Nasopharyngeal Carriage of Methicillin-Resistant Staphylococcus aureus: Incidence and Outcomes in Pregnant Women

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Context: Infections due to methicillin-resistant Staphylococcus aureus (MRSA), especially community-acquired MRSA, have increased substantially during the past decade. The optimal protocols for screening patients, particularly during pregnancy, have not been determined.

Objectives: To determine the incidence of nasopharyngeal carriage of MRSA in pregnancy as well as whether there was a correlation between positive maternal screening test results and an increased risk of adverse maternal or neonatal outcomes, including neonatal carriage of MRSA.

Methods: The authors conducted a retrospective review of medical records from Rockford Memorial Hospital in Illinois between December 14, 2007, and July 14, 2008. All patients, who were pregnant women admitted to the hospital, and their newborns had nasopharyngeal swabs collected for MRSA detection. Numbers of neonatal intensive care unit admissions and results of neonatal sepsis evaluations were noted. Maternal postoperative infections and anesthesia-related complications were noted and compared to those of control patients. Apgar scores at birth were compared with those of a control group.

Results: Of 1045 patients who were tested, 31 patients (2.9%) had positive results for MRSA. By comparison, the hospital-wide MRSA prevalence for this period was 7.9% (569 positive results of 7206 patients tested). This prevalence was substantially higher than that noted for the study population. Twenty-three of the 31 patients (74%) delivered at our institution and thus comprised the study group. A control group comprised 46 patients with negative results of MRSA screening. No positive results of neonatal MRSA screening tests were noted in either group, and no statistically significant difference between the 2 groups existed in 5-minute Apgar scores, neonatal intensive care unit admissions, or neonatal sepsis evaluations. Positive MRSA-screening test results were associated with a statistically significant decrease in the provision of regional anesthesia to the pregnant women (P=.05).

Conclusion: Maternal nasopharyngeal carriage of MRSA was not associated with adverse maternal or neonatal outcomes, including neonatal MRSA carriage. Regional anesthesia was provided less frequently to MRSA-positive individuals. Further studies in larger groups of patients are needed to help determine the optimal management of MRSA-positive patients during pregnancy.


Methicillin-resistant Staphylococcus aureus (MRSA) (Figure 1) was first isolated in England in 1961. Historically, risk factors for MRSA include elderly patients aged 70 years or older, prolonged hospitalization, ventilatory support, indwelling catheters, and residence in long-term care facilities.1 People without these risk factors typically have community-acquired MRSA, which is most often characterized by soft-tissue infections, particularly cellulitis and abscesses.2 The risk factors for community-acquired MRSA differ greatly from those for hospital-acquired MRSA. In the past decade, MRSA has been reported in young and healthy people who lack the historical risk factors for hospital-acquired MRSA.3 Children and those who participate in close-contact sports are at increased risk. Other risk factors include poor hygiene, close living conditions, and sharing of personal items (eg, toothbrush).4 Pregnant women are susceptible to many of these risk factors.

The median age of patients with community-acquired MRSA is 30 years, compared with 70 years for patients with hospital-acquired MRSA. Patients with typical risk factors for community-acquired MRSA include children (especially those in day care), competitive athletes, homeless people, and intravenous drug users. Community-acquired MRSA is contagious and easily spread by direct contact. Unlike hospital-acquired MRSA...
MRSA, most community-acquired MRSA species have a leukocyte-destroying exotoxin, which is produced by the Panton-Valentine leukocidin locus, that causes tissue necrosis. This virulence factor leads to infection in nonimmunosuppressed, noncompromised healthy women. However, community-acquired MRSA typically responds to a broader range of non-β-lactam antibiotics than does hospital-acquired MRSA. MRSA is mostly responsible for aggressive skin and soft-tissue infections. Among antenatal and postpartum women, previous reports have increasingly noted infectious morbidity attributable to MRSA, including severe systemic infections, wound infections, mastitis, infected episiotomy sites, necrotizing pneumonia, and pyomyositis. Previous studies of pregnant women have analyzed vaginal cultures for the presence of S aureus and MRSA. The studies noted a 17% incidence of S aureus; 2.8% of affected patients had MRSA. Reports from obstetric populations have shown the emergence of community-acquired MRSA colonization of the perineum, rectum, and lower genital tract. The vulva is an area that is susceptible to infection because of the risks associated with shaving, waxing, and sharing of hygiene products.

The routine testing of pregnant women for MRSA colonization can create a large economic burden, especially if there is no appreciable benefit to testing. With the emergence of MRSA colonization, an important question is whether nasopharyngeal colonization places the neonate at increased risk for vertically transmitted, early-onset neonatal infection. The objective of the present study was to determine the incidence of nasopharyngeal carriage of MRSA in pregnant women. We also analyzed obstetric and neonatal outcomes in women with nasopharyngeal carriage of MRSA compared with those of nonpregnant women who presented to the hospital in the same period. Because many hospitals routinely screen for MRSA in all patients admitted, we reviewed the data to help determine the optimal care for patients during pregnancy. Our goals were to provide data on incidence and outcomes based on nasopharyngeal carriage, to determine whether there was a possible difference in outcomes, and if so, to ascertain what the effect would be for patients and neonates.

**Methods**

A retrospective cohort study of medical records of women in whom nasopharyngeal carriage of MRSA was diagnosed between December 14, 2007, and July 14, 2008, was conducted at Rockford Memorial Hospital in Illinois. This period was chosen for the present study because it was the start date of mandatory hospital MRSA screening of all patients admitted to the institution. The present study was reviewed and approved by the institutional review board at Rockford Memorial Hospital.

All pregnant women admitted to the hospital whose delivery records were available during the timeframe of the study were included. Patients were excluded from the study if delivery records were not available. Some patients were transferred to the hospital because of pregnancy complications and subsequently were discharged home without having delivered. If a duplicate record was noted (eg, a patient who had multiple hospitalizations during the pregnancy), the most recent record before delivery was used. Discrepancies were monitored by reviewing the database and the dates that testing occurred—when tests for which results were positive were repeated, the results remained positive; likewise, when tests with negative results were repeated, the results remained negative.

After the patient was admitted to the hospital, a nurse collected a nasopharyngeal sample as part of the standard admission protocol. Patients were identified as having or not having MRSA using laboratory data obtained at admission or complex samples by using real-time PCR and reverse transcriptase PCR assays. Results are available in 75 minutes. Costs for the test and labor are $42.78 and $1.65, respectively, for a total cost of $44.43 per patient. In general, the PCR results at our institution are not confirmed by culture. In the initial institu-

![Figure 1. Color-enhanced electron micrographic image of Staphylococcus aureus (×5320). Custom Medical Stock Photo.](https://www.custommedicalstockphoto.com)
tional validation of the Xpert PCR assay, concordance between PCR and culture results was 100%.

The medical records of patients with positive test results were reviewed. A control group of patients matched for gestational age was selected to meet the study parameters, such as unit admission and sepsis workup. For patients who delivered at full term, the control patients were the next 2 patients who delivered. For patients who delivered preterm, the next patient who delivered at a similar gestational age was used as a control patient.

Data were collected and compiled in a Microsoft Office Excel spreadsheet (version 2007; Microsoft Corporation, Redmond, Washington). Collected data included gravidity, parity, gestational age, mode of delivery, Apgar scores, number of days of hospitalization after delivery, neonatal intensive care unit admissions, neonatal MRSA results, neonatal sepsis evaluations, postoperative infections, type of anesthesia used, and evidence of regional anesthesia infections. Neonatal nasopharyngeal swabs were collected from all neonates. Neonates in the MRSA-positive group (ie, neonates with mothers who tested positive for MRSA), as well as all neonates admitted to the neonatal intensive care unit from both groups, had umbilical swabs collected in addition to nasopharyngeal swabs. In accordance with hospital protocols and excepting any complications, neonates admitted to the neonatal intensive care unit underwent testing within 2 hours of birth and those admitted to the newborn nursery underwent testing within 4 hours of birth.

Hospital charts were reviewed to note any evidence of postoperative infection, including endometritis, mastitis, urinary tract infection, or other types of infection. If performed, a positive microbiologic culture result would also satisfy criteria for postoperative infection, regardless of whether the infection was managed with antibiotics. Postoperative infection was assumed to be present if antibiotics were used for more than 24 hours after delivery. Anesthesiologists checked on patients the day after delivery and assessed and addressed any complications that occurred.

Decontamination protocols were provided by the infectious disease department at Rockford Memorial Hospital. The standard protocol involves application of mupirocin 2% ointment to the nares and the use of chlorhexidine skin preparation (Hibiclens; Mölnlycke Health Care, Norcross, Georgia) for 7 days while showering. The decision to implement decontamination was made at the discretion of the provider.

Descriptive statistics were used to summarize the characteristics of the patients and the prevalence of MRSA. Statistical analysis was performed using single-factor analysis of variance between the 2 groups, for each variable studied. Statistical significance was set at $P \leq .05$.

### Results

A total of 1146 patient records were initially identified and reviewed. A total of 101 duplicate records were noted and excluded, leaving 1045 records in the study. No discrepancies in the duplicate records were noted during the study. Thirty-one MRSA-positive patients were identified, for an overall incidence of 2.9%. Eight patients were excluded from further analysis because they either had early pregnancy loss ($n=2$) or were discharged home without delivering ($n=6$). The control group comprised 46 patients with negative MRSA screening test results who were matched for gestational age at delivery. The overall hospital-wide prevalence of MRSA during the study period was 7.9%—569 MRSA-positive patients were identified from 7206 total patients. This was a statistically significant difference in prevalence compared to the prevalence in the study population ($P<.05$).

The mean maternal age in the study group was 25 years, the mean parity was 2, and the mean gestational age at delivery was 36.5 weeks.

The obstetric outcomes of the MRSA-positive patients and the control group and the respective neonatal groups are summarized in the Table and Figure 2. No positive neonatal

### Table. Methicillin-Resistant Staphylococcus aureus in Pregnant Women and Neonates: Outcomes of Study Participants*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>MRSA-Positive (n=23)</th>
<th>Control (n=46)</th>
<th>$P$ Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mother</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days of Hospitalization, No.</td>
<td>2.63</td>
<td>2.37</td>
<td>.406</td>
</tr>
<tr>
<td>Cesarean Delivery</td>
<td>7 (30.4)</td>
<td>18 (39.1)</td>
<td>.486</td>
</tr>
<tr>
<td>Postoperative Infection</td>
<td>0</td>
<td>1 (2.2)</td>
<td>.484</td>
</tr>
<tr>
<td>Regional Anesthesia Provided</td>
<td>14 (63.6)</td>
<td>39 (84.7)</td>
<td>.050</td>
</tr>
<tr>
<td><strong>Neonate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-Minute Apgar Score, mean</td>
<td>8.59</td>
<td>8.57</td>
<td>.938</td>
</tr>
<tr>
<td>Admitted to NICU</td>
<td>7 (31.8)</td>
<td>13 (26.5)</td>
<td>.653</td>
</tr>
<tr>
<td>Sepsis Workup</td>
<td>4 (18.1)</td>
<td>9 (18.3)</td>
<td>.985</td>
</tr>
<tr>
<td>Positive for MRSA</td>
<td>0</td>
<td>0</td>
<td>NA</td>
</tr>
</tbody>
</table>

* Data are presented as No. (%) except where otherwise specified. 
† $P \leq .05$ denotes statistical significance.

Abbreviations: MRSA, methicillin-resistant Staphylococcus aureus; NA, not applicable; NICU, neonatal intensive care unit.
MRSA test results were noted for newborns born to women in either group. There was no statistically significant difference between groups with respect to 5-minute Apgar scores, number of days of hospitalization, neonatal intensive care unit admissions, neonatal sepsis workups, or postoperative infections. A statistically significant difference between the 2 groups was found when the number of patients who received regional anesthesia was analyzed.

One postoperative infection was noted in the present study in a patient in the control group who was treated for postpartum endometritis. A power analysis revealed that the sample size would need to be greater than 400 patients to study in a patient in the control group who was treated for postoperative infection. A patient in the control group had started decontamination but delivered previously, 1 patient in the study group began following the decolonization protocol but delivered before completing treatment. As mentioned previously, 1 patient in the study group began following the decolonization protocol but delivered before completing treatment. The decision to implement this protocol is left to the discretion of the primary physician.

Although some of the findings were expected, the present study is, to our knowledge, one of the first studies to evaluate and compare obstetric and neonatal outcomes in patients with nasopharyngeal MRSA carriage. No neonatal MRSA infections were noted in the present study. Apgar scores were similar in both neonatal groups, as were the rates of cesarean section and postoperative infection in the mothers.

One patient in the present report was classified as having postoperative infection. A patient in the control group had endometritis diagnosed and managed with intravenous antibiotics. Another patient in the control group was treated prophylactically because of a wound separation. This event was not classified as an infection because the culture results were negative despite the fact that the patient received antibiotics. We would assume that patients with MRSA colonization are

**Figure 2. Comparison of outcomes in neonates and in mothers who tested positive for methicillin-resistant Staphylococcus aureus (MRSA) vs controls. No neonates tested positive for MRSA. Abbreviation: NICU, neonatal intensive care unit.**

**Comments**

Although screening for MRSA at admission is becoming required in an increasing number of institutions, the data suggest that this practice may not be warranted in the obstetric population. At a cost of $44.43 per patient, testing can become a huge expense, one without any appreciable benefit. In the elderly population, which is much more at risk, the practice certainly has been well studied and proved beneficial. However, the obstetric population in general is younger and healthier. It would be reasonable to limit testing to patients with known risk factors.

Our institution initiated the universal screening policy because early identification of patients colonized with MRSA and subsequent prevention of patient-to-patient spread of MRSA through infection-control measures are believed to be potent interventions to control MRSA. According to 2007 data, the Rockford, Illinois, region had higher rates of MRSA-related hospitalizations than the Chicago area, though the region’s rate was lower than the national average rate. In Illinois, the MRSA Screening and Reporting Act went into law in August 2007. The statute requires Illinois hospitals to enforce contact-isolation precautions and hand hygiene policies, perform annual facility-wide infection-control risk assessments, and conduct active MRSA screening for all intensive care unit patients and other high-risk patients.

For patients who test positive for MRSA carriage, our institution has a decolonization protocol approved by the infectious diseases department. The decolonization protocol involves application of mupirocin 2% ointment (Bactroban; GlaxoSmithKline, Research Triangle Park, North Carolina) to the nostrils and the use of chlorhexidine skin preparations during showers. To be considered decolonized, a patient needs to have negative results of 2 sets of cultures performed at least 72 hours apart after completion of treatment. As mentioned previously, 1 patient in the study group began following the decolonization protocol but delivered before completing treatment. The decision to implement this protocol is left to the discretion of the primary physician.

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more likely to be treated with antibiotics, especially if there is a concern for potential wound infection.

The statistically significant difference in which patients received regional anesthesia was not expected. However, the reason for this difference may have been an anesthesia-related concern about the risk of skin or epidural infection associated with MRSA carriage. No infections due to regional anesthesia were observed in the present study. We hope that these findings will allow more patients to receive regional anesthesia in the future, if so desired.

**Limitations**

The present study has several limitations. Delivery data were available for only 23 of the 31 cases, which limits our analysis of obstetric complications. As a tertiary care center, our institution has admitted many patients who were transferred from elsewhere because of pregnancy complications, most commonly preterm labor. Many patients are stabilized and discharged home a few days or weeks later. The small population size may explain the low rate of obstetric complications. Only 1 postoperative infection occurred in the study. With the current overall low rate of postoperative infections, the sample size would need to be much greater to analyze this outcome in detail. Also, some infections may be noted and treated after the patient is discharged home. Recent practice changes involving providing prophylactic antibiotics 60 minutes before incision for women undergoing cesarean section have also been shown to decrease rates of infection in patients. Molecular typing was not performed. Such typing may have provided more information on community- vs hospital-acquired MRSA. Antibiotic susceptibility testing could also have been performed.

**Cost**

In an era in which medical costs are scrutinized, all practice measures should be analyzed with the goal of determining whether patient outcomes are improved by the measure. The true cost of screening goes beyond the simple cost of the test. The actual cost of testing increases when MRSA-positive patients are placed in isolation and when providers wear a gown and gloves each time they enter the room. Decolonization of patients is also an expensive endeavor.

Until there is a clear benefit to performing MRSA testing on all patients, MRSA testing should be further studied. Extrapolating the costs to an annual basis results in an annual institutional cost at Rockford Memorial Hospital of at least $150,000 for testing pregnant women. This amount does not include the additional costs of treatment or the cost of gowns and gloves worn by healthcare personnel. At this time, the point at which there would be value in standard testing is not clear. Targeted testing would appear to be the most beneficial method of testing. Patients with skin or wound infections may benefit from MRSA testing in addition to specific cultures. Identification of MRSA carriage may prompt consideration of more aggressive treatment of infection. Patients having cesarean delivery are at risk for wound infection, and there may be some benefit to screening this population, especially in the presence of other factors, such as obesity and diabetes. At this time, there are no standard recommendations for the preoperative management of patients colonized with MRSA.

**Follow-Up at Rockford Memorial Hospital**

Our institution has discontinued routine screening of all obstetric patients and has moved to risk-based screening. We have included as a guide an algorithm of the current protocol for testing used at our institution (**Figure 3** and **Figure 4**). All patients are screened by nurses at admission and are asked various questions, including the following:

- Do you have any skin lesions or infections?
- Do you have a personal history of MRSA infection?
- Do you or a close contact have a history of recent soft-tissue infection?
- Were you admitted directly from another institution?
- Have you been hospitalized in the past 3 months?
- Have you been incarcerated in the past 3 months?

A patient who responds positively to any of these questions is more likely to have MRSA and is therefore screened for MRSA. In addition, patients transferred to a high-risk unit, such as the intensive care unit, would be screened. Screening is warranted in infants in the neonatal intensive care unit because by nature of their prematurity or illness, they are more susceptible to infection.

Screening all or a high-risk subset of patients for MRSA at the time of admission to the facility or nursing unit is known as “active surveillance.” This strategy, which is used to control the transmission of such pathogens as MRSA, is widely practiced in northern Europe and Canada and is becoming more common in hospitals throughout the United States. The aim of active surveillance culture is to identify every patient who is colonized with MRSA and to use contact precautions to prevent the spread of MRSA to other patients or to healthcare workers. In a study conducted at Brigham and Women's Hospital in Boston, Massachusetts, routine performance of MRSA cultures at admission and the use of contact-isolation precautions resulted in a 67% hospital-wide reduction in MRSA bacteremia. As we look more closely at the cost of healthcare, it is imperative that we strive to treat patients holistically and on an individual basis rather than routinely follow protocols that increase costs to the system. These resources would best be used to provide patient care in other areas.

A future direction for studies would be to examine the concordance between nasopharyngeal and vaginal carriage of MRSA in pregnant patients. Rockford Memorial Hospital does...
not have a mandatory protocol for treatment or decontamination; however, future studies could incorporate treatment outcomes as well. Future studies will also attempt to monitor patients for 4 to 6 weeks after delivery. We will also examine whether our active surveillance testing yields a higher detection rate at our institution.

**Conclusion**

The findings of the present study do not support routine nasopharyngeal screening for MRSA in pregnant women. Although the sample size was small, the study did not show any difference in maternal and neonatal outcomes between the 2 groups. The present study is, to our knowledge, one of the first studies to evaluate neonatal outcomes in the context of maternal nasopharyngeal carriage of MRSA. With MRSA emerging as a more prominent cause of skin and soft-tissue infections, as well as remaining a cause of hospital-acquired infections, we recommend using a low threshold to test patients who seem at risk or who have developed an infection, to allow for appropriate and timely treatment, if needed. At this time, it appears that testing is best used for patients with evidence of infection. Most of these infections are identified in the postpartum period as either mastitis or wound infection of the perineum or surgical incision.
References


19. MRSA Screening and Reporting Act, Ill Com p Stat ch 210, §83.
