

# A multimodal approach to central venous catheter hub care can decrease catheter-related bloodstream infection

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**Background:** This study was conducted to investigate decreases in catheter-related bloodstream infections (CRBSIs) through an evidence-based multimodal intervention.

**Methods:** This was a prospective interventional study of neonates with a central venous catheter (CVC) from a neonatal intensive care unit database, involving implementation of a multimodal approach to central venous catheter hub care using 2% chlorhexidine in 70% isopropyl alcohol and education of medical staff by audiovisual presentations. CRBSI rates in the pre-intervention period and postintervention period were compared.

**Results:** A total of 373 patients with a CVC (163 in the preintervention period and 210 in the postintervention period) were studied. Patient demographic and clinical characteristics were similar in the 2 periods. Extremely low birth weight infants constituted 40% of the cohort in the preintervention period and 38% of the cohort in the postintervention period. The CRBSI rate in patients with an umbilical artery catheter and an umbilical vein catheter decreased from 15/1000 catheter-days to 10/1000 catheter-days (odds ratio [OR], 0.47; 95% confidence interval [CI], 0.17-0.91). The CRBSI rate in patients with a peripherally inserted central catheter decreased from 23/1000 catheter-days to 10/1000 catheter-days (OR, 0.33; 95% CI, 0.12-0.91). These decreased CRBSI rates were sustained despite high device utilization. The incidence of gram-negative septicemia also decreased. Ten CRBSIs were prevented by this multimodal approach, representing significant health care cost savings.

**Conclusion:** This study demonstrates significant decreases in CRBSI rate for all catheter types and birth weight categories associated with the multimodal intervention. Audiovisual education is an effective tool for practice change. Reeducation and compliance monitoring should be part of all nosocomial infection prevention strategies, resulting in significant savings in health care costs.

**Key Words:** Catheter-related bloodstream infection; central line hub care; medical staff education; audiovisual educational materials; National Healthcare Safety Network; chloraPrep.

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Over the past 3 decades, advances in perinatal and neonatal technology, along with changing socioeconomic conditions and health behavior patterns, have resulted in an increase in the preterm birth rate, as well as in the survival rate of these high-risk infants, who require neonatal intensive care, including prolonged central venous catheter (CVC) access for medication, nutrition and monitoring.<sup>1,2</sup> Although CVC placement is a life-saving intervention for infants with poor

peripheral venous access, it carries an increased risk of infection and thrombosis.<sup>3-6</sup> The National Healthcare Safety Network's (NHSN) 50th percentile catheter-related bloodstream infection (CRBSI) rate is higher for extremely low birth weight (ELBW) infants (birth weight <1000 g),<sup>3</sup> with associated higher attributable mortality rate, cost per infection, and overall annual cost.<sup>7</sup>

The mechanisms of CRBSI have been elucidated, and various prevention strategies have been studied. Pathogenic organisms can gain access to the bloodstream through colonization of catheter ports and skin surrounding the insertion site, contaminated intravenous (IV) fluid, and hematogenous seeding from distant infection sites.<sup>8,9</sup>

Microbes that colonize the CVC hub and the skin surrounding the insertion site are the source of many CRBSIs.<sup>10,11</sup> Successful prevention strategies must reduce colonization at the insertion site and catheter hub or minimize microbial spread extraluminally from the skin or intraluminally from the hub toward the catheter tip. The Centers for Disease Control and Prevention (CDC) recommends disinfection of all vascular hubs, needleless connectors, and injection ports before access.<sup>7</sup> The CDC also recommends a

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comprehensive educational approach to improving CVC insertion and maintenance practices.<sup>7</sup> An expanding body of literature has demonstrated the impact of different educational and system-based interventions in decreasing CRBSI rates.<sup>12,15</sup> Most published intervention programs are multidimensional, that is, addressing more than one technical and/or social aspect of change to effect prevention. We implemented a multimodal intervention program focused on standardizing catheter hub care and involving an intense educational program in an effort to reduce the CRBSI rate.

## METHODS

### Setting and subjects

The site of this study was the neonatal intensive care unit (NICU) at Maria Fareri Children's Hospital, a 50-bed regional neonatal referral unit at Westchester Medical Center, New York Medical College. The study population included all patients admitted to the NICU between June 2005 and March 2007 with a CVC in place for more than 24 hours.

### Study design and intervention

This was a prospective interventional study of CRBSIs. In June 2005, a database of all neonates with a CVC was maintained by the Division of Newborn Medicine and the Department of Infection Control. The preintervention period extended from June 2005 to February 2006, and the postintervention period ran from March 2006 to March 2007. A multimodal approach to CVC care was implemented, involving creation of a NICU CVC database, a catheter hub care policy, an educational DVD of a NICU nurse demonstrating catheter hub access, a new catheter dressing policy, a catheter hub care checklist at every bedside, and a CVC cart in every patient room.

During catheter hub access, the surface area of the needleless port and the outer surface of the stop cork or Luer-lock threads of the catheter hub were scrubbed in a circular motion with friction using 2% chlorhexidine in 70% isopropyl alcohol (ChloraPrep Sepp, CareFusion, Leawood, KS) for 10 seconds and allowed to dry for 30 seconds. The catheter hub care protocol also mandated standard hand hygiene, the use of clean gloves, and the establishment of sterile fields with 4" × 4" gauze under the catheter port and the syringes used to access the hub with medications and flushing solution. The new catheter dressing change policy was to change dressings only when soiled, instead of routine weekly changes.

Several types of CVCs were used in our NICU. Umbilical artery catheters (UACs, VYGON Corporation, Montgomeryville, PA) and umbilical vein catheters (UVCs) had a stop cork (Smith Medical MD, Inc,

St. Paul, MN), with either a Luer Lock and an attached syringe for blood draws (Becton Dickinson, Franklin Lakes, NJ) or a Smartsite needleless connector (Alaris, CareFusion, San Diego, CA) for continuous or intermittent infusions. The Luer Locks and needleless connectors were cleaned with ChloraPrep Sepp during each access; the entire stop cork was changed every 24 hours. Peripherally inserted central catheters (PICCs, Becton Dickinson, Franklin Lakes, NJ) had a T-piece (Cardinal Health, Dublin, OH) connected to the IV tubing and a Smartsite needleless connector. The needleless connector was cleaned with ChloraPrep Sepp during each access. The T-piece remained in place for the duration of PICC use. PICC IV tubing was changed every 24 hours. In a Broviac catheter (C.R. Bard, Inc, Murray Hill, NJ) IV tubing was connected directly to the catheter during continuous infusion or a needleless connector was used for intermittent infusions. Needleless connectors were cleaned with ChloraPrep Sepp during each access. IV tubing was changed every 24 hours. The patients received both continuous and intermittent infusions, depending on their individual clinical needs.

In February 2006, 1 month of in-service was provided to the health care team in multiple sessions. Each session consisted of a 15-minute DVD demonstrating the 9 steps of catheter hub care (Table 3) to the health care team in small groups. The DVD also was made available on the NICU Web site for the health care team to view at any time. Catheter hub care checklists were at every bedside to remind the health care team of the various steps of the protocol. A CVC care cart also was placed in each room to facilitate ready access to cleaning materials. Hand hygiene campaigns that had been implemented were reinforced throughout the study period.

The level of staff adherence with catheter hub care policy was determined before and after the DVD educational presentation. Before the presentation, 24 nurses were observed at random performing the catheter hub care protocol; after the presentation, 26 nurses were observed. Adherence to each of the 9 points of the catheter hub care protocol was scored as either "yes" or "no" by independent observers well versed in the protocol.

Surveillance for CVC infection was done by an infection control nurse, using standard definitions.<sup>3</sup> This nurse visited the NICU every day.

Rates are presented as the number of CRBSIs per 1000 catheter-days. The New York Medical College's Institutional Review Board approved the study design and waived the need for informed consent.

### Definition

The CDC defines CRBSI as a positive blood culture with a catheter in situ for at least 48 hours without any other source of infection.

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