An Evidence-Based Catheter Bundle Alters Central Venous Catheter Strategy in Newborn Infants

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Objective To assess whether introduction of an evidence-based percutaneously inserted central catheter (PICC) care bundle reduced the risk of central line-associated bloodstream infection (CLABSI), thus altering the comparative risk of CLABSI in infants.

Study design This retrospective cohort study included all infants for whom an umbilical venous catheter (UVC) was placed as part of routine care between Jan 1, 2006, and Dec 31, 2009, a period during which standardized PICC insertion and care bundles were introduced. Duration of UVC use was divided in ≤7 days and >7 days.

Results Infants in the ≤7 days UVC group had 1.0 CLABSI/1000 catheter days, and infants in the >7 days UVC group had 4.0 CLABSI/1000 catheter days ($P < .001$). Controlling for birth weight, gestational age, and antibiotic use, the >7 days UVC group had a greater risk of CLABSI (OR, 5.48) than the ≤7 days UVC group. CLABSI rate increased more rapidly in UVC than PICC with increasing duration of catheter rose.

Conclusions Replacement of a UVC with a PICC when central venous access is needed after 7 days of age may reduce CLABSI. *(J Pediatr 2012;160:972-7)*.

Central venous catheters, such as umbilical venous catheters (UVC) and percutaneously inserted central venous catheters (PICC), are frequently used in the care of neonates in neonatal intensive care units (NICUs). However, the widespread use of central catheters in a high-risk population brings with it a number of potential complications.[1-9] The most common complications seen in neonates are central line-associated bloodstream infections (CLABSIs), which substantially contribute to the burden and cost of neonatal care.

Because the risk of complications may increase with duration of use, UVC are often removed after relatively short periods and replaced with PICC for maintenance of long-term fluid and nutritional status. However, PICC also have associated risks and complications, including dislodgment, obstruction, infiltration, broken or leaking catheters, thrombus formation, effusions, and sepsis.[2,3,8,10,11] Infection of either of these catheters is a major concern in neonates.

The safest strategy of UVC and PICC use in preterm infants remains unclear. Studies by several groups, including our own, have suggested that long-term use of UVC for periods as long as 14 to 28 days may not result in increased CLABSI risk when compared with short-term use of UVC (UVC for 7-10 days) followed by placement of a PICC.[2,12]

Evidence-based catheter care practices can reduce the occurrence of CLABSIs in adults and children.[13-20] One proposed approach to achieving low CLABSI rates is implementation of catheter care bundles, combinations of individual, evidence-based care practices that are introduced together, as a group, in the clinical setting. Beginning in November 2006, evidence-based catheter insertion and maintenance bundles were developed in our NICU. To implement these practices, a team of nurses (PICC team) was trained to provide catheter care with standardized checklists. We recognized that the effect of the PICC team might change the risk-benefit balance of short-term and long-term UVC strategies if PICC CLABSI rates fell dramatically. We hypothesized that implementing standardized, evidence-based PICC care by using a trained PICC team would reduce the incidence of CLABSI in patients with PICC. We further hypothesized that the infection-free catheter survival findings in the two catheter strategies would change, such that CLABSI rates would be higher in infants with long-term use of UVC than in infants with short-term use, each followed by PICC placement as needed.

Methods

This retrospective cohort study included all infants for whom a UVC was placed as part of routine care between Jan 01, 2006, and Dec 31, 2009, in a single 52-bed tertiary referral NICU. The University of Rochester institutional review board approved the study.

CLABSI	Central line-associated bloodstream infection
NHSN	National Healthcare Safety Network
NICU	Neonatal intensive care unit
PICC	Percutaneously inserted central catheter
UVC	Umbilical venous catheter

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Catheter Management

The clinical team made decisions about placement, type, and overall duration of central venous access. Central venous catheters were generally discontinued when the infant no longer required total parenteral nutrition or had approached total enteral intake of 100 to 120 mL/kg/day.

UVC Placement and Care. As part of routine care, placement of a UVC was attempted in infants with an expected need for prolonged central venous access on admission to the NICU. Routine care of the umbilical site included use of betadine for cord preparation before catheter placement. No triple dye was applied to any umbilical cord that had the potential to need a UVC. Either a single- or double-lumen catheter (3.5 or 5.0 French diameter) was inserted in sterile conditions. A second assistant or "buddy" was assigned and dedicated to placement of the UVC. This person assisted with the procedure and assured that sterile technique was maintained throughout the procedure. Neonates with UVC were not confined to back-lying position. All catheters were attached to transducers for continuous monitoring. Care of the catheters was standardized, with use of evidence-based bundled care and a series of procedural checklists. Catheters were sutured in place in the umbilical cord, and tape was then used to secure the catheter to the infant's abdomen. The clinical team (not the PICC team) was responsible for changing the fluids of the umbilical arterial and venous catheters. At the completion of the procedure, a procedural checklist was completed indicating use of sterile technique from the start of the procedure until the final placement and suture of the catheter.

PICC Insertion and Care. Placement of the PICC was performed in sterile conditions, and care of the catheters was standardized. Povidone-iodine solution, swabbed 360 degrees surrounding the chosen insertion site, was used for preparation. Either a 25- or 30-cm catheter with a 24-gauge introducer needle was inserted in the infant's brachial, axillary, saphaneous, or external jugular vein. All PICC solution changes were done by the PICC team (described below). Dressings were assessed hourly and changed when there was loss of adhesiveness, drainage at the site, or the dressing became too restrictive. A "second assistant" or "buddy" was available for PICC insertion, dressing changes, and care and maintenance to ensure that complete aseptic technique and highest standard of care were being used. A dedicated team of neonatal fellows, nurse practitioners, and physician assistants performed all dressing changes and catheter manipulations. Evidence-based care checklists were used for PICC insertion, catheter dressing changes, and care and maintenance of the PICC during solution changes.

In addition, beginning in November 2006, all providers in our NICU who were in contact with central catheters received education or re-education on catheter care and were introduced to the evidence-based care checklists for UVC and PICC insertion, PICC dressing changes, and care and maintenance of UVC and PICC during solution changes. All checklists were reviewed by a PICC team member, with any deviation in procedure prompting ongoing education of the providers.

PICC Team. In an effort to reduce CLABSIs in our NICU, a PICC team was formed in November 2006, consisting of 20 trained nurses who dedicated 4 hours/day exclusively to catheter care and maintenance, including the changing of central catheter solutions. The PICC team was not responsible for umbilical venous or arterial catheter care or fluid changes. Because of challenges inherent in staff scheduling, the PICC team provided PICC care for most, but not all days each month. Parenteral nutrition solutions for PICCs were changed once daily. The team used procedure carts specifically outfitted for PICC care and maintenance. The team used a closed medication administration system and adhered to strict evidence-based practices for solution changes and catheter care.[13] They performed hand hygiene and maintained aseptic technique when changing all intravenous tubing and when entering the catheter, including scrubbing the catheter hub with povidone-iodine. All catheter-tubing changes were performed by using a standardized intravenous tubing setup and changed according to a written unit policy. The catheter insertion site was inspected for any signs of infection and for dressing integrity. All PICC care was done by working alongside bedside nurses with a buddy system.

Evaluation of Infection

In our routine practice, evaluation of infection was initiated when an infant exhibited signs and symptoms of potential sepsis, including increased apnea/bradycardia, hypotension, temperature instability, lethargy, feeding intolerance with abnormal abdominal radiograph results, or sudden change in clinical status. All infants who had a sepsis evaluation performed had two peripheral blood cultures drawn simultaneously from 2 different sites when possible. Whole blood (0.3-1.0 mL) was placed in blood culture bottles and transported to the microbiology laboratory. Organisms were isolated and identified by using standard microbiology techniques. When the peripheral culture results were positive for an organism, a blood culture was obtained from the centra1 catheter when possible.

Care and treatment of CLABSI was clinically dependent on the organism being treated. When the UVC or PICC yielded positive culture results for coagulase-negative staphylococcus, antibiotics were routinely administered through central catheters, with repeat blood cultures to assess whether the line had been cleared of infection. When culture results remained positive, the catheter was removed. When the UVC or PICC yielded positive culture results for other pathogenic organisms, such as gram-negative bacilli or fungi, the catheter was immediately discontinued.

Definition for Infection

CLABSI was defined according to National Healthcare Safety Network (NHSN) guidelines.[17,18] The infant was considered to have a CLABSI when one of these two criteria were met: (1)