Next Steps for Health Care-Associated Infections in the Neonatal Intensive Care Unit

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KEYWORDS

• NICU • HAI • Infection prevention • Stewardship • Quality improvement

KEY POINTS

- Infection prevention and control (IP&C) strategies can reduce health care-associated infections (HAIs) in the neonatal intensive care unit caused by *Staphylococcus aureus*, multidrug-resistant gram-negative organisms, Candida, and respiratory viruses.
- IP&C strategies for HAIs include optimizing hand hygiene, active surveillance programs for selected pathogens, use of isolation precautions, and cohorting infected and colonized infants.
- Implementing evidence-based bundle strategies to prevent central-line-associated bloodstream infections and surgical site infections requires multidisciplinary quality improvement (QI) initiatives.
- Engagement with multidisciplinary teams, parents, and families; data transparency and detailed case review; accountability; and participation in collaborative efforts are effective QI strategies that can reduce HAIs.

INTRODUCTION

Infection prevention and control (IP&C) strategies in the neonatal intensive care unit (NICU) are essential to protecting neonates, who are uniquely susceptible to health care-associated infections (HAIs) due to immature host immune defenses, invasive devices that breach skin and mucosal surfaces, frequent use of antibiotics that disrupt the microbiome, and need for prolonged hospitalization which increases their risk of

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exposure to potential pathogens.[1,2] Neonates with HAIs have increased risk of mortality, adverse neurodevelopmental outcomes, and have associated increased health care costs.[3,4] Numerous institutions and structured collaboratives have successfully reduced HAIs using quality improvement (QI) methodologies.[5–7] QI methods to promote strategies like hand hygiene and use of aseptic techniques have been instrumental in IP&C in low-resourced units and high-resourced units.[8,9]

In this review, we provide context for QI and IP&C in the NICU as related to the burden of selected pathogens that cause late-onset sepsis (LOS), including methicillin-susceptible and methicillin-resistant *Staphylococcus aureus* (MSSA/MRSA), multi-drug resistant gram-negative bacteria (GNB), *Candida* species, and respiratory viruses. We also describe the burden of central-line-associated bloodstream infections (CLABSIs) and surgical site infections (SSIs). We highlight approaches that have been successful in mitigating LOS risk in NICUs and suggest potential next steps to improve IP&C.[10,11] Although there are interventions that can impact early-onset infection risk, those are mostly obstetric-based, and therefore, not included in this review. Finally, we conclude with general considerations for QI and IP&C, including family involvement, engagement of the multidisciplinary team, and participation in larger collaborative efforts.

SPECIFIC PATHOGENS

Methicillin-Susceptible and Methicillin-Resistant Staphylococcus aureus

Both MSSA and MRSA can colonize the anterior nares and skin of hospitalized infants, their families, and health care workers, and can contaminate surrounding surfaces and equipment in the NICU. MSSA and MRSA colonization occurs less commonly from perinatal transmission from mothers' anogenital tract.[12] The overall rate of *S aureus* infections, including MSSA and MRSA, in the NICU has ranged from 0.4% to 3.7% with an incidence ranging from 44.8 to 300 infections per 10,000 infants.[13–15] Although the rate of MSSA infections is approximately three-fold to four-fold higher than the rate of MRSA infections, the incidence of MRSA infections has increased.[16,17]

In addition to lower birthweight, prematurity, and invasive devices, colonization with *S. aureus* is an important risk factor for infection. Compared with uncolonized infants, colonized infants had 24.2 times the relative risk of developing MRSA infections.[18] As further evidence, bloodstream isolates from bacteremia were genetically identical to either the MSSA or MRSA isolates colonizing the nasal mucosa.[19]

S. aureus causes bloodstream infections (BSI), CLABSIs, skin and soft tissue infections, SSIs, and bone and joint infections. Such infections are associated with increased mortality, increased length of hospitalization, the potential need for debridement, disseminated infections, and long-term complications.[14,20,21]

Multidrug-resistant gram-negative bacteria

GNB cause life-threatening LOS in neonates.[22,23] GNB are becoming increasingly multidrug-resistant (MDR), resulting in fewer therapeutic options and higher mortality rates. In fact, lower rates of microbiological cure are reported in infants with MDR-GNB sepsis compared with infants with non-MDR-GNB sepsis.[24] In tertiary care NICUs in India, GNB accounted for 60% of LOS episodes, of which 45% were resistant to carbapenems.[25]

Although antimicrobial susceptibility profiles of GNB may vary regionally and nationally, there is much concern about the increasing burden of MDR-GNB infections in NICUs worldwide, particularly in lower- and middle-income countries. Thus, there is a focus on decreasing risk by avoiding prolonged use of empiric, broad-spectrum

antibiotics as such treatment alters the microbiome and increases selective pressure on endogenous flora, creating antimicrobial resistance and increasing the risk of necrotizing enterocolitis.[26–28]

Candida species

The highest incidence of invasive candidiasis occurs in extremely preterm infants <1000 g in birthweight or <27 weeks gestation. Disseminated candidiasis in term infants is more common in those treated with systemic steroids or born with congenital anomalies requiring abdominal or neurosurgical surgery.[29] Prolonged hospitalization and interventions needed in intensive care are risk factors for invasive fungal infections, most commonly caused by *C albicans* (~75%).[30] Less common non-albicans species include *C tropicalis*, *C parapsilosis*, *C glabrata*, and *C lusitaniae.*

Candida species are normal gastrointestinal (GI) flora. Use of broad-spectrum antibiotics can result in unopposed proliferation of *Candida*, resulting in translocation across GI mucosa and invasive infections.[22,31] In addition, indwelling central venous catheters (CVC) provide a portal of entry for fungi which can thrive in dextrose-containing and intralipid solutions.[22,31]

Candida spp. can cause BSI, urinary tract infections, endocarditis, meningitis, and renal or skeletal abscesses. Candidal infections can also present as non-invasive, mucocutaneous infections which can recur, but typically do not result in disseminated candidiasis.

Respiratory viruses

The availability of multiplex reverse transcriptase polymerase chain reaction (PCR) assays has increased the appreciation of health care-associated respiratory viral infections (HA-RVIs). NICU outbreaks of respiratory syncytial virus (RSV), influenza, human coronaviruses, parainfluenza, adenovirus, and rhinovirus/enteroviruses have been reported.[32–36] Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has also been reported in NICUs, albeit at lower rates than other populations.[37] Risk factors for sporadic cases of HA-RVIs include longer length of stay and contact with ill staff or visitors.[38] The incidence of HA-RVIs is somewhat difficult to ascertain due to variability in study designs, but has ranged from 6% to 30% in symptomatic infants and from 6.6% to 8% in infants evaluated for LOS.[38,39]

Infants with HA-RVIs may present with symptoms mimicking common manifestations of prematurity. However, we and others found that some infants with HA-RVI can be, somewhat surprisingly, asymptomatic.[40] In an active surveillance study of HA-RVI, 52% (26/50) infants <33 weeks gestation tested positive for one or more HA-RVI, some of whom were sequentially positive. These infections were not clinically suspected by treating providers. We found that 17% (15/83) of infants with HA-RVIs remained asymptomatic, which included unchanged oxygen saturation during continuous bedside monitoring.[41]

Adverse outcomes of HA-RVIs may include a longer hospitalization, unnecessary antibiotics, increased nutritional and respiratory support, risk of bronchopulmonary dysplasia, and home oxygen use on discharge.[40–42] The pooled worldwide case fatality rate is estimated to be 13%.[43]

Specific Health Care-Associated Infections

Central-line associated bloodstream infections

CLABSIs are viewed as preventable HAIs that should be prioritized in NICU QI and safety protocols due to adverse neurodevelopmental and growth outcomes in early childhood, increased mortality rates, and increased health care costs.[44–46] Preterm infants are most susceptible to developing CLABSIs due to immunologic immaturity,

poor skin and mucous membrane integrity, the need for prolonged use of central lines, and prolonged hospitalizations.

The CDC's National Healthcare Safety Network (NHSN) uses standardized infection ratio (SIR) as a summary measure to track HAIs over time; a SIR less than 1.0 indicates that fewer HAIs were observed than predicted.[47] Thanks to evidence-based prevention strategies described below, the national CLABSI SIR was 0.662 (CI_{95} 0.625–0.700) in pediatric hospital units, pediatric ICUs, and NICUs in 2020—the first year these data were reported for this subpopulation.[48]

Surgical site infections

The neonatal surgical population is increasing as NICU admissions increase, and as neonatal surgical care is advancing for congenital and acquired conditions. In addition to the association of SSIs with increased mortality, health care costs, and length of hospitalization, neonates with SSIs are significantly more likely to have pneumonia or sepsis, and require reintubation, re-operation, and readmission.[49]

Risk factors for SSIs in infants include modifiable and non-modifiable risk factors (**Fig. 1**). Increased SSI rates have been associated with wound class; clean, clean/contaminated, contaminated, and dirty/infected wounds had SSI rates of 1.8%, 2.7%. 3.9%, and 4.4%, respectively (P =.002). Length of surgery was also a risk factor; cases ≤1 hour had an SSI rate of 2.1% whereas those >1 hour had an SSI rate of 31% (P =.01).[49] MRSA colonization, blood loss requiring transfusion, higher postoperative glucose, lower gestational age, younger chronologic age, and prolonged hospitalization before surgery are SSI risk factors.[50–53]

Rates of SSIs are higher in neonates when compared with older children. In a single center study, SSI rates after cardiac surgery in infants <30 days was 6.8% compared with 3.4% in infants <1 year of age.[51] The American College of Surgeons National Surgical Improvement Program Pediatric (NSQIP-P) reported an SSI rate of 3% in neonatal surgical cases compared with 1.8% in all pediatric cases; higher SSI rates in neonates were most notable after general surgery and neurosurgery.[54] In the NSQIP-P database of 7,379 neonatal surgical procedures, most SSIs (70.5%) were deemed superficial whereas 8.3% were deep incisional and 18.7% were organ space infections.[49]

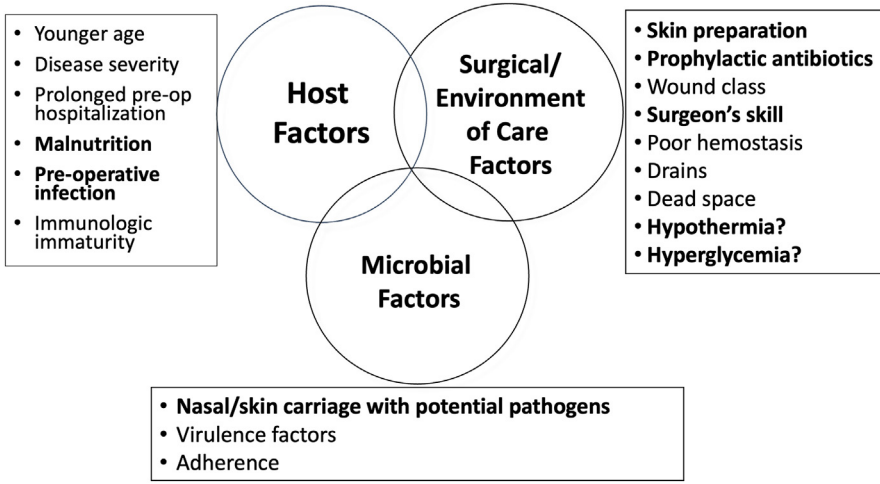

Fig. 1. Sample key driver diagram for MSSA and MRSA IP&C in the NICU.

Specific Quality Improvement Opportunities and Approaches

Hand hygiene

Hand hygiene, particularly the use of alcohol-based hand rub, is the standard of care globally and considered the most important evidence-based IP&C measure to prevent HAIs.[55,56] A volume of 2 to 3 mL of alcohol-based hand rub used for 20 to 30 seconds to cover all surfaces, between fingers and fingertips is adequate, but a larger volume may be needed for larger hands to ensure whole hand coverage.[57,58] Quality of hand hygiene can improve with return demonstrations of hand hygiene practices performed by staff and families.

Artificial nails and rings with stones can be contaminated with *S aureus*, GNB, or *Candida* species, and the presence of watches, rings, and artificial nails can impede effective hand hygiene. Long sleeves from clothes and white coats can become contaminated and lead to patient-to-patient transmission. Thus, some studies suggest that Bare Below the Elbows practices (**Box 1**) can reduce infection risk. Unlike hand hygiene, Bare Below the Elbows is not currently a universal standard practice, but may be useful in some settings.[59–65]

Box 1
Bare Below the Elbows practices for the NICU —sample policy

Rationale for Bare Below the Elbows
- Hand hygiene remains one of the most effective IP&C strategies to protect patients, families, and staff.
  - Alcohol-based hand sanitizers are highly active against gram-positive and gram-negative organisms and majority of viruses and fungi.
- Bare Below the Elbows can improve effectiveness of hand hygiene and reduce transmission of pathogens to patients.

Elements of Bare Below the Elbows
- Hand hygiene
- < ¼ inch long, clean, well-manicured nails
- No jewelry on hands or wrists except smooth ring without stones
- Sleeves above the elbows
- No white coats in the NICU

Hand hygiene effectiveness increases when:
- Skin is intact.
  - Dermatitis or cuts can harbor potential pathogens that are not effectively removed by hand hygiene.
  - Using moisturizers and protecting hands from irritation, for example, wearing gloves while using cleaning products outside of work, can maintain good skin condition.
- Artificial nails are not permitted.
  - Artificial nails can become heavily contaminated with gram-negative, gram-positive, and fungal organisms that can be transferred to patients and result in invasive infections.
- Hands and wrists are free of jewelry except for a smooth ring without stones
  - Wearing rings is associated with increased number of organisms on hands.
  - Rings can become contaminated with *S aureus*, gram-negative bacilli, and/or fungi.
  - Risk of contamination increases with more rings worn.
  - Jewelry can impede effective hand hygiene.
- Sleeves are above the elbow.
  - Long sleeves can be contaminated with pathogens.
  - Long sleeves can impede effective hand hygiene.
- White coats are removed before entering the NICU.
  - White coats can be contaminated, particularly with *S aureus*, including MRSA. Contamination of white coats can result in patient-to-patient transmission of *S aureus*.

Methicillin-susceptible and methicillin-resistant Staphylococcus aureus infection prevention and control strategies

Efforts to monitor the incidence and prevalence of MSSA and MRSA and implement strategies to reduce patient-to-patient transmission are increasingly common (Fig. 2). Successful strategies include geographic cohorting of infants colonized with MRSA and limiting the number of health care workers in direct contact with them.[66–68]

The CDC recommends active surveillance for *S aureus* when there is ongoing health care-associated transmission, higher rates of infections, and/or outbreaks. Guidelines also suggest surveillance at "regular intervals" based on local epidemiology and resources.[69] Many NICUs have implemented active surveillance for both MRSA and MSSA due to the higher prevalence of MSSA colonization and infections.[14,70,71] Data support targeting out-born infants for surveillance as the prevalence of colonization is as much as 29-fold higher than among inborn neonates. The proportion of out-born infants colonized with MRSA increases with older age at the time of transfer.[18]

Surveillance sites include the anterior nares, which are most likely to be colonized, and sometimes the umbilicus, perineum, and axillae.[18] Although PCR technologies have increased sensitivity compared with traditional cultures, disadvantages include lower specificity for MRSA detection and lack of isolates to undergo strain typing, which may be helpful during clusters and outbreaks.[72–74]

Some NICUs have implemented decolonization strategies for MRSA and/or MSSA routinely or in response to an outbreak to prevent infection in colonized infants and prevent transmission. The most used topical agents have been mupirocin applied to the anterior nares and chlorhexidine gluconate (CHG) baths. However, time and resources are needed to identify colonized patients and depending on the type of screening used, there may be false negative results. A NICU described their universal decolonization

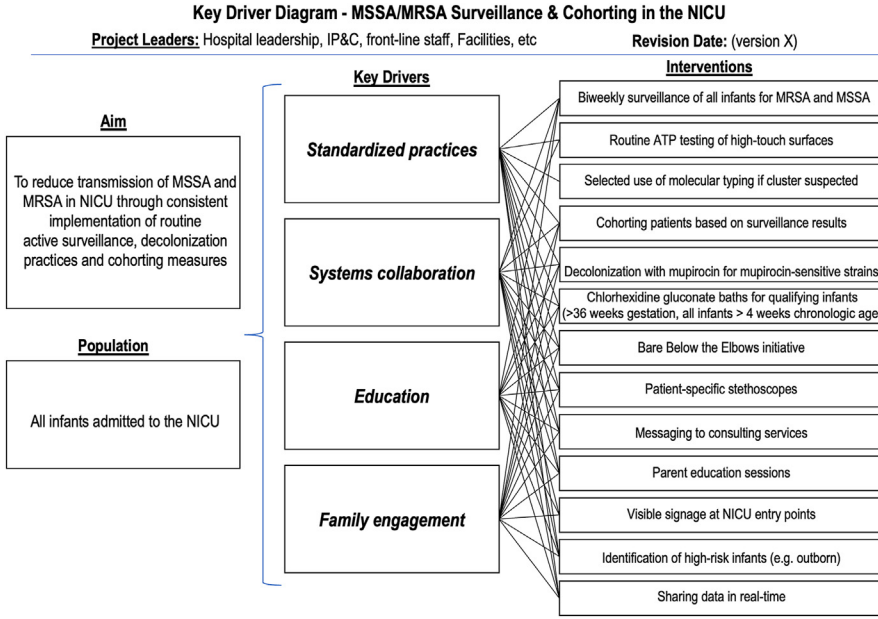

Fig. 2. *Examples of risk factors for SSIs in infants.* Host factors, factors related to the surgical environment of care, and microbial factors are associated with SSIs in infants. Risk factors that are potentially modifiable are bolded.

strategy with mupirocin which successfully decreased *S aureus* infection rates over 5 years, but this strategy has been studied primarily in adult ICU settings.[75,76]

Long-term efficacy and safety profiles of mupirocin and CHG remain of concern, especially in preterm neonates and young infants. There is potential for skin irritation and systemic absorption of CHG in premature infants, although infants with detectable serum levels did not exhibit harmful effects. The emergence of mupirocin resistance has been described, but not associated with adverse outcomes.[77] Rates of recolonization after decolonization measures have not been well studied in the NICU population, particularly because mupirocin is only directed to *S aureus* in the nares.

Strategies for multidrug-resistant gram-negative bacteria

NICUs can implement active surveillance for MDR-GNB, routinely update and disseminate their antimicrobial resistance patterns, and provide antimicrobial stewardship education for health care personnel.[78,79] Clinical pathways for antibiotic use, including shorter treatment durations when feasible, pre-approval of restricted broad-spectrum antimicrobials, and post-prescription review of these agents may slow the emergence of MDR-GNB.[80,81] Use of contact precautions for infants colonized or infected with MDR-GNB may reduce patient-to-patient transmission.[82]

Strategies for Candida

The stewardship strategies described above are also relevant for prevention of invasive candidiasis (IC). Additionally, antifungal prophylaxis with fluconazole has been studied for decades.[83] The incidence of IC varies among NICUs, and while fluconazole prophylaxis for very low birthweight infants did reduce fungal infection in NICUs with higher rates of IC, prophylaxis did not decrease mortality. Therefore, targeted use of fluconazole prophylaxis has been studied in infants deemed at high risk, such as those colonized with *Candida*, with a CVC, or receiving third generation cephalosporin agents or broad-spectrum antibiotics. Similarly, targeted fluconazole prophylaxis demonstrated a reduced incidence of IC, but did not impact overall mortality rates.[84–86] Further refining our understanding of high-risk populations and developing rapid, sensitive diagnostic methods for IC could improve the use of fluconazole prophylaxis.

Strategies for health care-associated respiratory viral infections

IP&C strategies for HA-RVI include optimizing hand hygiene for staff and visitors, restriction of visitors <12 year, rapid diagnosis and screening of exposed infants, use of transmission precautions, and cohorting of infected infants.[41,87,88] Other strategies include screening visitors for symptoms of viral infections and not permitting symptomatic visitors in the NICU. Policies that support staff not to work when ill, and that optimize vaccination of visitors and staff for vaccine-preventable illnesses, can prevent HA-RVIs.

IP&C related to SARS-CoV-2 exposure was a new frontier in the NICU. In addition to the aforementioned strategies, tactics for SARS-CoV-2 included admitting infected or exposed infants to single rooms on droplet and contact precautions, and airborne precautions, when available, for those requiring aerosol-generating procedures, such as intubation or open-line suctioning.[89]

Central line-associated bloodstream infections prevention strategies

The core tenets of national, regional, and local initiatives surrounding CLABSI reduction and prevention focus on standardized definitions, interdisciplinary collaboration, shared accountability, use of insertion and maintenance checklists and bundles, and routine surveillance with data transparency (**Table 1**).

Table 1
Core tenets of central line-associated bloodstream infections prevention

Standardized Definitions	*Central line: an arterial or venous intravascular catheter that terminates at or close to the heart or one of the great vessels, and is used for infusion, withdrawal of blood, or hemodynamic monitoring* *CLABSI: laboratory-confirmed primary bloodstream infection that develops in a patient with a central line in place within the 48-h period before onset of the bloodstream infection that is not related to infection at another site* *CLABSI rate: number of bloodstream infections attributable to central line per 1000-catheter days*
Interdisciplinary and hospital-wide collaboration	Nurses, advanced practice providers, resident physicians, neonatologists, hospital epidemiologists, hospital administrators, pharmacists, parents/family members
Shared accountability	Family engagement and empowerment related to hand hygiene and line care Unit-specific and role-specific champions Data transparency Shared mental model that CLABSIs are preventable infections
Checklists & bundles	Insertion bundles • Hand hygiene • Maximal sterile barrier precautions • Skin antisepsis with povidone-iodine, CHG, or alcohol • Stop procedure immediately if sterility compromised Maintenance bundles • Daily assessment of catheter need • Assessment of dressing integrity and line site cleanliness • Sterile dressing change procedures • Closed line system for infusion, blood draws, or medication administration
Routine surveillance	Patient safety rounds Tracking local rates in real time Comparison to national benchmarks Collaborative root cause analyses

The CDC's NHSN comprehensive standard definitions are used to classify a BSI as a CLABSI.[90] These definitions must be shared with patient-facing NICU staff to accurately identify the CLABSI rates and to gain the necessary buy-in required to consistently implement successful CLABSI reduction strategies. Creating a culture of responsibility among all health care providers, accurate data reporting, transparency surrounding central-line insertions and related complications, and a shared mental model that CLABSIs are preventable infections are crucial.[91]

The Agency for Healthcare Research and Quality created a neonatal CLABSI reduction project in 2011 with 100 NICUs across nine states.[92] This collaborative and several other published QI reports have demonstrated the success of bundle strategies, which are a set of evidence-based practices implemented together that result in better outcomes than each measure alone, especially related to line insertion and line maintenance.[93,94]

Strategies for surgical site infection

SSI prevention strategies include adequate pre-operative skin disinfection, appropriate timing of perioperative antibiotics, and maintenance of perioperative euthermia. Using the Research and Development Corporation and the University of California Los Angeles appropriateness method, a multidisciplinary consensus panel evaluated 20 clinical scenarios and provided expert guidance for implementing non-pharmacologic prevention strategies.[95] Monitoring adherence to pre-operative, intra-operative, and post-operative preventive strategies can reduce SSIs (**Table 2**).[95]

Next Steps for Infection Improvement

Although CLABSI rates are declining, less is known about the preventive strategies for BSIs that are not considered CLABSIs.[79,80] As such, the CDC NHSN plans to conduct surveillance for all hospital-onset bacteremia in qualifying NICUs. Retrospective data from our NICU from 2010 to 2019 demonstrated a higher rate of non-CLABSI BSIs than BSIs, as well as higher risk of total BSIs and CLABSIs in infants <33 weeks gestation in comparison to term neonates ≥38 weeks gestation.[96] Prevention strategies for non-CLABSIs are less well defined as these are likely to have multiple etiologies.

General Considerations for Quality Improvement and Infection Prevention and Control

Quality improvement approaches

Effective QI initiatives include tangible tests of change, measurable outcomes and balancing measures, and an understanding of systems issues that could impact success. These approaches can be useful in IP&C. For example, management strategies for MSSA and MRSA could involve regular screening and tracking of colonization and decolonization through the use of standard guidelines for surveillance. This may result in potentially negative consequences, such as development of mupirocin resistance with decolonization, and they can be expensive, so it is imperative to track and share these outcomes in real time. The need for cohorting based on surveillance results involves consideration of systems issues, such as NICU census, staffing, and geography. **Table 3** highlights specific QI opportunities related to IP&C in the NICU.

Engaging the multidisciplinary team

The QI work requires a team approach with key stakeholders including NICU front-line staff, hospital epidemiology, hospital administration, and families, who share a mental model regarding desired outcomes, real-time data transparency, and iterative feedback about successes and failures. Collaboration and communication at multiple levels are key—within the NICU among multidisciplinary providers and families, within the hospital among all units, within regional centers, and within national/international organizations. Interventions must move beyond education alone, which can at most achieve 80% to 90% success; teams must analyze how change processes can be embedded into the workflow. Data sharing and non-punitive open-forum review of cases to identify learning opportunities provide accountability so teams can be consistently successful.[97]

Family involvement in infection prevention and control

Family partnerships can and should be leveraged to promote IP&C. Several frameworks exist for family engagement, ranging from ad hoc focus groups to family advisory councils to families co-leading improvement initiatives.[98] One example of family involvement in CLABSI prevention was holding “germ school” to actively engage families with their own and provider compliance with hand hygiene and line care.[94]

Table 2
Pre-operative, intra-operative, and post-operative preventive strategies for surgical site infections

Timing	Example of Prevention Strategies	Comments
Pre-operative	Screening of anterior nares for *S. aureus* and decolonization with mupirocin	Consider for infants undergoing surgical procedures high rates of *S aureus* SSIs
	Bath with non-antiseptic or antiseptic soap on the day of or the day before surgery	Limited evidence that chlorhexidine gluconate antiseptic soap reduces SSIs compared with non-antiseptic soap
Intra-operative	Clean skin around incision site with dual-agent skin preparation containing alcohol	Alcohol-containing products are active against gram-negative and gram-positive bacteria, including multidrug-resistant organisms, and yeast.
	Use appropriate perioperative antibiotic prophylaxis based on surgery type	Risk of skin irritation in preterm infants
	Maintain normothermia	Parameters should include choice of agent, timing before incision, dose, intra-operative redosing, if needed, and discontinuation
		No available data on children
		Infants at increased risk of hypothermia due to less thermoregulatory capacity, less subcutaneous fat, and increased heat loss from larger head and surface area-to-body ratio
Post-operative	Standardize wound care	Consider use for high-risk wounds with negative pressure wound therapy that removes exudate and promotes wound healing
	Standardize wound dressing	
	Perform SSI surveillance using standard case definitions	Centers for Disease Control and Prevention National Health Care Surveillance case definitions applicable to infants

Table 3
Specific quality improvement opportunities and measures

Topic	QI Initiative	Measurable Outcomes	Balancing Measure	Tests of Change	Systems Issues
Hand hygiene	Hand hygiene practices and awareness	% HCW with appropriate hand hygiene practices	HCW dermatitis	Bare Below the Elbows	Supply chain issues
MSSA/MRSA	Active surveillance for MRSA/MSSA	% infants with surveillance cultures sent % with positive cultures % successfully decolonized % reduction in invasive infections	Mupirocin resistance CHG intolerance Cost of testing	Standard guidelines and timeline for surveillance	Cohorting Decolonization practices
CLABSI prevention	Practices surrounding central line care	% CLABSI reduction % device round audits Central line days Time to full feeds	Need for immediate line reinsertion Dermatitis	Insertion and prevention bundles	Staffing Clinical acuity
SSI prevention	Practices surrounding surgical site care	% MRSA/MSSA screening % appropriate peri-operative antibiotics % euthermic intraoperatively % euglycemic postoperatively	Cost of screening Antibiotic overuse	Standardizing perioperative antibiotics Optimizing nutrition	Coordinating with surgical and anesthesia teams

Engagement in larger collaborative efforts

Collaborative efforts and data sharing networks created by the NHSN, Children's Hospital's SPS, Vermont Oxford Network, Children's Hospitals Neonatal Consortium, and various state and regional perinatal quality collaboratives demonstrate similar strategies that can be utilized by every NICU to reduce the burden of HAIs. Collaborative networks should be easily accessible to all types of NICUs so that best practices can be shared among small and larger units alike.

SUMMARY

Neonates are uniquely susceptible to HAIs due to their immunologic immaturity and need for prolonged hospitalization. Pathogens like *S aureus*, MDR-GNB, *Candida,* and respiratory viruses can cause severe illness in this vulnerable population. CLABSIs and SSIs are prevalent in the NICU due to the need for long-term CVCs and a growing number of neonatal surgical admissions. IP&C strategies include universal hand hygiene, surveillance, cohorting, and care bundles. QI methodology, with its focus on involving the multidisciplinary team, actively engaging family partners, and providing real-time data transparently, has been successful in various IP&C initiatives. Participation in larger collaboratives can provide a forum to gauge local successes with national benchmarks and for bidirectional learning to improve care.

DISCLOSURE

The authors have nothing to disclose.

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