

# The Growing Problem of Methicillin-resistant *Staphylococcus aureus*: Will Hospitals Prevail?

Lynn McNicoll, MD, and Maureen Marsella, RN, CCM, CPC

**Mr. B, a 76-year old previously healthy** and active white man, suffered a severe burn to his back when his shirt caught fire. He had a history of hypertension and mild emphysema from a 40 pack-year smoking history. His only medications at baseline were a diuretic and inhalers. After a few weeks on the trauma service, he transferred to the medicine service. Pain management remained difficult, and multiple trials of different narcotics did not relieve his suffering without significant side effects. His respiratory status worsened slightly and he developed delirium. On hospital day 18, his respiratory status continued to worsen, a sputum culture grew **Methicillin-resistant *Staphylococcus aureus* (MRSA)**, and he was started on Vancomycin. The following day, his respiratory status deteriorated further, prompting transfer to the intensive care unit and intubation. He developed sepsis followed by multi-organ failure, and died two days later despite aggressive critical care management.

**Hospital-acquired healthcare-associated infections (HAIs)** such as MRSA increasingly surface in acute care in hospitals worldwide; Rhode Island is no exception. This review will discuss the epidemiology of MRSA, its consequences, and several strategies for dealing with this escalating problem.

## EPIDEMIOLOGY OF MRSA

### Prevalence

First described in the early 1960s, *Staphylococcus Aureus* quickly spread, causing outbreaks worldwide, and has since evolved into five different strains, including MRSA. In the early 1970s, MRSA accounted for only 2% of all *Staphylococcus Aureus* hospital-acquired HAIs. However, according to recent estimates, MRSA now accounts for 60%-70% of these infections,<sup>1,2</sup> and a 10-state study of emergency room patients reports that *Staphylococcus aureus* caused 76% of soft tissue infections, 59% from MRSA.<sup>3</sup> Although 1997-2007 data show that MRSA central line-associated blood

stream infections have declined by 50%, the percentage of MRSA *Staphylococcus* infections has increased to almost 70%.<sup>9</sup> Nationally, of the more than 94,000 patients who developed invasive MRSA infections in 2005 (a rate of 32 per 100,000 patients), about 20% died of MRSA during a hospital stay.<sup>4</sup>

### Incidence

There is significant inter-state variability in MRSA incidence.<sup>3,5,6</sup> A large prevalence study of 1,187 healthcare facilities in the US in 2006 showed the increasingly high MRSA colonization/infection rates in New Hampshire, New York, South Carolina, Maine, Delaware, Rhode Island, and Hawaii.<sup>5</sup> Rhode Island's rate of MRSA colonization or infection was 83.5 per 10,000 inpatients with 12 hospitals participating, while the national rate of MRSA colonization or infection was 46.3 per 10,000 inpatients. Importantly, hospital-acquired MRSA tends to be more virulent compared to community-acquired MRSA and has more drug resistance.

### Risk Factors

Even among patients not colonized with MRSA, the greater their antibiotic exposure, the greater their risk for the subsequent development of MRSA colonization or infection. Cephalosporins and fluoroquinolones are particularly implicated.<sup>7</sup> Once present, MRSA forms a biofilm on foreign objects, increasing the difficulty in eradicating the organism. For example, MRSA can form a biofilm and replicate on surfaces such as urinary catheters and endotracheal tubes, thus increasing the duration of antibiotic exposure needed to clear it, further increasing the risk of antibiotic resistance.<sup>7</sup>

Several patient populations present a high risk for MRSA colonization or infection. Although Klemens et al. found that most MRSA infections were healthcare-associated (85%), the majority began in the community among people with health risk factors such as:

(1) the presence of an invasive device, (2) a history of MRSA, or (3) a history of surgery, hospitalization, dialysis, or nursing home stay in the previous 12 months.<sup>4</sup> Additional patient risk factors for invasive MRSA infections included age 65 years or older, black race, and male gender.<sup>4</sup> Additionally, Mermel et al.'s multicenter study identified the following risk factors for MRSA colonization: older persons living in long-term care facilities (20%), HIV-infected patients (16%), and patients on hemodialysis (15%).<sup>8</sup> One reason for the higher MRSA risk in these patient populations as compared to the general population derives from their propensity to carry MRSA in their nares.

### Burden of Infection

MRSA infections can be both deadly and costly: patients with MRSA have a higher risk of skin and soft tissue infections, surgical site infections, pneumonia, longer hospital stays, healthcare costs, and mortality.<sup>3,4,5,6,9</sup> One study estimates that 19,000 people died of MRSA during hospital stays in 2005;<sup>4</sup> another calculates that the standardized mortality rate for invasive MRSA in 2005 to be 6.3 patients per 100,000.<sup>7</sup> A hospital-acquired MRSA infection costs about \$35,367, as compared with \$13,973 for other hospital-acquired HAIs.<sup>10</sup>

## MANAGEMENT OF MRSA

The inter-state variability in MRSA incidence<sup>3,5,6</sup> may partially relate to the different strategies used to identify MRSA colonization or infection (e.g., targeted screening vs. active surveillance), but also suggests significant opportunity to improve MRSA management using the tactics below.

### Prevention

Strategies to prevent the spread of MRSA are summarized in Table 1 and referenced in Mermel's companion article.<sup>11</sup> These strategies are included in several evidence-based guidelines and

**Table 1: MRSA Prevention Strategies**

STRATEGY	DETAILS
Hand Hygiene	<ul style="list-style-type: none"> <li>• Use alcohol-base hand rub before and after patient contact</li> <li>• Wash with soap and water if:               <ul style="list-style-type: none"> <li>– hands are soiled, after using the restroom, before eating, or if contact with a patient contaminated or infected with <i>Clostridium difficile</i></li> </ul> </li> <li>• Gloves when appropriate and wash hands after glove use</li> <li>• Educate on importance of hand hygiene and address barriers</li> <li>• Audit hand hygiene compliance, and provide feedback</li> </ul>
Isolation / Barriers with Identified Patients	<ul style="list-style-type: none"> <li>• Use universal precautions for handling body fluids</li> <li>• Wear gowns/gloves</li> <li>• Use masks for respiratory MRSA infections</li> </ul>
Clothing/Personal Attire	<ul style="list-style-type: none"> <li>• Avoid ties</li> <li>• Avoid loose fitting long sleeves</li> <li>• Do not allow fake nails</li> <li>• Launder lab coats frequently (or avoid them altogether)</li> <li>• Clean medical equipment often, especially stethoscopes</li> </ul>
Environment	<ul style="list-style-type: none"> <li>• Follow strict room decontamination procedures as 75% of surfaces in patient rooms are contaminated with MRSA</li> </ul>
Active Surveillance of MRSA	<ul style="list-style-type: none"> <li>• Screen most patients on admission, prior to joint replacement surgery, and on admission to a critical care unit</li> <li>• Ideally, screening upon discharge from the hospital (may be cost prohibitive)</li> <li>• Active treatment for nares decolonization of MRSA patients may be initiated with Mupirocin to each nostril twice daily for five days</li> </ul>
Antibiotic Stewardship	<ul style="list-style-type: none"> <li>• Avoid antibiotics for viral or benign processes (e.g. viral sinusitis, asymptomatic bacteriuria in older persons)</li> <li>• Use narrow-spectrum antibiotics when appropriate (avoid cephalosporins and fluoroquinolones)</li> <li>• Reduce the duration of antibiotics when appropriate (e.g. typical urinary tract infections only require three days of treatment or less than 24 hours post surgical intervention)</li> </ul>
Culture Change	<ul style="list-style-type: none"> <li>• Implement TeamSTEPPS™ (see Table 2)</li> </ul>

Studies have shown that hand hygiene quality improvement initiatives can effectively improve hand hygiene compliance and result in a concomitant decrease in hospital-acquired HAIs.<sup>12,13</sup>

**Active Surveillance**

Most studies related to MRSA prevalence refer to infection, rather than colonization, because of limited MRSA active surveillance. Hospitals now usually screen only select populations of patients on admission, and only retest for certain indications. Targeted populations include patients admitted to a critical care unit or awaiting elective joint replacement surgery and other high-risk elective surgeries where foreign objects remain in the body. Due to the absence of universal active surveillance at admission or discharge, the true incidence and prevalence of hospital-acquired MRSA colonization remains unknown.

Active surveillance benefits patients by identifying those who need decolonization and isolation precautions to reduce spread to others. During a hospital outbreak or a cluster of surgical site infections, hospitals must implement more aggressive active screening in a systemic manner within the hospital and perhaps the surrounding healthcare community, such as receiving facilities. However, experts' debate about the cost-benefit proposition regarding screening healthy community-dwelling patients at low risk for MRSA colonization continues, with opponents citing hospitals' shrinking resources and financial struggles. Proponents argue that the cost to the hospital for surveillance will be outweighed by the substantial costs avoided by the reduction in surgical site infections and hospital-acquired HAIs; and so the debate rages on.

supported by all the relevant infectious disease and healthcare organizations.<sup>10,12,13</sup> Experts agree that, among prevention strategies, hand hygiene persists as the single most important to prevent transmission of MRSA and other hospital-acquired HAIs.<sup>13</sup> Most hospital patient-to-patient MRSA transmissions occur via the contaminated hands of direct care workers.<sup>13</sup> Although hand hygiene seems intuitively important, compliance rates remain below 50% in

general for healthcare providers.<sup>13</sup> As detailed by Mermel,<sup>11</sup> alcohol-based hand rubs are comparatively more effective against MRSA than hand-washing, easier to accomplish, and lead to greater compliance; they do not work well for *Clostridium difficile*, the organism responsible for antibiotic-related diarrhea (and discussed in Pop-Vicas's companion article),<sup>14</sup> resulting in some confusion among healthcare providers about the best hand hygiene method.

**Culture Change**

Many studies have demonstrated comparatively greater success when quality improvement initiatives use adaptive activities and interventions in conjunction with concrete policies and measures, and optimized institutional culture ensures that all participants incorporate new policies into practice and recognize their empowerment to make change. This change in culture often proves to be the most difficult aspect of any qual-

**Table 2: TeamSTEPPS™ Strategies for Culture Change**

STRATEGY	DESCRIPTION
<b>CUS</b> “Stop the line”	<ul style="list-style-type: none"> <li>• I am <b>C</b>oncerned</li> <li>• I am <b>U</b>ncomfortable</li> <li>• This is a <b>S</b>afety issues</li> </ul>
<b>Two-Challenge Rule</b>	<ul style="list-style-type: none"> <li>• Assertively voice concern at least <i>two times</i></li> <li>• Team member must acknowledge concern</li> <li>• If the outcome is unacceptable: take a stronger course of action</li> </ul>
<b>DESC</b>	<ul style="list-style-type: none"> <li>• <b>D</b>escribe the specific situation</li> <li>• <b>E</b>xpress how the situation makes you feel</li> <li>• <b>S</b>uggest other alternatives – seek agreement</li> <li>• <b>C</b>onsequences should be stated in terms of impact – strive for consensus</li> </ul>
<b>SBAR</b>	<ul style="list-style-type: none"> <li>• <b>S</b>ituation – What is going on with the patient?</li> <li>• <b>B</b>ackground – What is the clinical background?</li> <li>• <b>A</b>ssessment – What do I think the problem is?</li> <li>• <b>R</b>ecommendation/Request – What would I do to correct it?</li> </ul>
<b>Other Communication Strategies</b>	<ul style="list-style-type: none"> <li>• <b>Call-Out</b> – used for critical information such as patient identification</li> <li>• <b>Check Back</b> – assuring that receiver has understood the message and provides repeat-back of the message</li> <li>• <b>Hand-Off</b> - “I PASS THE BATON”</li> </ul>

ity improvement initiative to achieve, but also the most important to realize sustainable behavior and process change. As part of the Centers for Medicare & Medicaid Services’ (CMS’s) national patient safety initiative to reduce MRSA infections, hospitals across the country have implemented the TeamSTEPPS™ approach to improve culture.<sup>15</sup> TeamSTEPPS™ is an evidence-based teamwork system aimed at improving communication and teamwork skills among healthcare professionals. Developed by the Department of Defense’s Patient Safety Program in collaboration with the Agency for Healthcare Research and Quality, TeamSTEPPS™’s scientific roots come from more than 20 years of research and lessons from the application of teamwork principles. Its key principles include optimizing leadership, delineating team structure, enhancing situation monitoring and mutual support, and optimizing communication. Although not specific to MRSA prevention, the core strategies outlined in Table 2 are associated with reduced MRSA prevalence in hospitals participating in CMS’s initiative.<sup>15</sup>

**RHODE ISLAND INITIATIVES**

Although incidence and prevalence of MRSA increasingly result in concern from healthcare professionals and the lay public, alcohol-based hand rubs effectively kill MRSA thus making it, theoretically, controllable. Rhode Island hospitals have implemented numerous formal and informal initiatives to reduce hospital-acquired colonization and infection.

**Surgical Care Improvement Project**

For nearly a decade, all 11 of Rhode Island’s acute care hospitals have participated in the **Surgical Care Improvement Project (SCIP)**, a national partnership of organizations interested in improving surgical care by significantly reducing surgical complications. SCIP uses an interdisciplinary team approach to reduce surgical site infections, and CMS publicly reports results for a series of related metrics on the website of Hospital Compare.<sup>16</sup> Overall, Rhode Island hospitals’ aggregate results rank high nationally in ensuring timely and accurate antibiotic administration and discontinuation relative to surgical procedures. Rhode Island hospitals have accomplished particularly

remarkable results regarding: the provision of the right antibiotic for the surgical intervention (98%); antibiotic administration within one hour of surgical incision (95%); and antibiotic discontinuation within 24 hours of a surgical intervention (94%), designed to reduce the antibiotic burden.<sup>16</sup> The Commonwealth Fund ranks Rhode Island in the top 10 states in the US for surgical site infection prevention measure performance.<sup>17</sup>

**Patient Safety Initiative**

As part of the CMS’s national patient safety initiative (described above), two area hospitals are collaborating with Quality Partners of Rhode Island, the state’s Medicare Quality Improvement Organization, to pilot a project to reduce the rates of MRSA colonization, transmission, and infection. Both hospitals’ teams have received extensive TeamSTEPPS™ training and are using a MRSA change package to focus improvement efforts primarily on their critical care units. The intervention includes: (1) initiating active surveillance, as well as pre-admission active surveillance and decolonization for high risk populations and procedures, (2) following aggressive hand hygiene protocols, (3) ensuring adherence to strict contact precautions, (4) improving antibiotic stewardship, (5) improving equipment and environment decontamination, and (6) promoting cultural transformation. This pilot aligns with many national health care improvement initiatives and requirements related to reducing or eliminating hospital-acquired HAIs.

**Audit and Feedback**

All of Rhode Island’s hospitals have rigorous infection control programs that include audit and feedback of hand hygiene practices, providing feedback to both healthcare professionals and hospital leadership. The Rhode Island Department of Health’s HAI public reporting program, described in Thomas’s article,<sup>18</sup> releases information about hospitals’ hand hygiene processes annually to focus public attention on this topic and encourage hospitals to improve. In addition to performing audit and feedback in a proactive, blameless manner (consistent with quality improvement principles), hospitals increasingly are reporting individual offenders to their supervisors.

## CONCLUSIONS

Although MRSA is an increasing focus in the literature, lay press, and the state's public reporting efforts, it poses several challenges for hospitals. Financial constraints, increasing demands, and overworked and stressed workforces are common barriers to quality improvement initiatives; and physician, nursing, and executive champions are required for the successful implementation of any hospital-wide initiative, such as the control of MRSA. The pessimists will say that the battle will never be won, that we will never eliminate multidrug-resistant organisms and these organisms are getting stronger and more virulent by the day.

However, because MRSA-related deaths are preventable, the optimists counter that we have no choice but to do our best to implement system-wide strategies to control MRSA. Patients like Mr. B deserve our best efforts. Even the best protocols and policies are ineffective unless the culture in the institution does not allow these scenarios to occur. Ideally, the medical resident would feel empowered to inform the attending that she

had not used the alcohol rub to disinfect her hands, or the nurse would stop the surgeon from gowning because she noticed that he contaminated his hands after scrubbing. With the specter of Vancomycin-resistant *Staphylococcus aureus* in the horizon, the issue becomes even more pressing and the race to control MRSA and other *Staphylococcus aureus* strains even more imperative.

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Lynn McNicoll, MD, is Assistant Professor of Medicine, The Warren Alpert Medical School of Brown University.

Maureen Marsella, RN, CCM, CPC, is Senior Program Program Coordinator, Quality Partners of RI.

## Disclosure of Financial Interests

The authors and/or significant others have no financial interests to disclose.

## CORRESPONDENCE

Lynn McNicoll, MD  
Division of Geriatrics  
Rhode Island Hospital  
593 Eddy Street, POB 438  
Providence, RI 02903  
Phone: (401) 444-5248