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Nurse-Driven Quality Improvement Interventions to Reduce Hospital-Acquired Infection in the NICU

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ABSTRACT

Hospital-acquired infections are a leading cause of morbidity and mortality in neonatal intensive care units. Central line–associated blood stream infection (CLABSI) and ventilator-associated pneumonia (VAP) are costly, preventable infections targeted for eradication by the Centers for Disease Control and Prevention. After evaluation of current practice and areas for improvement, neonatal-specific CLABSI and VAP bundles were developed and implemented on the basis of available best evidence. The overall goal was to reduce infection rates at or below benchmarks set by National Healthcare Safety Network. All neonates with central lines (umbilical or percutaneous) and/or patients who were endotracheally intubated were included. All patients were risk stratified on the basis of weight per National Healthcare Safety Network reporting requirements: less than 750 g, 751–1000 g, 1001–1500 g, 1501–2500 g, and greater than 2500 g. The research was conducted as a quality improvement study. Neonatal-specific educational modules were developed by neonatal nurse leaders for CLABSI and VAP. Bundle development entailed combining select interventions, mainly from the adult literature, that the nurse leaders believed would reduce infection rates. Nursing practice guidelines and supply carts were updated to ensure understanding, compliance, and convenience. A CLABSI checklist was initiated and used at the time of line insertion by the nurse to ensure standardized infection control practices. Compliance audits were performed by nurse leaders weekly on intubated patients to validate VAP bundle implementation. CLABSI and VAP bundle compliance was audited and infection rates were measured before and after both bundle implementations following strict National Healthcare Safety Network inclusion criteria for CLABSI and VAP determination. The reduction in CLABSI elicited 84 fewer hospital days, estimated cost savings of $348,000, a 92% reduction in CLABSI (preintervention to postintervention), and a reduction in central line days by 27%. The reduction in VAP resulted in 72 fewer hospital days, estimated cost savings of $300,000, 71% reduction in VAP (preintervention to postintervention), and a reduction in vent days by 31%. Nurses are central in hospital efforts to improve quality care. The bundled interventions provided the nurses with a structure to successfully implement a systematic process for improvement. Nursing leaders ensured that bundles were implemented strategically and provided consistent and specific feedback on intervention compliance with quarterly CLABSI and VAP rates. Real-time feedback assisted the registered

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nurses, neonatal nurse practitioners, and physicians appreciation of the effectiveness of the change in practice. Finally, empowering the bedside nurse to lead the bundle implementation increased personal ownership and compliance and ultimately improved practice and patient outcomes.
Key Words: central line–associated blood stream infection, quality improvement, ventilator-associated pneumonia

Hospital-acquired infections (HAIs) are a prevailing source of concern in many neonatal intensive care units (NICUs). Central line–associated blood stream infection (CLABSI) and ventilator-associated pneumonia (VAP) are costly, preventable complications targeted for eradication by the Centers for Disease Control and Prevention (CDC), Institute for Healthcare Improvement, and The Joint Commission. The urgent need to reduce HAIs is further compounded by the strong emphasis on transparency and public reporting now available to health care consumers as well as ineligibility for reimbursement from the Centers for Medicare & Medicaid Services.

Hospital-acquired infections are a significant patient safety threat, as they are a leading cause of morbidity and mortality in NICUs.[1-3] Infants who acquire these infections spend more days on mechanical ventilation and more days in the hospital and have higher costs associated with their care and a higher mortality rate than those who are free of infections throughout their hospitalizations in the NICU.[4,5] Infants born weighing less than 1500 g represent an extremely vulnerable population compromised by critical illness and less than ideal nutrition. These infants are especially susceptible to HAIs because of immune system irregularities including greater permeability of the skin and mucous membranes, decreased complement activity, and low levels of immunoglobulin.[6] Management of premature infants frequently requires the use of invasive devices, such as central venous catheters and endotracheal (ET) tubes, that significantly enhance the risk of infection.

Peripherally inserted central venous catheters and umbilical lines are widely used in the NICU to ease monitoring and delivery of fluids, nutrition, and medications. In the absence of aseptic insertion and maintenance strategies, contamination and colonization of central lines can lead to blood stream infection. CLABSI is a more common occurrence in NICUs than in adult or pediatric intensive care units.[1] This HAI extends patient length of stay by an average of 7 days, and one infection is estimated to cost up to $29,000.[7]

Ventilator-associated pneumonia is a common and severe complication in NICU patients.[8,9] The ET tube inhibits natural protective mechanisms of the upper airway and provides a direct conduit for translocation of bacteria to the lower lungs. Mechanically ventilated neonates are at particularly high risk of VAP due to extended periods of intubation, high numbers of invasive procedures performed, and absence of cuffs on small ET tubes. Duration of mechanical ventilation and very low birth weight have been recognized as 2 independent and statistically significant risk factors for predicting VAP in the NICU.[10] Previous blood stream infection is also a significant independent risk factor-associated VAP.[11] A conservative estimate of the cost of one neonatal VAP infection is $30,000.[12]

Much research has been conducted in adult and pediatric populations regarding CLABSI- and VAP-prevention bundle effectiveness. The Institute for Healthcare Improvement defines a bundle as a series of evidence-based interventions that, when implemented together, have a greater chance of positively impacting patient outcomes compared with when an intervention is used alone.[13] Success in reducing CLABSI and VAP in adult populations through bundle implementation has resulted in recommendations for implementation from the Centers for Disease Control and Prevention and the Institute for Healthcare Improvement. Despite differences in anatomy, physiology, and disease as well as the susceptibility of very low-birth-weight infants to develop HAI, only a small amount of research or clinical evidence has been published reflecting the efficacy of bundled interventions designed to reduce the incidence of CLABSI and VAP in the neonatal population. Published NICU CLABSI- and VAP-prevention bundles incorporate elements of successful adult and pediatric bundles. NICU CLABSI bundles aim to decrease risk of contamination at the time of insertion, reduce potential transmission of organisms during line maintenance, and remove the catheter as soon as it is no longer medically indicated.[14,15] Ventilator-associated pneumonia prevention bundles are designed to decrease ET intubation and duration of mechanical ventilation whenever possible as well as reduce the number of organisms available for translocation and colonization of the lungs.[16]

Quality improvement (QI) methods that include the implementation of prevention bundles have been successfully applied in diverse clinical conditions with great success.[13] Quality improvement in NICUs is driven by the recognition of variations in practice and outcomes using data from sources such as the Vermont Oxford Network and National Healthcare Safety Network. If the outcomes being measured are influenced by variations in how care is provided, implementation of successful interventions and consistent practices should improve performance and ultimately patient outcomes.

LOCAL PROBLEM AND INTENDED IMPROVEMENT

The Centers for Disease Control and Prevention and the National Healthcare Safety Network have published definitions for CLABSI and VAP in the neonatal population, allowing for surveillance in the NICU setting.[17] Through surveillance instituted in June 2008 in this NICU, it was recognized that CLABSI and VAP rates were well above national benchmarks. With nurses as the lead driving force for practice change, an interdisciplinary QI team designed NICU specific prevention bundles intended to eliminate CLABSI and VAP. Consistent with the hospital's process for evaluating best practice, the Colorado patient-centered interprofessional evidence-based practice model was used to guide the QI process.[18] Quality improvement project aims were to apply bundle interventions in a systematic manner and over time measure the effectiveness on patient outcomes in all 5 birth weight categories of neonates.

METHODS

Ethical Issues

This was a unit-based QI project and exempt from the institutional review board approval. All data used to track infection rates were part of the data collected by the infection-prevention department of the hospital. Hospital-acquired infection rates are publically reported data to regulatory agencies and available as aggregate infection rates based on 1000 device days. Data tracked on intervention compliance were not identified by patients but tracked by frequency of compliance of tasks directly observed or documented as completed. Consistent with this hospital practice, healthcare providers who were noncompliant with infection-prevention practices received individualized remediation; however, the confidentiality of this process is maintained by the infection-prevention team. Thus, there was no risk of confidentiality for nurses or healthcare providers in this project.

Setting

This western hospital is a level IIIB NICU within a 413-bed quaternary referral academic medical center. Most admissions are a result of an inpatient delivery service with an average yearly admission rate of 570 neonates. The NICU has 50 beds with an average daily census of 34 patients. The clinical staff consist of registered nurses (RNs), respiratory therapists, physical/occupational therapists, neonatal nurse practitioners, and physicians (resident, fellow, and attending).

Subjects

All neonates with central venous catheters and umbilical lines and/or patients who were mechanically ventilated were included in this QI project. All patients were birth weight stratified on the basis of National Healthcare Safety Network reporting requirements: category A, less than 750 g; category B, 751 to 1000 g; category C, 1001–1500 g; category D, 1501–2500 g; and category E, greater than 2500 g.

Planning the Intervention

The NICU interdisciplinary QI team met twice monthly to develop strategies for improving CLABSI and VAP. The interdisciplinary team included charge nurses, clinical nurse manager, clinical nurse specialist/educator, outcomes coordinator clinical nurse specialist (CNS), medical director, respiratory therapy clinical supervisor, and infection-prevention nurse. On the basis of team consensus and member interest/expertise, smaller groups worked to critically evaluate current practice and develop a detailed plan for improving practice for the 2 initiatives. The process for improvement followed the organizational QI model, FOCUS-PDCA, which is an acronym that stands for Find, Organize, Clarify, Understand, Select, Plan, Do Check, Act. This method breaks the elements into: Find a problem, Organize a team, Clarify what you know, Understand the variation, Select element(s) for practice improvement, Plan a process change, Do the practice change, Check on the outcomes, Act to hold the practice improvement (gain).

The QI team believed that all individuals caring for neonates were accountable for following the practice guidelines to reduce CLABSI and VAP; however, the nurses were the most consistent providers and thus were empowered to lead practice change interventions. The identified QI nurse leaders for this project were the CNS/educator, outcomes coordinator CNS, and infection-prevention RN. The QI nurse leaders were responsible for education of all providers, tracking compliance with interventions, and reporting patient outcomes to the team for ongoing evaluation and further improvement strategies. Using a pre-post design, the NICU implemented the CLABSI bundle on July 1, 2009, and the VAP bundle on February 1, 2010.

Central Line–Associated Blood Stream Infections

A thorough review of the literature to include neonatal specific evidence, CDC, adult infection control and epidemiology, and pediatrics was completed. In addition, team members queried potential best neonatal practices via electronic listserv and contacts with local facilities. Following critical evaluation of the current best evidence, team leaders developed changes to the unit nursing practice CLABSI guideline and defined elements for the CLABSI neonatal bundle (see Box 1).

Education Strategies

After unsuccessful attempts at finding previously developed neonatal CLABSI educational tools, the

BOX 1. Neonatal Central Line–Associated Blood Stream Infection (CLABSI) Bundle Interventions[14,15,33–36]

- Strict hand hygiene and universal gloving
- Daily CLABSI surveillance
- Nursing checklist during central line catheter insertion
- Central line procedure carts
- Maximal barrier precautions for inserter and assistant, maintaining 3-foot sterile perimeter around access point
- Skin antisepsis
- ChloraPrep is used for patients 27 weeks gestation or greater and >1000 g and any patient 14 days of life or older
- Povidone-iodine is used for patients <27 weeks gestation and/or <1000 g
- Proper procedure for skin antisepsis (ChloraPrep versus povidone-iodine)
- Central line maintenance (access and changing of tubing/fluid)
- Dressing changes

QI nurse leaders created a computer-based NICU CLABSI educational module. Critical elements included a focus on patient safety, clinical impact of CLABSI, and rationale for each bundle components (Table 1). The hospital's online learning management system was used to educate all NICU RNs, neonatal nurse practitioners, and physicians. The education is updated and repeated annually. Three notebooks containing hardcopies of the online training information and neonatal central line infection–prevention tips were made available for quick reference.

One month before bundle initiation, the QI nurse leaders sent staff electronic communication with information about why practice changes were necessary, education module access and due date, unit guideline changes, and instructions on how to complete the nursing checklist for central line insertion.

Planning the Study of the Interventions

The infection-prevention RN collected daily line counts and investigated all positive blood cultures to determine whether criteria were met for a CLABSI according to the National Healthcare Safety Network definition. To track compliance, bedside nurses submitted complete checklists to the CNS/educator. The infection-prevention RN and CNS/educator verified that each new central line placed had a corresponding nursing checklist and used complete checklists to monitor and reform inserter compliance with bundle elements.

Methods of Evaluation

To ensure data quality, the QI nurse leaders strictly followed the National Healthcare Safety Network inclusion criteria for central line infection determination. Surveillance of CLABSI infection rates was defined per 1000 line days. Surveillance CLABSI rates data were posted using graphic displays on a unit outcomes bulletin board and reviewed at monthly staff meetings. The QI team assessed the outcome through comparison of quarterly CLABSI rates. Incidences of infection were recognized as defects, and root cause analysis for continuous improvement of interventions was employed. Consistent communication at staff meetings,

TABLE 1. Summary of Checklist Compliance[a]

	July 2009–June 2010 (N = 334 Forms)	July 2010–June 2011 (N = 337 Forms)
Time out occurred before start of the procedure	95%	97%
Hand hygiene compliance	98%	99%
Skin preparation was observed and/or correct preparation solution based on infant age/weight	92%	94%
Sterile drape procedure directly observed	96%	98%
Provider maintained sterile field throughout the procedure and donned appropriate attire for procedure	97%	99%
Assistant maintained sterile field throughout the procedure donned appropriate attire for procedure	99%	99%
Documentation complete (no missing documentation)	99%	99%

[a]*Items listed on the checklist were marked as completed or not, based on the nurse's direct observation of the item. Values in percentage reflect documentation of completed bundle elements by providers and/or nurses.*

BOX 2. Neonatal Ventilator-Associated Pneumonia (VAP) Bundle Interventions[a]

Focus Area 1: Minimize exposure to pathogens
Strict hand hygiene and universal gloving
Limit circuit breaks
Replace stand-by circuits with new tubing if patient requires reintubation
Focus Area 2: Intubation
Intubation equipment maintained as clean as possible during intubation attempts (sterile field)
Ensuring that ET tube is properly positioned every 3 to 4 h
Focus Area 3: Extubation readiness
Ventilator-weaning protocol (published separately)
Use of positive airway pressure devices when possible
Focus Area 4: Oral care
Palate protectors cleaned every shift
Oral suctioning prior to hands-on care or suctioning of ET tube
Single-use oral suction catheters
Oral care with human milk or sterile water (if no human milk available) every 3 to 4 h
Focus Area 5: Equipment management
Head of the bed elevated 15° to 30°
Use separate suction canisters and tubing for ET tube and oral suctioning

Abbreviation: ET, endotracheal.

[a]Data from Spatz and Edwards,[27] Grap et al,[37] and MacKenzie.[39]

e-mail, and QI meetings allowed a forum for feedback from staff and providers about the bundle functionality, barriers, and questions. Nursing checklists were also reviewed for noncompliance or supply issues. The CNS/educator followed up with individuals to ensure comprehension and educate when necessary.

Ventilator-Associated Pneumonia

In the fourth quarter of 2009, the NICU QI team recognized that VAP rates were higher than national benchmarks. Oral care and ventilator management practices among nurses and respiratory therapists were variable and poorly defined in the unit practice guidelines. Quality improvement nursing leaders completed a comprehensive literature review and again found limited evidence to guide VAP prevention in the neonatal population. Successful bundle elements from adult and pediatric populations were combined with Institute for Healthcare Improvement recommendations to develop a bundle specific to the NICU (see Box 2).

Education Strategies

Similar to the CLABSI project, the VAP QI team created a computer-based education module mandatory for NICU staff providing direct care to mechanically ventilated neonates. The self-paced education module is revised and completed annually. All NICU providers received electronic communication regarding the 5 focus areas of the bundle and specific bedside interventions to reduce the risk of VAP (Table 2). NICU VAP bundle reference guides were available throughout the unit for quick access.

Planning the Study of the Interventions

After the VAP bundle implementation on February 1, 2010, the outcomes coordinator CNS conducted twice weekly audits on all ventilated patients. Audits included a review of the bed elevation, suction setup, suction supplies at bedside, and documentation related to oral care and suctioning. During audits, one-on-one education was provided as necessary. If parents were present at the bedside, they were asked about observation of oral care and provided education. The infection-prevention RN tracked ventilator days and surveyed chest x-ray films and clinical data to determine whether VAP inclusion criteria were met according to the National Healthcare Safety Network definition.

Methods of Evaluation

Before and after implementation of the NICU VAP bundle, the QI team strictly followed the National Healthcare Safety Network inclusion criteria for VAP reporting; VAP infection rates per 1000

TABLE 2. Summary of Lessons Learned

Challenge/Barrier to Improvementation	Systems-Based Solution
CLABSI: Nurses not feeling empowered enough to confront nonadherent providers during line insertion	Nurse QI leader informed nonadherent providers individually.
	RNs encouraged to call or page nurse QI leaders at any time if line requiring assistance asking line inserter to adhere to unit policies.
	Improving the culture of working together to ensure patient safety was discussed frequently at staff meetings, case study reviews, and one-on-one follow-up.
CLABSI: Failure to complete central line checklist	CNS/educator followed up individually with nurses who did not complete checklist
	Incorporated CLABSI rate reduction and nursing checklist completion into the nursing performance appraisal process
CLABSI: Providers using povidone-iodine instead of ChloraPrep because it was packaged in umbilical line trays	ChloraPrep taped to the outside of every umbilical catheter tray to ease access
CLABSI: Alcohol pad used for line maintenance too small for effective hub cleansing	Stocked larger alcohol pad
VAP: Air leaks of 70% to 100% in patients acquiring VAP; large space between the ET tube and trachea allows for translocation of bacteria to the lower lungs	Declined use of cuffed ET tubes that may cause mucosal ischemia
	Promote diligent oral care and suctioning of the oropharynx
VAP: Routine suctioning of ET tube	Intensive one-on-one education regarding the potential harm of habitual ET tube suctioning

Abbreviations: CLABSI, central line–associated blood stream infection; CNS, clinical nurse specialist; ET, endotracheal; QI, quality improvement; RN, registered nurse; VAP, ventilator-associated pneumonia.

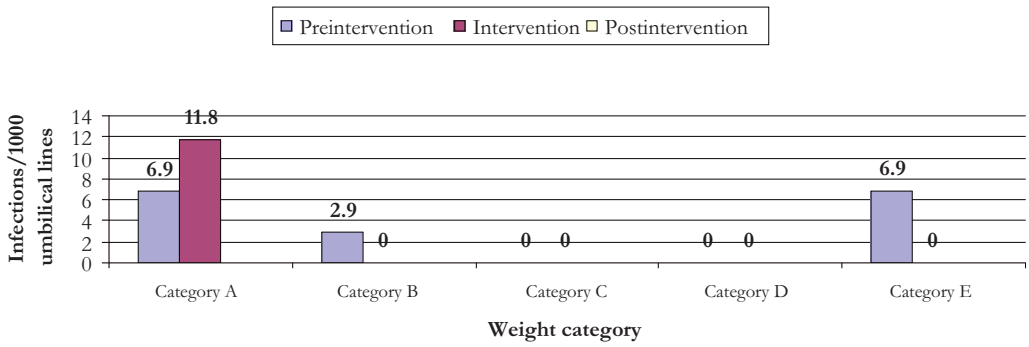
ventilator days. As with CLABSI data, quarterly rates are posted via graphic displays on the unit outcomes bulletin board and reviewed at staff meetings. Root cause analysis methods are used in each incidence of VAP to identify areas for bundle improvement. Audit data and open communication with frontline staff allowed QI nurse leaders to identify barriers and continuously strengthen the prevention bundle.

RESULTS

Before implementation of the CLABSI bundle (July 1, 2008–June 30, 2009), infants with umbilical lines in categories A, B, and E had CLABSI rates above national benchmarks, 6.9, 2.9, and 6.9 infections per 1000 umbilical line days, respectively. Infants with a central venous catheter had CLABSI rates above benchmark in all weight categories. No standard procedures were enforced during the placement of central lines and povidone-iodine was the antiseptic of choice for skin preparation. During the year of bundle implementation (July 1, 2009–June 30, 2010), CLABSI rates significantly decreased in all categories of neonates with umbilical lines except category A (<750 g at birth) (see Figure 1). Rates of infection in neonates with central venous catheters decreased in all weight categories except category B (751–1000 g at birth) (see Figure 2). This NICU achieved the goal of elimination of CLABSI in umbilical lines the postintervention year after (July 1, 2010–June 30, 2011), reporting a rate of 0 in all weight categories of neonates who had umbilical lines (see Figure 1). Rates in infants with a central venous catheter were 0 in all categories except category C (1001–1500 g) (see Figure 2). Although the average NICU daily census remained stable, total line days decreased by 27% from the preintervention year when compared with the postintervention year.

The number of central line checklists completed by bedside RNs in the first year of this QI project was 334. The compliance rate of checklist completion in the second year was 337. Table 1 provides a summary of checklist task compliance. An additional finding regarding the checklist was that the nurses communicated suggested changes as well as

FIGURE 1.



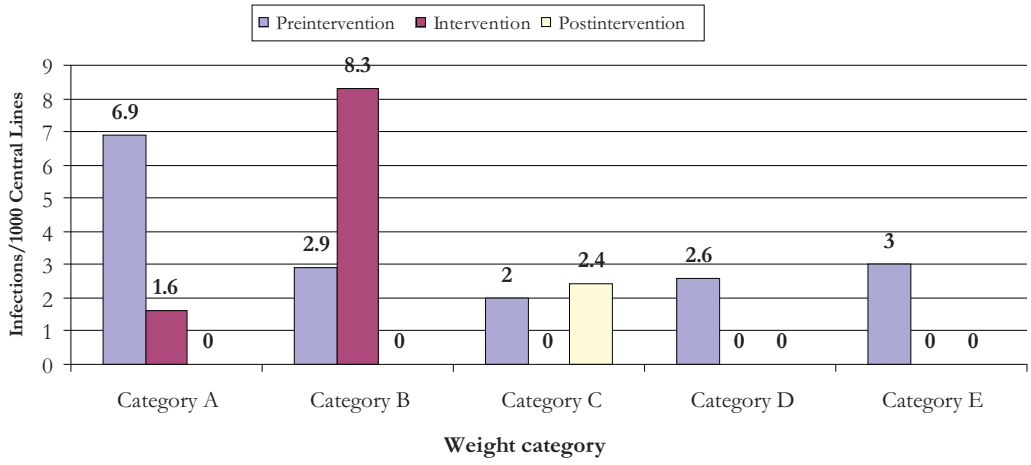
2009–2011 umbilical-catheter associated central line infections.

any resistance to bundle elements the nurse experienced with the provider performing the procedure. This informal communication on the checklist allowed for rapid follow-up by the clinical nurse specialist or NICU medical director. After July 2009, this NICU had 2560 central lines and only 1 central line infection, an overall rate of 0.4 infections per 1000 central line days. The reduction in CLABSI suggests an estimated death rate of 0.1 (1.4 lives saved), 84 fewer hospital days, and additional cost savings of $348,000.[7]

The incidence of VAP also decreased after bundle implementation. Preintervention (January 1, 2008–December 31, 2009), the reported VAP rates that were above benchmark were in categories A (8.9 infections per 1000 ventilator days) and C (6.2 infections per 1000 ventilator days). The VAP bundle, implemented February 1, 2010, had an annualized reduction in VAP rate to 0 in all categories of infants except categories A and B, with reported 12.4 and 7.5 infections per 1000 ventilator days, respectively. Post-VAP bundle implementation (January 1, 2011–December 31, 2011), the NICU reported a VAP rate of 0 infection per 1000 ventilator days in all weight categories of infants except category A (3.9) and category B (7.8). Overall ventilator days decreased from 1591 preintervention to 1099 postintervention (31% reduction in ventilator days) (see Figure 3). This reduction in VAP resulted in 72 fewer hospital days with an estimated cost savings of $300,000.[19]

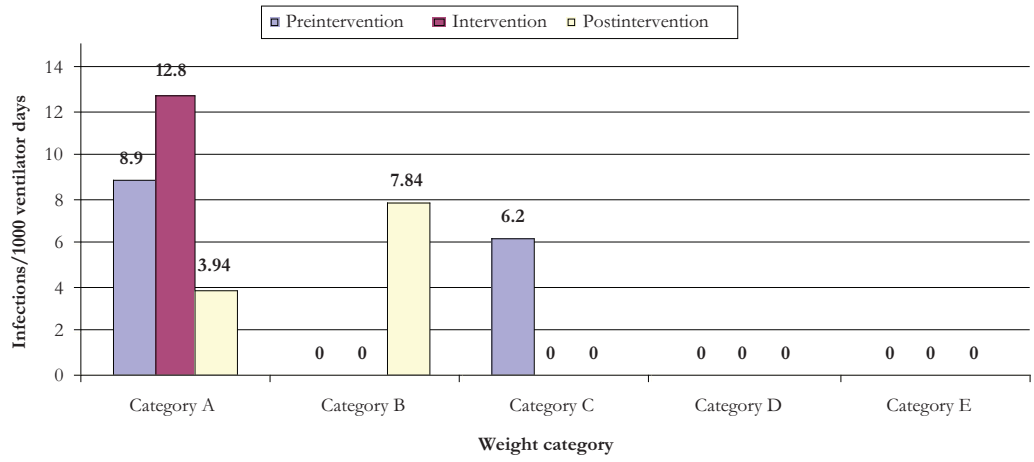
Individual bundle intervention compliance rates from audits showed improvement in compliance with bundle elements over time. Bundle elements such as hand hygiene (96%), elevation of HOB (100%), and cleaning the palate protector (88%) were quickly adapted within 3 months of bundle implementation. Other interventions that were new

FIGURE 2.



2009–2011 central line–associated blood stream infections.

FIGURE 3.



2009–2011 Ventilator-associated pneumonia.

to nursing practice specifically oral suctioning before initiation of hands-on care and oral care with colostrum/breast milk took longer for the staff to incorporate into daily practice.

DISCUSSION

The goal of the QI project was to eliminate prevailing HAIs through education and bundled intervention implementation in the NICU. This nurse-led initiative did achieve significant and sustained decreases in CLABSI and VAP over the 2-year time period. Both infections were prevented for more than 250 days, resulting in significant and sustained improvements in patient outcomes and cost savings.

Critical evaluation of CLABSI and VAP literature from nonneonatal patient population was effectively adapted to the NICU patient population with positive patient outcomes. Similar prevention strategies and success stories have since been reported enhancing the development of evidence-based neonatal bundles to improve practice.[14,20-22]

Improving practice requires multifactor elements. Education that focused on HAI prevention, specified bundle elements, revising practice guidelines, tracking compliance, and reporting patient outcomes were essential to helping NICU care providers see the impact of the practice change. Root cause analysis was used to identify possible practice failures that may contribute to infection. This process allowed for critical analysis of the QI project and revisions to continually improve care outcomes. In an effort to sustain momentum for reduction of HAIs, unit benchmark goals are established annually and incorporated into performance evaluations to enhance provider accountability. Bundle elements have been incorporated into the electronic medical record, prompting best practices and enhancing accuracy of documentation.

One unexpected outcome was 931 fewer central line days and 927 fewer ventilator days in the postintervention period, even though the unit census remained static. Device days continue to decrease. The decrease in line days is most likely related to increased awareness of the harm and cost associated with central line infections. Before the bundle intervention, the NICU culture reflected the belief that lines should not be immediately pulled once an infant was on full enteral feedings because of a fear that the infant could potentially have feeding issues and need that line at a later date. Evidence shows that catheter duration is a significant risk factor for CLABSI in the NICU.[7] With the implementation of the bundle, the need for each central line was more routinely evaluated and discontinued. Implementation of the VAP bundle demonstrated a reduction in the duration of intubation by emphasizing extubation readiness. Physician leaders developed a standardized weaning protocol initiated in the first hour after birth intended to decrease hypocarbia as well as intubation time. Noninvasive ventilation was used at increased frequency in an effort to reduce the risks associated with mechanical ventilation when possible.

Before bundle implementation, RNs and respiratory therapists had few oral care interventions in the NICU. The Institute for Healthcare Improvement's VAP-prevention pediatric supplement recommends "comprehensive mouth care appropriate to the age of the patient."[23,p2] Chlorhexidine products are not recommended for use in infants less than 2 months of age. The use of colostrum/breast milk for oral care is protective and theoretically reduces risk of infection[24,25] and can be safely used in the smallest and

sickest neonates.[26] More studies are needed to show effectiveness of this independent intervention. Using available evidence,[27] we included the use of mother's own colostrum/breast milk as age-appropriate oral care in addition to routine suctioning of oropharyngeal secretions with single-use catheters to prevent microaspiration of secretions. Compliance audits showed that these oral care interventions were more difficult for frontline staff to incorporate into daily practice than other bundle elements. To successfully integrate oral care practices into routine bedside care, nurse leaders placed visual reminders on each ventilator. This intervention reminder significantly improved compliance.

Multiple lessons were learned through the QI process to reduce CLABSI and VAP in this NICU. Table 2 provides a summary of key challenges, barriers, and opportunities for improvement throughout the course of this practice change project. Quality improvement nurse leaders created systems-based solutions to these problems. Creating a culture of nurse empowerment, interdisciplinary teamwork and transparency were instrumental to problem solving and the reduction of HAIs.

PROJECT LIMITATIONS

Because the prevention interventions were bundled, we cannot know what intervention(s) was most effective in reducing these HAIs. Also, these QI project interventions were specifically designed for this NICU setting; thus, results are not intended to be generalized but are specific to this NICU practice environment.

IMPLICATIONS FOR PRACTICE

Nurses are central in hospital efforts to improve quality. Because nurses are pivotal to the care of hospitalized patients, using nurse leaders in improvement activities helps empower staff to engage in and move QI initiatives forward.[28] In our NICU, nursing QI leaders were successful because they were able to raise collective awareness and expectations for practice. These accountability expectations led to a considerable culture change in this NICU that allowed for real, sustained improvement in patient outcomes. The collaborative team process for improving patient outcomes also enhanced the bedside nurses' sense of empowerment to remind providers about bundle elements and enhanced mutual respect as well as communication. Through these interventions and QI methods empowerment, respect, communication, and accountability among all NICU team members were enhanced. This process of culture change has facilitated several other improvements in NICU care as staff members are more flexible and adaptable to changes in bedside practice.

Reliable implementation of neonatal specific prevention bundles combined with improvement methodology can significantly reduce CLABSI and VAP rates.[29-32] Bundled interventions provided nurses with a structure to ensure a systematic process for improvement. Checklists can be used to educate nurses about interventions that reduce HAI as well as hold them accountable for care provided. Executing a practice change supported by nursing leadership and nursing staff created a mechanism for care focused on achieving high-quality care, free of infections. By promoting bedside nurses as QI ambassadors, NICU staff felt empowered and engaged in these patient safety initiatives allowing for sustained improvement. Having nurses successfully implement interdisciplinary QI program to reduce CLABSI and VAP increased personal ownership and compliance, was cost-effective, and ultimately improved practice and patient outcomes.

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