

Original Article

Healthcare worker perceptions surrounding *Staphylococcus aureus* transmission and prevention practices in the neonatal intensive care unit

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Abstract

Objective: To understand healthcare worker (HCW) perceptions surrounding *Staphylococcus aureus* transmission and prevention in the neonatal intensive care unit (NICU).

Design: Qualitative case study with focus groups.

Setting: A level IV, 150-bed NICU at a Midwestern academic medical center that conducts active surveillance and decolonization of *S. aureus*-positive patients.

Participants: NICU HCWs, including bedside nurses, nurse managers, therapy services personnel, pediatric nurse practitioners, clinical fellows, and attending neonatologists.

Methods: Semistructured focus group interviews, assembled by occupation, were conducted by 2 study team members. Interviews were video recorded and transcribed. Deductive coding and thematic analyses were performed using NVivo software.

Results: In total, 38 HCWs participated in 10 focus groups (1–12 participants each), lasting 40–90 minutes. Four main themes emerged: (1) Methicillin-resistant *S. aureus* (MRSA) and methicillin-susceptible *S. aureus* (MSSA) are inconsistently described as high risk. (2) Infection prevention interventions are burdensome. (3) Multiple sources of transmission are recognized. (4) opportunities exist to advance infection prevention. HCWs perceived MSSA to be less clinically relevant than MRSA. Participants expressed a desire to see published data supporting infection prevention interventions, including contact precautions, environmental cleaning, and patient decolonization. These practices were identified to be considerable burdens. HCWs perceived families to be the main source of *S. aureus* in the NICU, and they suggested opportunities for families to play a larger role in infection prevention.

Conclusions: These data highlight opportunities for HCW and parental education, research, and reevaluating interventions aimed at improving infection prevention efforts to reduce the burden of *S. aureus* in NICU settings.

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Staphylococcus aureus colonization is common in hospitalized infants.^{1–3} Persistent *S. aureus* colonization poses risk for the development of infections,^{1,3,4} including skin and soft-tissue infections (SSTIs), respiratory tract infections, bacteremia, and musculoskeletal infections.⁵ These infections are associated with increased mortality,^{6–8} morbidity,^{6,7,9–11} and hospital length of stay,⁸ and they impose a significant cost burden for families and hospitals.¹²

Given the risks associated with *S. aureus* colonization in neonates, infection prevention (IP) strategies, including contact precautions and hand hygiene measures, are frequently implemented by healthcare workers (HCWs).^{13,14} Although consensus about when active surveillance and decolonization for *S. aureus* should be performed in the NICU is lacking,^{15,16} these IP measures have traditionally been instituted to prevent methicillin-resistant *S. aureus* (MRSA) transmission in the neonatal intensive care unit (NICU). However, most *S. aureus* infections are caused by methicillin-susceptible *S. aureus* (MSSA), with similar risk for morbidity and mortality as MRSA.^{6,10,17–20} Thus, some centers have implemented IP measures to reduce the risk of MSSA infection.²¹ Gaps remain in the literature characterizing how NICU

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HCWs conceptualize their role in the transmission and prevention of *S. aureus*. We sought to understand HCW perceptions surrounding *S. aureus* transmission and prevention in the NICU using a qualitative approach. This information can guide future *S. aureus* prevention interventions, educational initiatives, and research in the NICU.

Methods

Setting and participants

From July to October 2021, we conducted semistructured focus groups with HCWs practicing in the St. Louis Children's Hospital (SLCH) NICU. This level IV, 150-bed NICU has ~1,500 admissions annually and has mostly private rooms, with some patient beds in an open-bay layout. Purposive sampling was conducted to include a variety of professions represented in the clinical setting. Clinicians were stratified based on their role: bedside nurses, nurse managers, therapy services personnel (respiratory and occupational therapists), advanced practice nurses, clinical fellows in neonatology, and attending neonatologists. To address and minimize the effect of power differentials on participant dialogue, separate focus groups were conducted for attending neonatologists, neonatology fellows, bedside nurses, and nursing leadership plus advanced practice nurses. Each focus group was conducted by nonhealthcare professionals (S.P. and S.M.) to allow for candid discussion. Focus groups were conducted in person and virtually via Microsoft Teams (Microsoft, Redmond, WA). This study was approved by the Washington University Institutional Review Board. Informed consent was obtained from all participants.

Recruitment

Individuals were recruited through a combination of strategies that are standard for qualitative research in healthcare settings, including flyers posted in the NICU and staff lounge, in-person canvassing of HCWs in the NICU (by S.P. and G.I.), unit-wide emails, and announcements during provider meetings.²² We conducted focus groups until we reached appropriate diversity in the sample as well as thematic saturation.²³

Infection prevention procedures at SLCH

Active surveillance for MRSA has been conducted since 2004, wherein all NICU infants are screened for nasal MRSA colonization at admission and weekly thereafter until hospital discharge. MRSA-colonized infants are placed in contact precautions (requiring all HCWs to wear isolation gowns and gloves when entering the patients' rooms), and they undergo a decolonization regimen (Table 1). In June 2020, active surveillance for MSSA colonization, and decolonization of infants detected to be MSSA colonized, was implemented. The 7-day decolonization regimen includes twice-daily application of mupirocin to the nares, periumbilical, and perianal regions. Infants whose postmenstrual age is >30 weeks receive 3 chlorhexidine baths (on days 1, 3, and 7). On day 4, additional measures include enhanced cleaning and replacement of patient bed, linens, suction tubing and canister, and nasal cannula tubing or ventilator circuit and tubing.

Data collection

A semistructured interview guide was created using input from a multiprofessional team with expertise in neonatology, infectious

diseases, IP, and qualitative methods. The questions addressed HCW perceptions and practices regarding the clinical significance of MRSA and MSSA colonization, transmission dynamics, challenges to IP, and potential interventions to reduce transmission.

Data analysis

Interviews were recorded and transcribed using Microsoft Teams software (Redmond, WA). The transcripts were deidentified and reviewed (S.P.) to ensure accuracy. Deductive coding was used in this analysis, and 3 authors (S.P., S.M., and S.F.) developed the original code book based on prior literature comprising infection prevention in the healthcare setting. The code book was updated, including the addition of 1 code, and updates were made to definitional clarity and examples after the 2 coders met to discuss coding discrepancies. The final code book is provided in the Supplementary Materials (online). Transcripts were double-coded by 2 independent authors (S.P. and S.M.) using NVivo software. Discrepancies between the coders were discussed until consensus was reached, and disputes were settled by a third coder (S.F.). Following coding, we conducted thematic analysis to understand the patterns and recurrences in the coded transcripts.

Results

We conducted 10 semistructured focus groups with 38 NICU HCWs. Participants included 6 attending neonatologists, 3 neonatology fellows, 3 therapists, 10 bedside nurses, 15 nurse leaders or educators, and 1 advanced practice nurse. There was 100% participation by all consented HCWs. Focus groups lasted 40–90 minutes, and each was comprised of 1–12 participants. Four themes emerged: (1) MRSA and MSSA are inconsistently described as high risk. (2) IP interventions are burdensome. (3) Multiple sources of transmission are recognized. (4) opportunities exist to advance IP. In Table 2, we present nonexhaustive, example quotes to illustrate the findings within each theme.²⁴ Additional example quotes are provided in the Supplementary Table (online).

MRSA and MSSA are inconsistently described as high risk

Participants discussed the risk of MRSA in 3 ways: risk to patients, risk to themselves, and risk compared to MSSA. Clinicians did not communicate great concern about the development of infection in infants colonized with either MRSA or MSSA. Those expressing less concern often cited their perception of a low frequency of invasive *S. aureus* infections in their NICU to support their belief. Many who expressed great concern attributed their risk perception to either a memorable personal experience caring for an extremely ill patient or recognized specific patient risk factors that pose increased infection vulnerability (Table 2, quote 1.1).

Physician focus groups viewed MSSA as less clinically relevant than MRSA, whereas nursing groups were less certain about the clinical differences between MSSA and MRSA (Table 2, quote 1.2). All groups expressed the perception that MSSA decolonization was often less successful than MRSA decolonization (ie, patients remained persistently colonized with MSSA or frequently reacquired colonization after a period of eradication).

Overall, HCWs were not worried about their personal risk for *S. aureus* infection. However, several communicated concern about bringing pathogens from the hospital to their children at home. Participants commonly expressed that working in

Table 1. *Staphylococcus aureus* Infection Prevention Policies and Protocols at SLCH Level IV NICU

Bare-to-touch policies	Followed by all staff entering patient rooms: <ul style="list-style-type: none"> – Bare from the elbow down. No long sleeves at the bedside, sleeves must be above the elbow – No wristwatches or wrist jewelry – No rings, except 1 plain band – Hair long enough to touch the collarbone must be pulled up
Screening and contact precautions	<ul style="list-style-type: none"> – Surveillance culture (nares swabs) are obtained for <i>S. aureus</i> (MRSA and MSSA) detection upon NICU admission and weekly thereafter. – Patients with a positive surveillance culture for MRSA are placed on contact precautions: healthcare personnel are required to wear gowns and gloves when entering the patient's room. – Decolonization protocol (see below) for both MRSA- and MSSA-colonized patients – Parents of MRSA-colonized infants are not required to wear gowns and gloves, but are instructed to perform proper hand hygiene with soap and water or an alcohol-based hand rub both before entering the patient's room and before each time they touch their infant. If their hands are visibly soiled, then they are instructed to use soap and water. – Routinely asking surveillance questions to parents about past <i>S. aureus</i> colonization and infection history is not performed – Patients with a parent who has a known history of an MRSA infection or colonization during that pregnancy are placed on contact isolation on admission to the NICU. <ul style="list-style-type: none"> – If the patient's admission MRSA screening culture and 3 subsequent weekly MRSA screening cultures are negative, contact isolation can be discontinued – If the patient's admission MRSA screening culture is positive, they will remain on contact precautions for the duration of their stay
Decolonization protocol	<p>Day 1: Day of initial positive MRSA or MSSA screening result</p> <ul style="list-style-type: none"> – Apply Bactroban (nares, periumbilical, perianal) twice daily – If patient is >30 weeks postmenstrual age, begin CHG bathing with 2% CHG wipes – Change out bed linens <p>Day 2: Apply Bactroban (nares, periumbilical, perianal) twice daily</p> <p>Day 3: Apply Bactroban (nares, periumbilical, perianal) twice daily</p> <p>Day 4: Apply Bactroban (nares, periumbilical, perianal) twice daily and repeat CHG bath if patient is over 30 weeks postmenstrual age</p> <p>Additional day 4 change out:</p> <ul style="list-style-type: none"> – Exchange infant bed/crib/isolette, bed linens, Boppy covers, bouncy seat, swing covers, Dr. Brown's nipples and bottles, nasogastric/orogastric tubes, suction tubing and canister, nasal cannula tubing, ventilator circuit and tubing. – Exchange or clean all toys and personal items in the patient's room. <p>Day 5: Apply Bactroban (nares, periumbilical, perianal) twice daily.</p> <p>Day 6: Apply Bactroban (nares, periumbilical, perianal) twice daily.</p> <p>Day 7: Repeat of Day 1</p>
Persistent colonization	<ul style="list-style-type: none"> – If baby's positive culture(s) persists for 2 consecutive weeks after completing the above protocol, repeat the decolonization protocol. If the infant's skin is not tolerating the wipes, the CHG solution can be used in place of the wipes. – If the infant remains positive after completing 2 rounds of decolonization, a third round of the decolonization protocol is typically not recommended except in specific clinical scenarios after discussion with the IP team.

Note. NICU, neonatal intensive care unit; MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-susceptible *S. aureus*; IP, infection prevention; CHG, chlorhexidine gluconate.

healthcare would be extremely difficult if they constantly worried about personal infection risk.

Infection prevention interventions are burdensome

HCWs described how IP interventions, including contact precautions, patient screening, patient decolonization, and environmental cleaning, placed burden on patients, families, and clinicians. Clinicians were primarily concerned about the physical and emotional burden on families. HCWs emphasized that patients on isolation were stigmatized, resulting in less interaction by HCWs and potentially resulting in delayed social development. When discussing colonization status and subsequent interventions, clinicians described communication strategies in which they attempted to minimize the blame and burden placed on families by framing MRSA as a common nosocomial disease (Table 2, quote 2.1).

HCWs identified contact precautions and environmental cleaning as substantial burdens. Clinicians described challenges when trying to follow contact precautions and often cited these challenges to explain drifts in practice. These barriers fell into 4 broad categories: general workflow interruptions, emergent scenarios, quick events, and confusion about patient isolation status.

Participants reported that contact precautions disturbed their normal workflow. Gowns were described as hot and uncomfortable, which limited the amount of time individuals stayed in rooms of patients requiring contact precautions. Physician groups described how isolation requirements changed the order of their examinations before rounds, as well as how often and how long they spoke with families in these rooms (Table 2, quote 2.2).

All clinicians expressed that it was difficult to adhere to contact precautions when a patient was clinically decompensating. They described a prioritization of the immediate clinical needs of the patient over any potential infection risk posed by not wearing a gown when entering the patient's room. However, HCWs also identified nonemergent scenarios, such as turning off a feeding pump or silencing an alarm, which would lead to a drift in practice. Some HCWs expressed the perception that they were not contributing to *S. aureus* transmission if they quickly went into a room and did not touch the patient. Physicians recognized unique barriers for teams not based in the NICU (eg. consulting services), citing that these groups may be unfamiliar with the signage indicating infants requiring contact precautions. Focus groups with nursing leadership also recognized that policies to discontinue contact precautions (Table 1) are confusing for staff members (Table 2, quote 2.3).

Table 2. Nonexhaustive, Example Quotes Within Each Coding Theme to Illustrate Findings

Theme Exemplified by Quote	Provider Type	Quotes
Disease severity	Nurse leadership	^{1.1} “I do think once you get more experienced and you’ve seen the osteomyelitis that comes with it, and you’ve seen a baby get so sick . . . I think that is something you carry with you. But until you experience something like that, or it really hits you, I think it’s easy to kind of overlook or dismiss.”
	Nurse leadership	^{1.2} “We treat it [MSSA] differently than MRSA because they don’t go on isolation for it [. . .] Sometimes we will decolonize these kids, I think a maximum of 4 times a piece and then after that we don’t do it for them anymore if they continue to test positive. So, I think for the nurses, we kind of question—Is this something we should be more worried about or is this the same as MRSA?”
Burden of intervention	Nurse leadership	^{2.1} “I think how we explain it to parents almost does a disservice, because we are so cautious to not upset them, but then in doing that, we actually downplay the severity of it, because we don’t want them to feel like they have this scarlet letter. But in the end, their baby needs to be treated differently.”
	Physician	^{2.2} “It would be great to just zoom in, sit down, and talk to them very quickly. It’s just an MSSA or MRSA positive and I’m not touching the baby. It’s kind of silly because it’s (contact precautions) blocking me from getting to do what I want to.”
	Nurse leadership	^{2.3} “I think one thing to that kind of gets confusing to staff is that our patients will go on isolation for MRSA for one week of positive, and then they’ll decolonize and then will be negative for their screenings after and then they stay on isolation [. . .] I think that maybe can add to the drift in practice because people know the MRSA status is now negative, but there’s still an isolation.”
Sources of transmission	Therapist	^{3.1} “Nobody’s making them (families) wash their hands as they leave, and then they go out in the hall, they touch the elevator, they go to the cafeteria, they touch the elevator coming back, you know then they go home to their own kids. It’s just a revolving door then.”
	Bedside nurse	^{3.2} “I think one of the things I learned with a patient recently is how many times without thinking, even if you have gloves on, you go and listen to your patient and you take a pulse and you come to the computer and you touch the keyboard and then you go back to the patient, you know, and you still have your same gloves on [. . .] you’re touching the environment all the time, and then touching the patient again.”
Future opportunities for infection prevention	Bedside nurse	^{4.1} “We as medical staff at a hospital have been trained on how to decrease infection risks and to do proper hand hygiene. We know the history behind infections. We have a lot of education to back us up where some parents might not have that background and not understand that you have to wash your hands for a certain amount of time, and you have to do it every time before you touch the baby. [. . .] So, it’s trying to educate those parents and have them understand the impact that they have on their child.”

Clinicians also described a large work burden associated with required environmental cleaning. Nurses described time constraints that made it difficult at the beginning of each shift to follow environmental cleaning protocols that are completed in all patient rooms. In addition to daily cleaning, a large cleaning effort on day 4 of the decolonization protocol (Table 1) was perceived to be a uniquely heavy, albeit necessary, burden. Many nurses also expressed frustrations about systemic barriers to environmental cleaning such as inadequate availability of cleaning supplies.

Recognition of multiple sources of transmission

HCWs described their impressions of how people and environmental surfaces could be sources of transmission. Nearly every focus group perceived families as the main source of *S. aureus* in the NICU. Common explanations for this perception included families being less educated about IP and hand hygiene and the fact that families are not required to follow contact precautions (Table 2, quote 3.1). Participants acknowledged that HCWs could be a source of transmission, although they discussed that they were unaware of robust supporting data.

HCWs recognized how hospital surfaces act as sources of transmission and described how people, including themselves, may spread *S. aureus* from these surfaces to patients via physical contact (Table 2, quote 3.2). Often, participants pointed to the burden and challenges faced with contact precautions and other protective equipment to explain the drift in practice that would lead to HCWs transmitting *S. aureus* from the environment to patients. In addition to hospital surfaces, HCWs frequently discussed how

families might introduce *S. aureus* into the NICU through their personal belongings, especially cell phones.

Opportunities to advance IP

HCWs identified several areas for future IP, including interventions targeting families, scrub sinks, and ultraviolet technology. Participants expressed interest in families playing a larger part in IP. They described possible interventions surrounding education, hand hygiene, family screening, and family decolonization. In line with their approach to minimize blame and stigma when communicating to families about *S. aureus*, HCWs expressed more favorable views toward interventions that focused on empowering or educating families (Table 2, quote 4.1). To this end, HCWs hesitated to offer decolonization immediately after the patient’s first positive colonization screening test and instead were in favor of offering families decolonization the second time that a patient tested positive.

Other potential interventions were also shared frequently across all focus groups. There was a high level of interest in bringing back scrub sinks and increasing the use of ultraviolet technology to decontaminate personal belongings and hospital equipment. Although these interventions were often discussed favorably, HCWs strongly expressed that they wanted to assess the evidence surrounding any intervention before implementation. To understand HCW perceptions, we specifically queried participants about 2 MRSA IP practices that have previously been implemented during outbreak settings: periodic HCW worker screening and periodic HCW decolonization without screening.^{25–27} Overall, there was a lack of interest for either intervention due to concerns

about stigma from patients' families, altered work schedules due to testing positive, and the further development of antibiotic-resistant bacteria.

Discussion

Few studies have characterized how HCWs conceptualize infectious disease transmission and prevention in acute-care settings. We assessed NICU HCW perceptions regarding *S. aureus* disease severity, sources of transmission, challenges to IP, and opportunities for future interventions within a NICU that practices active surveillance for *S. aureus* colonization, contact precautions, and decolonization. The findings from this study illuminate areas for future education and research and highlight the need to re-evaluate or redesign current IP strategies.

During our focus groups, in general, HCWs did not express a high level of concern regarding *S. aureus* colonization among NICU patients, or the risk colonization poses for subsequent infection.²⁸ However, there was variability in individual HCW perceptions; those with personal experience caring for critically ill neonates with *S. aureus* infection voiced concern about *S. aureus* colonization and infection risk. The lack of concern regarding colonization was even more pronounced for MSSA, which HCWs believed to be less clinically relevant than MRSA. In turn, the utility of MSSA screening and decolonization was questioned. Multiple studies have demonstrated that *S. aureus* colonization, with either MRSA or MSSA, indeed poses increased risk, by up to 24-fold, for the development of invasive infection in neonates.^{1,3,4,6,20,29} Nationally, the incidence of MSSA invasive infection exceeds MRSA invasive infection by 2.5-fold, with similar risk for morbidity and mortality.^{6,10,17–20} Additionally, implementation of MSSA surveillance and decolonization in the NICU setting has been associated with a sustained reduction in MSSA infections.^{20,30} Hence, our focus groups revealed an opportunity to educate HCWs with both local and national data demonstrating the substantial risk of infection associated with *S. aureus* colonization (MRSA and MSSA), the morbidity and mortality associated with these infections, and the reduction in infection incidence with decolonization and other IP measures.

HCWs perceived initiatives to prevent *S. aureus* acquisition and transmission, particularly personal protective equipment and environmental cleaning, to be a substantial burden. Inconsistencies in adhering to contact precautions were identified, and efforts to decontaminate environmental surfaces were felt to be difficult in the context of performing patient care. However, environmental surfaces are important reservoirs for *S. aureus*, and enhanced cleaning has been demonstrated to reduce MRSA transmission and acquisition in these settings.^{31–33} Further compounding these challenges, consensus regarding optimal IP practices is lacking. For example, institutions vary regarding practices such as surveillance, decolonization, and universal gloving.^{15,16,34} This inconsistency underscores the need for future studies that incorporate the realities of these complex settings to ultimately devise effective, yet minimally burdensome, IP measures.

HCWs overwhelmingly attributed families as the primary source of *S. aureus* transmission to NICU infants. A study conducted at Johns Hopkins University demonstrated that, among NICU patients who acquired *S. aureus* colonization during their hospitalization, approximately half became colonized with a strain that was also recovered from their parents, while the remaining half became colonized with a non-parental-concordant strain. However, infant acquisition of nonparental *S. aureus* strains was also identified.²⁹

These data suggest that although parents play a role in *S. aureus* transmission, other sources, including HCWs and environmental reservoirs, may be important contributors as well.^{35–37}

Our data reveal specific IP opportunities with variable buy-in from HCWs. HCWs favored initiatives focused on family education compared with those that targeted HCWs or that restricted families through mandatory policies. HCWs also responded favorably to offering families the option to perform decolonization. Given the success of parental decolonization in reducing the prevalence of *S. aureus* colonization in neonates in one study,²⁹ this may be a viable route to pursue. Their support of these family-focused initiatives may be consistent with their belief that families were the primary source of transmission. On the other hand, HCW screening and decolonization initiatives were viewed less favorably by HCWs due to concerns about confidentiality, altered work schedules, and antibiotic resistance. Thus, while the efficacy of screening and decolonizing HCWs may be indicated in specific scenarios, the threshold for implementation is high.

An important strength of this study is the cumulative knowledge derived from the engagement of diverse cohorts of frontline clinicians engaged in the delivery of critical care. This study had several limitations. First, we used a variety of recruitment strategies to obtain this sample, which resulted in a lack of ability to track overall response rate. Moreover, this sample represents individuals who self-selected to participate. This study was conducted at a single site and may not be generalizable to other settings, especially since reported HCW attitudes may be influenced by institutional practices, including active surveillance and decolonization, which vary among institutions. Lastly, data were collected through focus groups; this setting may have led participants to alter or limit their responses. Similar research that employs individual interviews or even anonymous surveys could further explore this topic.

In conclusion, using focus groups, we characterized HCW attitudes surrounding *S. aureus* in the NICU. We illuminated HCW perceptions regarding the risk posed by *S. aureus* colonization, particularly MSSA, which in turn may contribute to drifts in IP practices and perceived burdens associated with IP procedures. Our data highlight the importance of educating HCWs about mechanisms of transmission, infection risk, and the rationale for IP practices. Sharing local and published data may increase adherence to infection control practices. Moreover, addressing systemic challenges to reduce work burden is also essential. Enhancing HCW knowledge and relieving work burden could improve IP efforts and mitigate *S. aureus* in NICU settings.

Supplementary material. To view supplementary material for this article, please visit <https://doi.org/10.1017/ice.2023.86>

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