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Central line-associated bloodstream infections in the NICU: Successes and controversies in the quest for zero

Renée E. Mobley, MD, and Matthew J. Bizzarro, MD*

Division of Neonatal-Perinatal Medicine, Department of Pediatrics, Yale University School of Medicine, New Haven, CT

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ABSTRACT

Central line-associated bloodstream infections (CLABSI) are among the most common healthcare-acquired infections in the neonatal intensive care unit (NICU) population and are associated with an increased risk of morbidity and mortality, as well as increased healthcare costs, and duration of hospitalization. Over the past decade, numerous local, statewide, and national quality improvement initiatives have resulted in a significant reduction in CLABSI rates. The majority of successful initiatives have utilized similar strategies to implement and sustain their efforts, including education of NICU staff in the principles of quality improvement, creation and implementation of central line insertion and maintenance bundles and methods for assessing compliance, formation of dedicated central line insertion and maintenance teams, and utilization of reliable and effective methods for collecting, analyzing, and displaying data. Despite this progress, continued work toward discovery of better practices, such as the safest and most effective agent for cutaneous antisepsis or identification of optimal outcome and process measures, is required if further progress is to be made. Additionally, sustained progress in reducing the burden of neonatal infections may require a shift in focus away from CLABSI and toward the reporting, investigation, and prevention of all NICU-onset bacteremia.

Introduction

Preterm infants in the neonatal intensive care unit (NICU) are highly susceptible to healthcare-acquired infections (HAI) given their immature immune systems and need for invasive procedures, support devices, and prolonged hospitalization.[1] Preterm infants with HAI are significantly more likely to die and, in survivors, to experience neurodevelopmental and growth impairment as compared to their uninfected counterparts.[2,3] Furthermore, the adjusted costs of hospitalization

Abbreviations: NICU, neonatal intensive care unit; HAI, healthcare-acquired infections; VLBW, very low birth weight; BSI, bloodstream infection; PICC, peripherally inserted central catheters; CLABSI, central line-associated bloodstream infections; BW, birth weight; CDC, Centers for Disease Control and Prevention; HICPAC, Healthcare Infection Control Practices Advisory Committee; PQCNC, Perinatal Quality Collaborative of North Carolina; ELBW, extremely low birth weight; PI, povidone–iodine; CHG, chlorhexidine gluconate; SPC, statistical process control; NHSN, National Healthcare Safety Network; SIR, Standardized Infection Ratio

* *Corresponding author*.
E-mail address: renee.mobley@yale.edu (R.E. Mobley).

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and duration of NICU stay for very low birth weight (VLBW) infants with at least one bloodstream (BSI) infection may be increased by as much as $50,000 and 10 days, respectively, as compared to VLBW infants without a BSI.[4]

Central lines, particularly peripherally inserted central catheters (PICC), are utilized frequently in preterm infants for nutritional support and medication administration, and central line-associated bloodstream infections (CLABSI) are among the most common HAI encountered in the NICU. A CLABSI is considered a preventable hospital-acquired condition and a great deal of attention has therefore been focused on CLABSI given their high rate of associated costs and complications as well as state mandates for public reporting of institutional-specific data. Several successful quality improvement efforts to reduce CLABSI in the NICU have been reported over the last decade, with common strategies for reduction and sustainability that include a change in the mental model of CLABSI from inevitable to preventable,[5] a focused effort on formal training of NICU staff in the principles of quality improvement,[6–10] the creation and implementation of central line insertion and maintenance bundles based on best practice recommendations,[6–11] the formation of dedicated central line teams,[12,13] establishment of CLABSI prevention collaboratives,[7,9,10] and data reporting and transparency.[14]

Concerted efforts such as these led to a 46% reduction in national CLABSI rates from 2008 to 2013[15] and, in the NICU population, reductions in CLABSI rates in all birth weight (BW) categories[16–21] (Fig.). Despite these successes, sustainability and eradication for many institutions remain elusive. This review will focus on some of the successful principles and strategies utilized consistently in local and collaborative NICU CLABSI prevention efforts. In addition, we will explore some of the controversies and unresolved issues that remain in the "quest for zero."

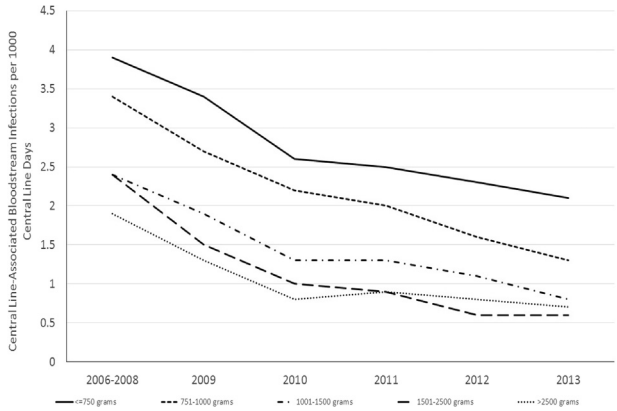

Fig – This figure represents the National Healthcare Safety Network pooled mean central line-associated bloodstream infections per 1000 central line days for level III NICUs. Rates for the following birth weight categories are depicted: ≤750 g; 751–1000 g; 1001–1500 g, 1501–2500 g, and >2500 g, with data represented over six reporting periods (2006–2008, 2009, 2010, 2011, 2012, and 2013).[16–21]

Central line insertion and maintenance

Bundles

A bundle is a small group of evidence-based interventions that, when implemented together, result in a better outcome than when executed individually.[22] Central line insertion and maintenance bundle components are often derived from recommendations by national organizations such as the Centers for Disease Control and Prevention (CDC) and the Healthcare Infection Control Practices Advisory Committee (HICPAC) and categorized based on the quality of supporting evidence.[11] Checklists are typically utilized to assist in bundle implementation by reinforcing key principles and practices, verifying compliance, and establishing a culture of responsibility among staff.[6] Basic components of central line insertion bundles typically include proper hand hygiene, barrier precautions, and cutaneous antisepsis, while maintenance bundles primarily incorporate processes for central line dressing assessment and change, replacement of administration sets, and disinfection of needless connections[11](Tables 1 and 2). Prompt central line removal has also been recognized and recommended as a major contributing factor in reducing CLABSI rates.[7,9,11] The Perinatal Quality Collaborative of North Carolina (PQCNC) cited prompt central line removal as a key component to the success of their initiative.[7] As part of their maintenance bundle, the PQCNC recommended that a central line be removed when 120 ml/kg/day of enteral feeds were achieved and evaluated the daily necessity of each central line by asking the question, "If a line was not in place today, would one be placed?"[7]

Bundle use is typically considered as "all-or-nothing" with compliance based on verifying that all elements are performed. Although this approach makes it difficult to assess the impact of any individual component, global adherence to bundle implementation and checklist use has been shown to decrease CLABSI rates in the ICU population.[23] Maintenance bundle use and compliance is particularly important in the NICU, where central lines are utilized for prolonged durations.[12,24] In addition, the majority of CLABSI in the NICU population appear to originate from contamination of the catheter hub making disinfection of the hub and all needleless connections a key component in CLABSI prevention.[25] In a retrospective review of hospitals participating in the CDC National Health Safety Network (NHSN), it was determined that a reported bundle compliance of ≥95% was required to see an associated decrease in CLABSIs.[23] Schulman et al.[26] demonstrated that for each 30% increase in maintenance checklist utilization, CLABSI rates in the New York State Collaborative decreased by 16.5%.

Central line teams

The training and implementation of a dedicated intravascular access team with a standardized approach to insertion and maintenance can reduce variability in practice, the burden of training and retraining a large staff, and, ultimately, the risk of line-related complications.[12,13,27] The vast majority of central line teams in the NICU are comprised of nursing staff, and the National Association of Neonatal Nurses has published practice guidelines for central line insertion and