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Infection Prevention Practices in Neonatal Intensive Care Units Reporting to the National Healthcare Safety Network

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Abstract

Background—Patients in the neonatal intensive care unit (NICU) are at high risk for healthcare-associated infections. Variability in reported infection rates among NICUs exists, possibly related to differences in prevention strategies. A better understanding of current prevention practices may help identify prevention gaps and areas for further research.

Methods—We surveyed infection control staff in NICUs reporting to the National Healthcare Safety Network (NHSN) to assess strategies used to prevent MRSA transmission and central-line associated bloodstream infections in NICUs.

Results—Staff from 162 of 342 NICUs responded (response rate 47.3%). Most (92.3%) NICUs use central-line insertion and maintenance bundles, but maintenance practices varied, including agents used for antisepsis and frequency of dressing changes. Forty-two percent reported routine screening for MRSA colonization upon admission for all patients. Chlorhexidine gluconate (CHG) use for central line care for at least one indication (central line insertion, dressing changes, or port/cap antisepsis) was reported in 82 NICUs (51.3%). Among sixty-five NICUs responding to questions on CHG use restrictions, 46.2% reported no restrictions.

Conclusions—Our survey illustrated heterogeneity of CLABSI and MRSA prevention practices and underscores the need for further research to define optimal strategies and evidence-based prevention recommendations for neonates.

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Introduction

Healthcare-associated infections are an important cause of illness and death among infants, especially premature neonates. Central line-associated bloodstream infections (CLABSI) are the leading type of device-associated infections among patients in the neonatal intensive care unit (NICU) reported to the National Healthcare Safety Network.[1] The incidence of CLABSI reported from NICUs is consistently among the highest reported when compared to other hospital locations.[1] Methicillin-resistant *Staphylococcus aureus* (MRSA) infections remain a significant cause of HAIs among NICU patients.[2,34] Evidence-based recommendations for preventing CLABSI and MRSA transmission, largely based on studies assessing preventability in adults, have been published.[5,6] However, there are relatively few studies that evaluate the preventability of HAI in pediatric settings, and NICU-specific infection prevention studies are sparse. Consequently, variation in HAI prevention practices in NICUs is likely to exist and yet information about this variation is not currently available. This survey was aimed at garnering a better understanding of current NICU prevention practices and to describe variability in practices among US NICUs to identify areas where further research is needed.

Methods

Study Participants and Design

We identified NICUs that reported CLABSI data to the National Healthcare Safety Network (NHSN) from January 1 through December 31, 2009. In December 2010, NHSN-designated contacts at each identified facility were sent the survey using an online survey tool[7] which delivered via email the link for the survey. The e-mail requested completion of the questionnaire by one member of the infection prevention team. Team members could work together to answer questions if necessary, and we asked for submission of only one survey per facility. Reminders were sent at two week intervals to non-responders until the close of the survey on February 18th, 2011. These activities were considered not to be human subjects research by the CDC's Institutional Review Board and IRB approval to tie facility rates to the study was not granted.

Survey Instrument

The survey included questions regarding demographic information, strategies to prevent MRSA transmission, and CLABSI prevention practices. Published literature available at the time of survey design was reviewed to construct questions about prevention practices. It was piloted among Infection Preventionists (IP) and infectious disease physicians in six facilities via telephone to improve clarity, readability, and minimize response time. Revisions were made based on suggestions from the pilot group. The questionnaire was then entered in an online survey tool.[7] Respondents were not required to answer all questions in order to advance through the survey. Supplementary data on responding hospitals were obtained from the NHSN Annual Facility Survey, which collects information including geographic location, facility type, medical school affiliation, and number of beds.

Statistical analysis

Data analysis was performed in SAS 9.2 (Cary, NC). NHSN facility characteristics were merged with survey data. Those institutions that recorded an invalid NHSN organization identification were excluded. Respondents and non-respondents were compared using χ^2 analysis for facility type, region, and teaching affiliation. Median numbers of beds were compared using non-parametric testing (i.e. Kruskal-Wallis Test). A 2-tailed P value < 0.05 was considered significant. Numbers of responses to each question were tallied, and frequencies of answer selections calculated. Percentages represent the selected answer choice divided by the numbers of NICUs that responded to the question.

Results

Characteristics of participating NICUs

The survey was distributed to 342 NICUs in 39 states. Responses were received from 162 (47.3%) unique NICUs from 32 states; no duplicate surveys were received. Two NICUs were excluded because the facility identification numbers were not valid NHSN identification numbers. Table 1 displays facility characteristics of survey participants and non-responders gathered from the NHSN Annual Survey. Hospital type and region were similar among responders and non-responders, but responders tended to be larger facilities with teaching affiliations. The majority of participants reported their hospital role as an infection preventionist who routinely covers 1 or more NICUs (89/159, 56%); remaining participants reported their role as IP managers (62/159, 39%), hospital epidemiologist (2/159, 1%), or other (6/159, 4%).

Prevention of transmission of MRSA in NICUs

Survey participants were asked about practices in their NICU surrounding MRSA transmission prevention and decolonization. When asked about the importance of MRSA, 78.2% (111/142) reported that MRSA has not been an important, endemic cause of healthcare-associated infections in their NICU; 19% (27/142) reported that while MRSA is not a significant cause of HAIs, they have experienced at least one cluster or outbreak of MRSA in the previous 12 months. The majority of NICUs reported routine screening for MRSA colonization upon admission, but most did not conduct point prevalence screening (Table 2). Of note, 41% (58/141) reported that their state mandates MRSA reporting or screening. For patients found to be colonized or infected with MRSA, almost all (98.6%) instituted Contact Precautions, and the majority either placed these patients in a private room or a designated area with other MRSA-positive patients (Table 2). Cohorting of nursing staff to only MRSA positive patients was reported by 38.7% of NICUs (Table 2).

For the 132 facilities that reported *ever* screening patients for MRSA, the most commonly reported anatomical site of screening was the nose 93.2 % (n=123), followed by umbilicus 26.5% (n=35), axillae 25% (n=33), and groin 22% (n=29). The screening methods reported also varied widely, and included PCR/DNA based screening, standard culture methods, or rapid culture (MRSA selective media) methods; these methods were evenly dispersed among NICUs. One-third of surveyed NICUs reported ever attempting to decolonize NICU patients colonized or infected with MRSA (Table 3). Among the 44 NICUs that reported

mupirocin use for decolonization, 22 (50%) did not have any restrictions on weight, gestational age, or chronological age prior to use, and 42 (95%) reported the intranasal site as the most common site of application. Use of chlorhexidine gluconate (CHG) baths for decolonization was less common (7/48, 14.6%).

Prevention of central line-associated bloodstream infections

The majority of NICUs reported use of central line insertion and maintenance bundles. The key components of insertion bundles were generally consistent across NICUs. Selected questions concerning CLABSI prevention practices are shown in Table 4. The majority of NICUs reported that education and training programs were available for staff who insert central lines (Table 4).Maximal barrier precautions for insertion of central lines were reported to be used by 98.5% of NICUs, but when asked specifically about drape type, 13.5 % (19/141) reported using drapes that cover the insertion site only. The most common reasons for central line use reported by 145 NICUs were: total parenteral nutrition administration (95.2%), administration of intermittent medications (93.8%), administration of blood products (69%), collection of blood cultures (51%), and collection of blood for laboratory tests other than culture (51%). Duration of umbilical catheter use was limited by 69.3% (97/140) of NICUs. The most common use duration limits reported by 94 NICUs were: 6–10 days in 63.5%, 11–15 days in 19.2%, 1–5 days in 12.8%, and 16–21 days in 3.2%. Duration of use was not limited at all for peripherally inserted central catheters (PICC) in 85.8% (121/141) of NICUs; for those that reported a limitation on duration of PICC line use, 75% (15/20) reported a timeframe less than 6 weeks.

Use of maintenance bundles was reported by 65.0% of NICUs, and the need for a central line was assessed daily in nearly all (Table 4). Hand hygiene was performed before accessing a central venous catheter “often” (i.e. approximately 75% of the time) by 25.2% of NICUs and “always” (i.e. approximately 100% of the time) by 73.4% of NICUs. The frequency of catheter site dressing changes varied, with 54 % reporting changes *only* if visibly soiled, damp, or if a non-occlusive dressing; 46% report changes on a specific schedule. For those centers using schedules, transparent dressings were changed every 3–7 days by 71.9% (49/64) and gauze dressings were changed within 3 days by 63.6%, (28/44).

The use of CHG and other antiseptics for practices including central line insertion, dressing changes, and port/cap antisepsis is shown in Table 5. Povidone iodine was used most often (63.4%) for catheter-site dressing changes, and alcohol swabs were used most often (74.7%) for catheter port/cap antisepsis. CHG use for at least one indication (i.e. central line insertion, dressing changes, or port/cap antisepsis) was reported in 51.3% (82/160). Nine NICUs that reported use of CHG for central line insertion did not respond to questions surrounding restrictions. When asked about restrictions (e.g., chronological or gestational age, birth weight) on CHG use for central line insertion, 46.2% (30/65) NICUs reported no restriction on use. Among the 65 NICUs that reported restrictions on use for central line insertion, the most frequent gestational age restriction was 28 weeks (20, 30.8%), the most frequent chronological age restriction was 8 weeks (6, 9.2%), and the most common birth weight restriction was 1,000 grams (9, 13.8%). Seventeen NICUs (26.2%) reported using gestational age alone as a restricting factor; four reported using birth weight alone and four

reported using chronological age alone. Ten NICUs reported a combination of at least two of these factors in restrictions. Restrictions on CHG use for dressing changes and port/cap antisepsis were similar to the restrictions reported above.

Discussion

As the largest survey to date of NICU practices and policies surrounding HAI prevention strategies, this survey illustrates the heterogeneity of practices nationally and helps direct future lines of research. The findings in this survey are generally consistent with smaller previously published NICU HAI prevention strategy surveys,[8–11] but offer a broader perspective on the variability of these practices across a range of facility types. The responses are representative of those NICUs that report to NHSN, and comprise a wide geographic distribution as well as diverse facility types and sizes. Nearly one quarter had no teaching affiliation, and individual unit bed size varied widely; in contrast, other studies have garnered responses from only medical school-affiliated centers or did not offer details regarding unit size. Hence, this survey likely provides a more representative description of practices than other previous efforts and points to the need for studies that can provide evidence for best practices in areas including MRSA prevention strategies, components of central line maintenance bundles, use of CHG in central line maintenance, and strategies to assure appropriate central line access (e.g., restricting central line access for blood draws).

MRSA central line-associated bloodstream infections have been declining in adult intensive care settings[12] but remain problematic in NICUs.[2–4] In accordance with CDC guidance on the control of multi-drug resistant organisms in healthcare settings,[13] the practice of almost all NICUs was to place patients in Contact Precautions when MRSA infection or colonization was identified. Although MRSA screening is not routinely recommended, our survey found that 41.5% of NICUs were routinely screening patients on admission. This is lower than the 65% reported in a previous survey.[10] This difference may be related to variation in responses from states that mandate MRSA screening. Variability was noted in screening mechanisms (both body site screened and testing method used) and decolonization protocols. Among those NICUs that attempt to decolonize patients, most often the physician determines which patients are decolonized, and standardized decolonization protocols were uncommon. Despite the fact that mupirocin has not been approved by the U.S. Food and Drug Administration (FDA) for use in children less than 12 years-old, mupirocin use for MRSA decolonization was reported by 44 facilities surveyed. These results highlight the need for controlled studies in NICU settings addressing the effectiveness of MRSA screening in preventing MRSA HAIs, and establishing optimal screening procedures and decolonization protocols, so that evidence-based recommendations can be established.

While pediatric studies of central-line care bundles have demonstrated an impact in CLABSI rate reduction, these evaluations have often included both insertion and maintenance bundles without individual assessment of each bundle component.[14–19] In our survey, nearly all NICUs reported use of insertion bundles while fewer reported use of and maintenance bundles for central lines. Recent studies have demonstrated the importance and impact of implementing maintenance bundles on CLABSI reduction in pediatric patients.[15] The composition of the maintenance bundles varied among the NICUs participating in our

current survey. For example, practices surrounding dressing changes vary with some centers *only* changing dressings if soiled and others adhering to a schedule; CDC guidelines recommend changing dressings when soiled, but routine schedules based on dressing type are also prescribed for changing dressing even if not soiled.[5] The guidelines do offer a caveat for infants when "the risk for dislodging the catheter may outweigh the benefit of changing the dressing";[5] hence, centers may be choosing to change dressings on a less frequent schedule given risk and/or difficulty of replacing an inadvertently dislodged catheter. CDC recommendations for bundle implementation state that the components of the bundle should be both evidence based and cost-effective,[5] which can prove difficult in NICU patients given the paucity of evidence for some practices; hence, further studies surrounding appropriate maintenance practices for central-lines in NICU patients are needed.

Greater than half of all participating NICUs reported using CHG for at least one of the following indications: central line insertion, dressing changes, or port/cap antisepsis. While CHG is a recommended component of adult central line insertion and maintenance practices, there is no recommendation for its use in infants less than 2 months of age.[5] The FDA recently changed the labeling of CHG products to state "use with care in premature infants or infants under 2 months of age. These products may cause irritation or burns".[20] Despite these issues, practice surveys in addition to ours have confirmed its use in patients with a broad range of chronological ages, gestational ages, and birth weights.[9] In our survey, 50% of NICUs reported using CHG for central line insertion or maintenance, and only six of these reported restriction of its use to infants over 2 months of age. Furthermore, we found that restrictions ranged widely from no restriction to restrictions that used a combination of all three of the aforementioned factors. These data may indicate that community practices have advanced in the absence of evidence based recommendations. This may be reflective of the restriction of the recommendation process when applied to pediatric populations where adequately powered randomized-controlled trials may be lacking.

It has been suggested that pediatric patients' central lines are accessed and used differently than those in adult patients (i.e., lines are maintained for a longer duration and more frequently used for blood draws). This survey provides information regarding the reasons for and frequency of central line access in NICU patients. Perhaps most concerning, half of NICUs reported using central lines to obtain blood samples for routine laboratory testing. Frequent central line manipulation has been suggested as a possible risk for CLABSI.[21,22] Blood coating the internal catheter surface and needless connectors may directly increase the likelihood of biofilm formation leading to infection.[23] A prospective cohort study carried out among NICU patients demonstrated that the risk for CLABSI increased with increasing number of blood samples taken through the central line.[22] Central lines are likely used for blood collection to minimize painful peripheral blood draws in the neonate, and any intervention aimed at limiting this practice must consider this. In depth examination of the reasons that central lines are accessed, the appropriateness of line access, the necessity of the laboratory testing, and potential strategies to minimize central line access are warranted.

There were several limitations to this survey. Participants may have been inclined to report what they perceived to be correct or desired responses, as opposed to true practices.

However, the anonymity of the electronic format of this survey may have limited this effect, as has been suggested elsewhere.[24] Because we were unable to link responding facilities to their reported NHSN infection rates, we could not determine whether reported rates of MRSA infections were indeed lower in the facilities that reported that MRSA was not an important, endemic cause of HAIs in their NICUs. The overall response rate was 47.3%, which is remarkable given the amount of clinical detail requested from responders. While respondents could have differed from non-respondents in terms of their strategies for prevention of MRSA infections and CLABSIs, this would not change the conclusion that there is a great deal of variability in these practices. Finally, while responders were more likely to be larger facilities with a teaching affiliation, there was wide geographic representation with smaller, non-teaching hospitals representing 22% of respondents; hence, these results are informative regarding practices in a wide array of NICU types.

Conclusion

Encouragingly, in areas where published recommendations are available, most reported practices were in accordance with these recommendations; these include such practices as using Contact Precautions for patients with MRSA, assessing the need of a central-line daily for removal when not necessary, performance of hand hygiene prior to central-line use, education for all people inserting central-lines, and use of maximal barrier precautions when inserting a central-line. Reported practices surrounding MRSA screening and decolonization as well as chlorhexidine use for central line insertion and maintenance demonstrated the greatest variability. This variability is likely related to the paucity of pediatric-specific recommendations which is secondary to, not only, the lack of pediatric studies, but the increasing standard for evidence prior to recommendation development. This is especially important in pediatric populations where smaller numbers of impacted patients, parental concern, or other factors may impact the ability of researchers to reach adequate sample size. Consideration must also be given to the appropriateness of evidence derived from adult studies and in what areas is it essential to have pediatric specific studies prior to developing recommendations. Hence, uniformity of practice and implementation of potentially better practices is sacrificed for higher standards of evidence, but may be achievable if alternative standards for recommendation development are considered.

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Table 1

Characteristics of NICU facilities of survey participants compared with non-responders

Characteristic	Participants (n=160)	Non-responders (n=182)	p-value χ^{2*}
Facility Type n (%)			**0.19**
General Hospital	139 (86.9)	168 (92.3)	
Children's Hospital	14 (8.7)	11 (6)	
Other	7 (4.4)	3 (1.7)	
Teaching affiliation n (%)			**0.03**
Yes	124 (77.5)	122 (67)	
No	36 (22.5)	60 (33)	
Region n (%)			**0.55**
Northeast	65 (40.6)	63 (34.6)	
Midwest	26 (16.3)	28 (15.4)	
South	39 (24.4)	47 (25.8)	
West	30 (18.7)	44 (24.2)	
Median Hospital bed size	392 (250–595)	338 (200–460)	**0.03***
(IQR) Median NICU bed size (IQR)	30 (20–43.5)	20 (14–36)	**0.0002***

* NOTE: Wilcoxon rank-sum used to generate p-value for these columns

Table 2

Selected practices for the prevention of MRSA transmission in NICUs of survey respondents

Question	No. of Respondents (%)
Does your facility screen NICU patients routinely on admission? (n=142)	
YES, all patients screened	59 (41.5)
YES, but only selected patients (i.e. transfers)	48 (33.8)
NO, but we will screen on admission during outbreaks/increased transmission	9 (6.4)
NO, MRSA screening on admission is not done	26 (18.3)
Does your facility routinely perform point prevalence testing for MRSA among NICU patients? (n=141)	
YES	49 (34.8)
NO	91 (64.5)
Don't know	1 (0.7)
In your NICU, which of the following actions are taken for patients found to be infected or colonized with MRSA? (n= 142)	
Contact precautions initiated	140 (98.6)
Sign posted outside room/cohorted area describing the isolation precautions	124 (87.3)
Visitors required to wear personal protective equipment	99 (69.7)
Patient placed in private room if available	94 (66.2)
Patient placed in designated room or area with other MRSA positive patients	90 (63.4)
Does your NICU EVER designate specific nursing staff to only MRSA positive or only MRSA negative patients? (n=142)	
YES	55 (38.7)
NO	82 (57.8)
Don't know	5 (3.5)

Table 3

Reported practices in NICUs of survey respondents for decolonization of patients colonized or infected with MRSA

Question	No. of Respondents (%)
Does your NICU ever attempt to decolonize patients colonized or infected with MRSA? (n=142)	
YES	48 (33.8)
NO	88 (62.0)
Don’t know	6 (4.2)
Which Patients are decolonized? (n=48)	
All MRSA positive patients	15 (31.3)
All MRSA positive patients who meet certain clinical requirements (stability, gestational age/weight)	2 (4.2)
Some patients but determined by clinician	25 (52.0)
Only during outbreak situations	2 (4.2)
Never or rarely done	4 (8.3)
Does your facility have a standard regimen for MRSA decolonization? (n=48)	
YES	27 (56.2)
NO	21 (43.8)
Do you use mupirocin for decolonization? (n=48)	
YES	44 (91.7)
NO	3 (6.3)
Don’t know	1 (2.0)
Do you use Chlorhexidine baths in your NICU for MRSA decolonization? (n=48)	
YES	7 (14.6)
NO	40 (83.3)
Don’t Know	1 (2.1)

Table 4

Selected practices in NICUs of survey respondents for the prevention of central line–associated bloodstream infections

Question	No. of Respondents (%)
Does your NICU have an education or training program for staff responsible for insertion of central lines?	
YES	130 (91.5)
NO	12 (8.5)
Does your NICU use central line catheter BUNDLES for INSERTION of central lines in neonates?	
YES	131 (92.3)
NO	11 (7.7)
What components are included in your NICU central line insertion bundle? (n=131)	
Insertion checklist	113 (86.3)
Packaged trays, carts, or boxes that include full sterile barriers	120 (91.6)
Hand hygiene	128 (97.7)
Maximal barrier precautions	129 (98.5)
Skin antisepsis	129 (98.5)
Staff are empowered to stop a non-emergent procedures if it does not follow sterile insertion practices	126 (96.2)
Conduct insertion training for all care providers (including slides and videos)	87 (66.4)
Does your NICU use bundles for MAINTENANCE of central lines?	
YES	93 (65.0)
NO	50 (35.0)
Are there daily assessments of the NICU patient’s need for a central line? (e.g. during patient rounds)	
YES	129 (97)
NO	4 (3)

Table 5

Selected uses for chlorhexidine and other antiseptics in NICUs of survey respondents for management of central line insertion and maintenance

Chlorhexidine and other antiseptic use in NICUs			
–	**USES**		
	Central line insertion (n=145)	**Dressing Changes (n=142)**	**Port/cap antisepsis (n=146)**
AGENT n (%)			
Chlorhexidine gluconate	74 (51.0)	66 (46.5)	33 (22.6)
Povidone iodine	105 (72.4)	90 (63.4)	9 (6.2)
70% isopropyl alcohol/alcohol swabs	41 (28.3)	47 (33.0)	109 (74.7)
Other*	0	3 (2.1)	3 (2.1)

*included normal saline, ‘nothing used’