Impact of Methicillin-Resistant Staphylococcus aureus (MRSA) Decolonization Protocol on Colonization and Infection Rates in a Level III Neonatal Intensive Care Unit

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Abstract

**Background:** In recent decades, the US has seen a substantial increase in Methicillin-resistant Staphylococcus aureus (MRSA) infections and outbreaks in neonatal intensive care units (NICU). In an effort to eliminate MRSA infections and potential outbreaks, in 2005 we implemented a MRSA Decolonization Protocol in our Level III NICU. The protocol primarily consisted of 4 pieces: 1) contact precautions, 2) Hibiclens® bath, 3) mupirocin ointment to the nares, and 4) continued surface surveillance cultures. The purpose of this 10-year study was to determine the impact our NICU Decolonization Protocol had on the rates of MRSA colonization and infection.

**Methods:** All neonates born between January 2002 and December 2012 (N = 8283) admitted to our Level III NICU were identified. Patients were subsequently divided into 2 groups based on date of protocol implementation: Group 1 consisted of neonates born preprotocol (January 2002–December 2004) and Group 2 of neonates born postprotocol (January 2005–December 2012). Frequency of MRSA colonization and infection were our primary endpoints.

**Results:** Group 1 included 2139 infants, of whom 96 developed MRSA colonization (n = 87) and/or infection (n = 9). Group 2 had 6144 infants; 178 developed MRSA colonization (n = 167) and/or infection (n = 11). The frequency of MRSA colonization (Group 1: 4.1% vs. Group 2: 2.7%; P = .002) and infection (0.4% vs. 0.2%; P = .05) was significantly lower in Group 2.

**Conclusions:** The proportion of neonates with MRSA colonization and/or infection in our Level III NICU was significantly reduced following implementation of a decolonization protocol.

Methicillin-resistant Staphylococcus aureus (MRSA) is a common bacterium that has become endemic to hospitals. Infants in neonatal intensive care units (NICU) represent a particularly at-risk population. Factors such as young gestational age, low birth weight, need for surgical procedures, and utilization of devices, such as mechanical ventilation, have been shown to predispose infants to MRSA colonization and infection.1,3

A large number of humans (30%–70%) are carriers of Staphylococcus aureus.3 Neonates are often exposed shortly following birth via the environment and/or their parent’s or healthcare worker’s skin.3⁶ Between 1995 and 2004, NICUs in the US experienced a 300% increase in MRSA infections.6 Around 2001 and 2002, we also noticed an amplified rate of MRSA colonization and infection.

In an effort to eliminate subsequent infections and potential MRSA outbreaks, we implemented a MRSA Decolonization Protocol in our Level III NICU. This protocol was first applied in January 2005 and primarily consisted of 4 pieces: 1) contact precautions, 2) Hibiclens® bath, 3) mupirocin ointment to the nares, and 4) continued surface surveillance cultures. Hand hygiene is also an...
area of emphasis, as staff members are required
to perform hand hygiene before and after caring
for and/or handling infants. In addition, both
staff and parents are required to wear gloves and
gowns while in the patient’s room if they have a
positive culture for MRSA.

MRSA infection is associated with significant
morbidity in infants, as it can result in subsequent
infections; these include, but are not limited to,
skin infections, conjunctivitis, bloodstream
infections, surgical site infections, pneumonia,
meningitis, and respiratory tract infections.9,10
NICUs throughout the country have sought to
reduce MRSA infections and outbreaks; how-
ever, as of 2005, optimal management strategies
remained unclear. The purpose of this study was
to determine the impact of a NICU MRSA Decol-
onization Protocol on neonatal rates of MRSA
colonization and infection.

Methods
Following approval from the Greenville Health
System Institutional Review Board, we identi-
fied all neonates born between January 2002 and
December 2012 (N = 8283) admitted to the Level
III NICU at Greenville Memorial Medical Center
(GMMC), a large, tertiary care academic health
center. These patients were subsequently divided
into 2 groups based on date of protocol imple-
mentation: Group 1 consisted of neonates born
preprotocol (January 2001–December 2004) and
Group 2 of neonates born postprotocol (January
2005–December 2012). Neonates colonized or
infected with MRSA (n = 274) were then identi-
fi ed by retrospective chart review. Infants trans-
ferred from an outside institution or another
floor at GMMC with a MRSA-positive culture
upon admission were excluded from this study
(n = 15).

Data collection included gender, birth weight,
gestational age, mode of delivery, placement of
PICC (peripherally inserted central catheter)
line, presence of necrotizing enterocolitis (NEC)
or other infections, surgery, and MRSA strain.
Primary endpoints were incidence of MRSA
colonization and infection. MRSA colonization
was defined as having a MRSA-positive culture
of the anterior nares and/or skin surface. MRSA
infection was defined as having a MRSA-positive
culture from blood, wound(s), tracheal aspirate,
urine, or cerebrospinal fluid.

Surveillance cultures were collected 1–2 times
per week on all infants in the NICU who were
not under contact precautions for MRSA. Naso-
pharyngeal, axillary, and perianal areas were
swabbed with 3 individual cotton swabs and
placed inside a single vial with sterile saline solu-
tion. During Group 1’s study period (prior to
2005), all vials were centrifuged and transferred
to sheep blood plates in the GMMC laboratory; this
process took between 4 and 5 days to produce
a positive culture. Starting in 2005 (Group 2), the
laboratory began using Chrome Agar® in place of
sheep blood plates; this change enabled growth
observation at approximately 24 hours. MRSA
strains were further characterized using pulsed-
field gel electrophoresis.11

The MRSA Decolonization Protocol included
a physician’s order for MRSA isolation, contact
precautions, a Hibiclens bath, mupirocin (Bac-
trobani™) to nares 2 times per day for 5 days, and
continued surface surveillance cultures until
Infection Prevention approved removal from iso-
lolation. Standard policy in the NICU required all
staff members to follow contact precautions and
to perform hand hygiene before and after caring
for and/or handling infants. Additional measures
required parents to wear gloves and gowns when
in the room with their infant if they had a positive
culture for MRSA.

Patients included in the analysis were not colo-
nized or infected upon admission to the NICU.
Bivariate analysis was performed to compare
infant characteristics between study groups.

Categorical variables were compared using Chi-
square test. Continuous variables were compared
using student’s t-test. Data are presented as fre-
cuency and percentage for categorical variables
or mean ± standard deviation for continuous
variables. P values < .05 were considered indic-
ative of statistical significance. All statistical
analyses were completed using SAS Enterprise
Guide 7.1 software (Statistical Analysis System,
Cary, NC).

Results
During the study period, 8283 neonates were
admitted to the NICU at GMMC and met the
inclusion criteria. From these, 2139 were born
preprotocol (Group 1), of whom 96 developed
MRSA colonization (n = 87) and/or infection
(n = 9). From the 6144 infants born postprotocol
(Group 2), 178 developed MRSA colonization (n = 167)
and/or infection (n = 11). All 20 patients who
were infected with MRSA were infected prior to
to identification of colonization. The frequency of
MRSA colonization (Group 1: 4.1% vs. Group 2:
2.7%; P = .002) was significantly lower in Group
IMPACT OF MRSA DECOLONIZATION PROTOCOL IN NICU

2; frequency of MRSA infection was also lower in Group 2, although only marginally significant (0.4% vs. 0.2%; \( P = .05 \)) (Table 1).

Patient demographics and risk factors are described in Table 2. Neonates born preprotocol and postprotocol were comparable with regard to gender, birth weight, gestational age, PICC line placement, mechanical ventilation, and days to colonization. Mode of delivery and need for surgery were significantly different between groups, with a higher proportion of neonates in Group 1 born by C-section (77.1% vs. 65.2%, \( P = .04 \)) and a higher proportion of infants in Group 2 requiring surgery (49.0% vs. 70.0%, \( P < .01 \)).

From the 274 colonized infants, 179 (65%) had strain typing data available. From these, 14 unrelated MRSA strains were identified, of which community-associated MRSA USA300 was most common (n = 28), followed by hospital-associated MRSA USA800 (n = 22). One MRSA infection progressed to sepsis and ultimately necrotizing pneumonia and resulted in death; this was the only mortality in the study. MRSA strain VIIc was the causative organism in this mortality—this was the only infant colonized with this particular strain.

Discussion

MRSA colonization is a risk factor for progression to infection. This study demonstrates that efforts to decolonize neonates can statistically impact rates of infection. This study is the first to describe the benefit of decolonization in a vulnerable group of infants. There were no adverse events associated with the use of the topical chlorhexidine and mupirocin.

Infections in neonates are associated with increased cost, prolonged length of stay, exposure to additional antibiotics, and increased invasive procedures such as central venous access, lumbar puncture, and even surgical interventions. Additionally, new literature reports invasive blood stream infections lead to increased risk of poor neurodevelopmental outcomes in preterm infants.

Efforts to prevent colonization with MRSA should be first line. By using active surveillance to identify infants who become colonized early and adherence to expanded contact precautions that include family members, in addition to healthcare workers, the decrease in transmission of MRSA in the NICU setting can be accomplished. However, if colonization occurs, additional measures to decrease or eliminate bacterial bioburden appear to decrease the risk of progression to infection.

Conclusion

This study demonstrates that measures of active surveillance for early recognition of colonization and isolation combined with implementation of a NICU MRSA decolonization protocol can reduce colonization and infection rates, and the associated morbidities attributable to infection.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>MRSA status preprotocol and postprotocol.</th>
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<tbody>
<tr>
<td></td>
<td>Preprotocol</td>
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<tr>
<td>N</td>
<td>2139</td>
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<tr>
<td>Infection, no. (%)</td>
<td>9 (0.42%)</td>
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<tr>
<td>Colonization, no. (%)</td>
<td>87 (4.07)</td>
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<tr>
<td>Total: infected or colonized, no. (%)</td>
<td>96 (4.49)</td>
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<tr>
<th>Table 2</th>
<th>Patient demographics and risk factors.</th>
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<tbody>
<tr>
<td></td>
<td>Preprotocol</td>
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<tr>
<td>N</td>
<td>96</td>
</tr>
<tr>
<td>Female, no. (%)</td>
<td>48 (50.0)</td>
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<td>Pre-term delivery, no. (%)</td>
<td>92 (95.8)</td>
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<td>Gestational age, no. (%)</td>
<td>&lt;36 weeks</td>
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<td></td>
<td>&lt;32 weeks</td>
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<td>Mode of delivery, no. (%)</td>
<td>C-section</td>
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<td></td>
<td>Birth weight (kg), mean ± SD</td>
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<td></td>
<td>Low birth weight (&lt;2.5kg)</td>
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<tr>
<td></td>
<td>Days to colonization, mean ± SD</td>
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<td>Mechanical ventilation, no. (%)</td>
<td>21 (21.9)</td>
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<tr>
<td>PICC line, no. (%)</td>
<td>66 (68.7)</td>
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<tr>
<td>Surgery, no. (%)</td>
<td>47 (49.0)</td>
</tr>
</tbody>
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SD, standard deviation; PICC, peripherally inserted central catheter.
References


Abbreviations and Acronyms

MRSA = methicillin-resistant *Staphylococcus aureus*; NICU = neonatal intensive care unit; GMMC = Greenville Memorial Medical Center

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