Implementation of a methicillin-resistant *Staphylococcus aureus* (MRSA) prevention bundle results in decreased MRSA surgical site infections


Michael E. DeBakey Department of Surgery, Baylor College of Medicine, and Michael E. DeBakey Veterans Affairs Hospital, Houston, TX, USA

**Abstract**

**BACKGROUND:** Methicillin-resistant *Staphylococcus aureus* (MRSA) surgical site infections (SSIs) increase morbidity and mortality. We examined the impact of the MRSA bundle on SSIs.

**METHODS:** Data regarding the implementation of the MRSA bundle from 2007 to 2008 were obtained, including admission and discharge MRSA screenings, overall MRSA infections, and cardiac and orthopedic SSIs. Chi-square was used for all comparisons.

**RESULTS:** A significant decrease in MRSA transmission from a 5.8 to 3.0 per 1,000 bed-days (*P* < .05) was found after implementation of the MRSA bundle. Overall MRSA nosocomial infections decreased from 2.0 to 1.0 per 1,000 bed-days (*P* = .016). There was a statistically significant decrease in overall SSIs (*P* < .05), with a 65% decrease in orthopaedic MRSA SSIs and 1% decrease in cardiac MRSA SSIs.

**CONCLUSION:** Our data demonstrate that successful implementation of the MRSA bundle significantly decreases MRSA transmission between patients, the overall number of nosocomial MRSA infections, and MRSA SSIs.

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**KEYWORDS:** MRSA; Surgical site infection; MRSA bundle

* Staphylococcus aureus is a ubiquitous organism found even as normal human flora. It can produce a variety of clinical presentations ranging from cellulitis to severe sepsis. Methicillin-resistant *Staphylococcus aureus* (MRSA) was first isolated in the early 1960s. A short 20 years later, the first community-acquired MRSA (CA-MRSA) infection was found in individuals who were not affiliated with healthcare centers. Crum et al demonstrated that since 2002, cases of CA-MRSA infections increased significantly, with intrafamilial transmission being a significant cause. Furthermore, locations such as daycare centers, prisons, and military installations, as well as intravenous drug abuse, facilitate the spread of MRSA.

Over the past decade, the prevalence of MRSA carriers has increased ranging from 3.7% to 20%.

Surgical site infections (SSIs) are defined as those infections presenting up to 30 days after a surgical procedure if no prosthesis is placed and up to 1 year if a prosthesis is implanted in the patient. In the United States, SSI is a serious complication with an incidence of 2% to 5% in patients undergoing...
surgery. Overall, SSI is the second most common nosocomial infection (24%); most cases are preventable by adhering to appropriate prevention practices. MRSA SSI has been known to significantly increase postoperative length of stay, cost, and mortality.

The Centers for Medicare and Medicaid Services (CMS) announced that after October 1, 2008 it will not compensate for preventable acquired conditions, including SSIs, after an elective surgical procedure, specifically mediastinitis after coronary artery bypass surgery. Beginning in October 2009, other conditions being considered for nonpayment include SSI after total knee replacement, *S. aureus* sepsicaemia, and *Clostridium difficile* infections. Also, CMS is considering adding MRSA infections to this list of conditions for nonpayment. Therefore, successful prevention measures against nosocomial infections must be implemented to improve patient outcomes by reducing morbidity and mortality.

Given these data concerning the high prevalence of MRSA SSI and potential high costs, surgeons must be informed not only of the current treatment options, but also of preventative measures for transmission in the hospital setting. In late 2006, our hospital implemented a MRSA prevention bundle to decrease MRSA transmission and nosocomial infections. Our objective was to examine the impact of the MRSA bundle on SSIs.

### Methods

After approval of the Baylor College of Medicine Institutional Review Board, patients were identified with MRSA infections at the Michael E. DeBakey Veterans Affairs Medical Center (MED VAMC). Data were collected from October 2005 to October 2008 and included demographic information, comorbid conditions, initial MRSA nasal screening results, each subsequent culture result on transfer to a different unit and at discharge, and presence of MRSA and/or *C difficile* infections.

The MRSA bundle was initiated in 1 medical unit in October 2006 and then implemented hospital-wide by October 2007. Data were collected retrospectively from October 2005 to October 2006, while November 2006 to October 2008 data were collected prospectively. The MRSA bundle has 5 components: (1) MRSA nasal screening of patients upon admission, transfer, and discharge; (2) contact isolation of positive patients; (3) standardized hand hygiene; (4) cultural transformation campaign with staff and leadership engagement through positive deviance; and (5) ongoing monitoring of process and outcome measures. MRSA screening was performed via nasal swab and analyzed by the GeneXpert MRSA polymerase chain reaction (PCR) assay (Cepheid, Sunnyvale, CA) with results available in 70 minutes. Descriptive statistics were used to summarize the characteristics of the patients, prevalence of MRSA per year, and rates of MRSA transmission. All data are presented as means ± SD. Univariate analysis was performed using the chi-square test.

### Results

From 2007 to 2008 all patients admitted to the MED VAMC were screened for nasal MRSA. During the study period, we observed a trend toward an increase in effectiveness in MRSA screenings on admission and discharge from 94% and 82% in 2007 to 95% and 86% in 2008, respectively (*P* = not significant [NS]). However, the prevalence of MRSA did not change and remained 18% of all admitted patients (Table 1). After implementation of the MRSA bundle there was not only a significant decrease in MRSA transmissions from 5.8 per 1,000 bed-days in 2007 to 3.0 per 1,000 beds days in 2008 (*P* < .05), but also a significant decrease in overall MRSA nosocomial infections from 2.0 to 1.0 per 1,000 bed-days (*P* = .016; Table 2). After implementation of the MRSA bundle, there was a statistically significant decrease in overall SSI (*P* <.05). Although not significant, the orthopedic MRSA SSI decreased by 65% (*P* = NS) and cardiac MRSA SSIs decreased by 1% (*P* = NS). We also observed a decrease in nosocomial MRSA bloodstream infections per 1,000 bed-days of care from 2.9 in 2006 to 2.5 in 2008 (*P* = NS).

Before the implementation of the MRSA bundle, the rate of hospital-acquired MRSA infections peaked at 7 per 1,000 bed-days of care. After the initiation of the MRSA bundle in a medical unit then subsequently hospital-wide, a decreasing linear trend was observed (Figure 1). In addition, the total *C difficile* infections, which were used as a surrogate for nosocomial infections, decreased, as did the rate after implementation of the MRSA bundle (Figure 2).

### Table 1 Prevalence and screening rates for admitted patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence of MRSA</td>
<td>18%</td>
<td>18%</td>
</tr>
<tr>
<td>MRSA screening on unit admission</td>
<td>94%</td>
<td>95%</td>
</tr>
<tr>
<td>MRSA screening on unit discharge</td>
<td>82%</td>
<td>86%</td>
</tr>
</tbody>
</table>

### Table 2 Impact of MRSA bundle on MRSA transmission and infection

<table>
<thead>
<tr>
<th>Variable</th>
<th>2007</th>
<th>2008</th>
<th><em>p</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA transmissions</td>
<td>5.8 per 1,000 BD</td>
<td>3.0 per 1,000 BD</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>MRSA infections</td>
<td>2.0/1,000 BD</td>
<td>1.0 per 1,000 BD</td>
<td>.016</td>
</tr>
</tbody>
</table>

BD = bed days.
Staphylococcus aureus has become a persistent pathogen in the community and hospitals throughout the world. The appearance of antibiotic resistance was first detected in 1961, giving rise to the term MRSA, and followed by the first documented CA-MRSA infection in 1980. Since then, the incidence and prevalence of MRSA has increased at alarming rates. According to data from the National Nosocomial Infection Surveillance System (NNIS) there has been a continued annual increase in MRSA cases with a peak increase of nearly 60% in 2004. In 2006, a 15-year study by Crum et al demonstrated an increase in incidence of CA-MRSA beginning in 2002—between 2002 and 2004 there was an over 200% increase in cases CA-MRSA preceded by 10 years of negligible change.

Our study illustrates that the prevalence of MRSA in admitted patients remained the same during the 2-year study period at 18% and is consistent with what has been reported in the literature. A recent prospective multicenter study found an overall MRSA colonization prevalence ranging from 3.7% to 20%, and specifically in surgical intensive care units (ICU), a prevalence of 10.3%. Furthermore, we observed an increase in effectiveness of MRSA screening from admission and discharge comparing both years of our study. We credit this increase in effectiveness to education of clinical staff in appropriate techniques of hand washing, measuring compliance with culture collections, and rapid PCR identification of MRSA-positive cultures. Outcome measures are tracked on each unit, and data are updated monthly. Meetings involving all staff are scheduled to discuss unit data, including admission swabbing rates, discharge/unit transfer swabbing rates, number of patients colonized, number of patients with healthcare-acquired infections, and hand hygiene compliance.

Several risk factors account for the rise in MRSA infections, including transmission in healthcare settings, over antibiotic-prescribing practices, and new, more virulent strains. Many investigators describe the carrier state of MRSA as an important risk factor for subsequent infection. Approximately 10%–40% of individuals without hospital contact are colonized with MRSA in their nares, and up to 7% of healthcare workers are also carriers of MRSA. The reservoir size has been identified as the dominant factor in the spreading of MRSA to new patients. Caregivers’ contaminated hands are accredited as the most frequent form of transmission. Transmission can occur by skin to skin contact or contact with contaminated inert objects such as stethoscopes and blood pressure cuffs. A recent study showed an increased risk of 4% among those patients whose prior room occupant was MRSA-positive. Therefore, prevention in transmission can be achieved with proper hand hygiene before moving to another patient, adequately disinfecting personal equipment such as stethoscopes, and thorough cleansing of hospital room daily and after patient discharge.

SSIs occur in 2%–5% of patients undergoing surgery in the United States. SSIs are responsible for an increase in hospital stay and mortality and are associated with significant costs, especially when the SSI is caused by resistant bacteria such as MRSA. The presence of an SSI doubles the risk of death, while the presence of an MRSA SSI increases the risk of death 11-fold after surgery. Seventy-seven percent of these deaths are caused directly by the SSI, with S aureus being the most common cause. A study by Anderson et al analyzing the impact of S aureus on SSI revealed an increase in mortality rates, longer hospitalization, and increase hospital cost in elderly patients when compared with uninfected patients with similar age. When SSI is caused by MRSA the hospital stay can increase by as much as 2 weeks. During 2005, a total of 1,010 SSIs occurred in a study of 26 hospitals, in which S aureus was found in as many as 331 (37%) patients, and of these 175 (53%) were due to MRSA. In this study, MRSA was the single most common pathogen isolated.

While the rising levels of MRSA are frightening, other issues are cause for alarm. The latest reports illustrated an increased incidence of invasive MRSA infection on people who had healthcare encounters within the previous year. MRSA’s high human and financial impact has led to na-
tional mandates of preventive measures and individual hospitals developing aggressive protocols to decrease nosocomial MRSA colonization and infection. In general, the costs of screening and preventive actions are less than the cost of caring for MRSA-infected patients. Different programs for MRSA infection control apply a combination of interventions rather than a single approach.

The Institute of Healthcare Improvement (IHI) recommends reducing MRSA infection by using the following 5 components of prevention: (1) hand hygiene; (2) decontamination of environment and equipment; (3) active surveillance cultures; (4) contact precautions for infected and colonized patients; and (5) device bundles, such as catheter-related bloodstream and ventilator-associated pneumonia bundles. Our MRSA bundle is identical to the 1 recommended and included an ongoing monitoring process and outcome measures. After implementation of the above MRSA bundle, we observed a significant decrease in MRSA transmission and overall MRSA nosocomial infection rate. Our results correlate with other published reports, specifically a recent study by Huang et al, which demonstrated a decrease (75%) in MRSA bacteremia after implementation of nares surveillance of MRSA and contact isolation precautions in ICU patients during admission and weekly thereafter. Another study showed a decrease of 70% in MRSA infections in 1 patient care unit after implementation of a “bundle of interventions.”

Overall, our SSI rate significantly decreased after implementation of the MRSA bundle with an observed decrease in cardiothoracic and orthopedic surgery patients. To our knowledge this is the first report demonstrating this effect. This observed decrease correlates with a decrease in transmission of MRSA in the hospital, as well as a general decrease in nosocomial infections. This can be attributed to improving infection awareness and compliance with hygiene practices.

It is important to emphasize that prevention measures cannot only decrease MRSA prevalence but also affect other antibiotic-resistant pathogens such as vancomycin-resistant enterococci and C difficile. The cases of MRSA and C difficile infection during the study period decreased after the MRSA bundle was implemented. Some authors attributed this to decreased use of MRSA antibiotics, such as clindamycin, since these antibiotics predispose patients to C difficile infections. However, we think the decrease in C difficile infections is because of the bundle implementation, especially the compliance with hand hygiene and increased attention to environmental cleaning.

The limitations of the study include that MRSA screenings were performed using PCR analysis, which allowed for rapid identification of MRSA from the nares but did not allow for genetic testing of the isolates to determine if they were community- versus healthcare-associated strains. For screening it is not imperative to identify the strain of MRSA since isolation precautions will be undertaken for any positive patient as part of the bundle. However, when an infection does occur, genetic information regarding the MRSA isolate may be helpful in treatment options. Another limitation was the use of administrative data from the Infection Control database, which did not allow for accurate length of stay data to determine the impact of cost secondary to an MRSA SSI. However, Engemann et al estimate that an MRSA SSI costs approximately $118,500 compared with $73,000 for a methicillin-sensitive S aureus (MSSA) infection. The difference of approximately $45,000 per infection can result in a significant cost savings even if 1 infection is prevented using the MRSA bundle.

In summary, our data demonstrate a significant decrease in MRSA transmission between patients, as well as a decrease in the overall number of nosocomial MRSA infections and MRSA SSIs after a hospital wide implementation of a MRSA prevention bundle. Additional studies on earlier identification of MRSA positive patients undergoing a surgical procedure through preoperative screening may decrease the incidence of MRSA further and will be the next step in our campaign against SSIs.

References