion site, CVC dislocation, pleural effusion/extravasation of fluid into the tissue, or CLABSI.

In this study, we used a CLABSI definition for patients < 1 year old, based on the Centers for Disease and Control (CDC) definition (Horan, Andrus, & Dudeck, 2008). *CLABSI* was defined as a laboratory-confirmed bloodstream infection with a UVC or PICC in place for a minimum of 2 days or in place on the day of event or the day before. *Laboratory-confirmed bloodstream infection* was defined by using one of the first two following definitions: Criterion 1 was defined as one or more positive blood cultures, with the exception of skin micro-organisms, not related to another infection source. Criterion 2 was defined as clinical signs of sepsis (especially for patients < 1 year old), such as fever or hypothermia, apnea or bradycardia,