

# Case Study: An MRSA Intervention at Evanston Northwestern Healthcare

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**M**ethicillin-resistant *Staphylococcus aureus* (MRSA) is now endemic in many hospitals in the United States,<sup>1,2</sup> and with rising rates can be considered epidemic in most areas of the country. Colonization with this organism is associated with increased risk of disease,<sup>3</sup> which is associated with high cost<sup>4</sup> and poor clinical outcomes.<sup>5</sup>

We developed a comprehensive MRSA control plan on the basis of the Institute for Healthcare Improvement (IHI)'s five components to MRSA control (Table 1, page 733),<sup>6</sup> of which active surveillance and contact isolation proved most important. In this article, we describe the planning, introduction, and impact of nasal MRSA surveillance.

## Setting

Evanston Northwestern Healthcare (ENH) is a three-hospital organization in the immediate northern suburbs of Chicago with approximately 40,000 annual admissions, 75 affiliated off-site offices, 450 staff physicians, and more than 1,000 affiliated physicians.

■ Hospital 1, a 476-bed academic facility with multiple residency programs, has a high proportion of surgical patients.

■ Hospital 2, a primary care teaching hospital with 143 beds, serves a large population of elderly long term care facility residents.

■ Hospital 3 is a community hospital with 239 beds.

There are 45 intensive care unit (ICU) beds overall at

the three hospitals. The organization has a well-supported infection control department, including a full-time physician epidemiologist, a director of infection control, 4.5 full-time equivalent (FTE) infection control professionals, an administrative assistant, and 3 laboratory personnel dedicated to support the infection control patient safety effort.

An overall time line that integrates the important events in the MRSA infection reduction program is provided in Figure 1 (page 736). In 2002–2003, ENH began detecting small clusters of patients with MRSA infection, which seemed to be increasing in frequency. In February 2003, a pilot project that used MRSA nasal surveillance testing on all Evanston Hospital ICU admissions and discharges was initiated. After one year, this pilot identified 22 patients as MRSA carriers, including 8 transmissions of MRSA during their ICU stay. The infection control department then performed an organizationwide MRSA colonization point prevalence in August 2004. Clinical leadership was involved with the design of the investigation and pledged that necessary interventions would be established if MRSA prevalence was high. The point prevalence survey detected MRSA colonization in 8.5% of inpatients, some threefold higher than the 2.7% reported by Jernigan and colleagues from an admission MRSA prevalence survey done a few years earlier.<sup>7</sup> In addition, 65% of the inpatients identified as MRSA carriers were not previously known to our infection control program. These findings started the planning process in motion to

deploy our MRSA reduction initiative.

During the initial planning process, it was appreciated that a comprehensive MRSA control program would be costly. However, because ENH had already adopted a systemwide electronic surveillance service designed to detect health care–associated infection (HAI) outbreaks,<sup>8</sup> which had the capability of assessing financial loss associated with HAI, a cost-benefit analysis could be readily performed. This tool had already been used to help ENH leadership appreciate the considerable cost (loss) resulting from HAIs and provided a means of projecting savings if HAIs could be prevented. This realization provided confidence that a well-planned MRSA control program would not only be clinically beneficial but also economically viable and provided the groundwork for developing a business plan for the new program.

## Developing the Intervention

### ADMISSION MRSA SURVEILLANCE ISOLATION AND DECOLONIZATION

The successful management of MRSA has been accomplished at the national level<sup>9–10</sup> in the Nordic countries. The Dutch experience supports the effectiveness of decolonization using mupirocin ointment and disinfectant bathing.<sup>11</sup> Thus, we decided to develop an admission MRSA surveillance isolation and decolonization program, with the novel innovation of using molecular diagnostics, which would be modeled after similar “search and destroy” programs established in northern European countries. A report by Raboud and colleagues was helpful in the planning; they described a model for determining the effectiveness of rapid molecular testing in an MRSA surveillance program and the clinical outcome required to recover the cost of surveillance for admitted patients.<sup>12</sup> An internal review of the excess cost of MRSA bloodstream infection (BSI) was performed on the records of our patients from 2004 that was consistent with the excess medical cost calculations from Raboud et al., and this information was then used to construct the business plan for our program that projected cost and benefit for a two-year time period.

### LEADERSHIP TEAM

The initial leadership team, created in January 2005, consisted of the health care epidemiologist [L.R.P.], the senior vice president of nursing, the senior vice president

Table 1. IHI's Five Key Components to MRSA Control and their Status at ENH\*

#### 1. Hand Hygiene

**ENH Program:** There is an active program that includes all recommended aspects, including staff; ready availability of sinks, soap, and alcohol dispensers placed in convenient locations; and real-time feedback of compliance to health care providers. Despite this, hand hygiene compliance is no better than the approximate 50% reported by other health care providers in the Chicago area.<sup>†</sup>

#### 2. Decontamination of Environment and Equipment

**ENH Program:** The environmental services personnel are thoroughly trained and have checklists that instruct them on how the various hospital areas and equipment are to be cleaned and disinfected. Observations and environmental cultures (looking for MRSA and VRE) that were performed by infection control found the cleaning performed to be satisfactory and effective at removing the targeted pathogens from the environment.

#### 3. Active Surveillance

**ENH Program:** This was effective and is described in the text.

#### 4. Contact Precautions

**ENH Program:** This was effective and is described in the text.

#### 5. Device Bundles

**ENH Program:** Although our monitored infection rates are low for this aspect of care, the bundles to further reduce infection related to central lines and mechanical ventilation are under development and measurement validation is nearing completion. They will be implemented by the end of 2007.

\* IHI, Institute for Healthcare Improvement; MRSA, methicillin-resistant *Staphylococcus aureus*; ENH, Evanston Northwestern Healthcare; VRE, vancomycin-resistant enterococci.

† Hayden M.K., et al.: Reduction in acquisition of vancomycin-resistant enterococcus after enforcement of routine environmental cleaning measures. *Clin Infect Dis* 42:1552–1560, Jun. 1, 2006; Lankford M.G., et al.: Influence of role models and hospital design on hand hygiene of healthcare workers. *Emerg Infect Dis* 9:217–223, Feb. 2003.

of quality, and one of the three hospital presidents. Frequent multidisciplinary meetings were held to design and launch the initiative. Members were also drawn from infection control, infectious disease, internal medicine, nursing, information systems, information technology, building management, environmental services, pathology and laboratory medicine, and finance. The health care epidemiologist developed the program, including informational handouts for health care staff and patients about MRSA, an instructional document and training video on

how to swab the nose, and the design of order sets for MRSA surveillance swabbing as well as for the decolonization protocol.

### STRATEGIES

When the universal surveillance program for MRSA was deployed, ICU admission surveillance was already in place at all three of the hospitals. These ICUs had gained knowledge that would help facilitate the initiative and served as models for the other patient care areas. Specifically, we were aware of the issue of noncompliance (initially only 67% in the ICUs), and so a series of strategies was developed to ensure maximal buy-in before rolling out universal surveillance:

- Recruitment, education, and involvement of nursing leadership at each hospital in the program
- Promulgation of educational documents and video for staff and patients
- Grand rounds for physicians
- Documented education with annual competency evaluations for the patient care technicians, who were primarily performing the swabs
- Streamlined computerized test order entry
- Development of a test kit that included a swab and instructions placed in each patient room prior to admission
- Real-time surveillance compliance with feedback and education to nursing units with suboptimal testing rates

### GOALS

The project's goals were developed by the initial leadership team and included in the business plan. The two overarching goals, determined on the basis of the published literature and the resource capacity of the organization, were as follows:

- Demonstrate a clinical benefit by reducing MRSA HAI (this was the driving force behind the program).
- Be at least cost neutral.

On the basis of the likely time required to show a clinical benefit from published data, these goals were to be achieved no later than two years into the program. In fact, they were achieved by the end of Year 1 (described later). As part of the planning process, outcome measures or milestones were developed that were to be monitored (Table 2, page 735). Cost analysis was to be conducted by

the finance department and the program leadership.

### DATA MONITORING AND TRAINING

Infection control was responsible for (1) data monitoring to assess compliance with goals and (2) training of nursing personnel to perform and process nasal swab surveillance orders. The epidemiologists were responsible for the generation of performance reports to be distributed to the corporation president, the chief financial officer, and the chief executive officer. Globally, the information was internally and externally (regionally and nationally) disseminated through presentations as well as planned publications in the professional literature. These latter functions served to keep the leadership current with the medical literature and thus assist them in understanding ongoing developments at other organizations. In the program's final model, the only staffing additions required were 1.4 FTE personnel to the laboratory to perform the needed MRSA testing 7 days per week.<sup>13</sup>

## Implementing the Improvement Project

### CRITICAL ISSUES

The planning phase (January–June 2005) identified the following critical issues that would need to be resolved before initiating the program:

- Patient education information regarding testing and MRSA colonization; this information was eventually placed into the patient information handbook given to all those admitted to our hospitals.
- Development of streamlined order sets for testing, decolonizing, and isolation
- Development of a process to cosign verbal orders (when needed)
- Development of an employee education tool to include swabbing instructions
- Ensuring there were sufficient isolation carts and related waste containers for the expected increase in patients isolated (this increase was measured to be 20% after the program began)
- Addressing any needed staffing changes
- Determining nasal MRSA testing methodology

### WHICH TEST TO USE?

The decision as to which test to use in the laboratory

was a major consideration. Traditional assays require two to three days for MRSA detection. If facilities can use preemptive isolation (guilty until proven innocent), then the time to a result is not an issue. However, many facilities are not architecturally designed to accommodate this protocol, so isolation only occurs after tests are positive.<sup>14,15</sup> Newer methods such as real-time polymerase chain reaction (PCR) have in-laboratory turnaround times for positive results of about two hours if performed soon after specimen collection. However, most hospitals are not staffed for real-time production, and so tests are batched. This approach can still return results in less time than traditional testing; ENH can report the result from screening tests in approximately 0.5 days, presenting the possibility of modifying the traditional need for preemptive isolation. Also, real-time PCR is significantly more sensitive<sup>13</sup> but has a catalog price approximately 2½ times that of optimal agar testing. Ultimately, because the enhanced sensitivity and rapidity of PCR testing offered the opportunity to only place patients into contact isolation after a positive result was obtained (rather than preemptively), this test method was chosen. We also modified the preanalytical test procedure so that laboratory testing required three minutes of hands-on time for each determination, enabling all screening to be done by a single person in the laboratory each day.<sup>13</sup> This represented the only additional personnel needed for the MRSA reduction program.

### THE MONTH BEFORE

One month before the MRSA program began on August 1, 2005, all materials, supplies, and personnel were in place. Training was done during the final planning month, as was validation of the MRSA testing and practicing of all elements undertaken to make certain the planned processes would actually work. The need for careful planning and practice in large undertakings<sup>16</sup> proved true for the new MRSA program.

## Results

### TESTING COMPLIANCE

Compliance with testing should be monitored. Initial compliance with admission testing was approximately 80%. By the end of the program's first year, electronic reminders had been added to the nursing unit computer screens, and compliance increased to > 90% and has been

**Table 2. Planned Outcome Measures (Milestones) for the ENH MRSA Control Program\***

1. Performance measurements (90% compliance was set as the goal for a and b)
  - a. Compliance with admission testing
  - b. Compliance with prescription of decolonizing therapy
  - c. Monitoring of MRSA laboratory test performance†
2. Outcome measurements
  - a. Reduction of health care–associated BSI (as a surrogate for overall MRSA HAI reduction)
    - A statistically significant reduction of BSI was the goal of this measure.
  - b. The monitoring of admission MRSA colonization prevalence
    - As an observation of potential community population impact
  - c. An eventual repeat point prevalence of inpatient MRSA colonization‡
    - As a measure of served population impact

\* MRSA, methicillin-resistant *Staphylococcus aureus*; ENH, Evanston Northwestern Healthcare; BSI, bloodstream infection; HAI, health care–associated infection.

† Paule S.M., et al.: Performance of the BD GeneOhm methicillin-resistant *Staphylococcus aureus* test before and during high-volume clinical use. *J Clin Microbiol* 45:2993-2998, Sep. 2007. Epub Jul. 11, 2007. .

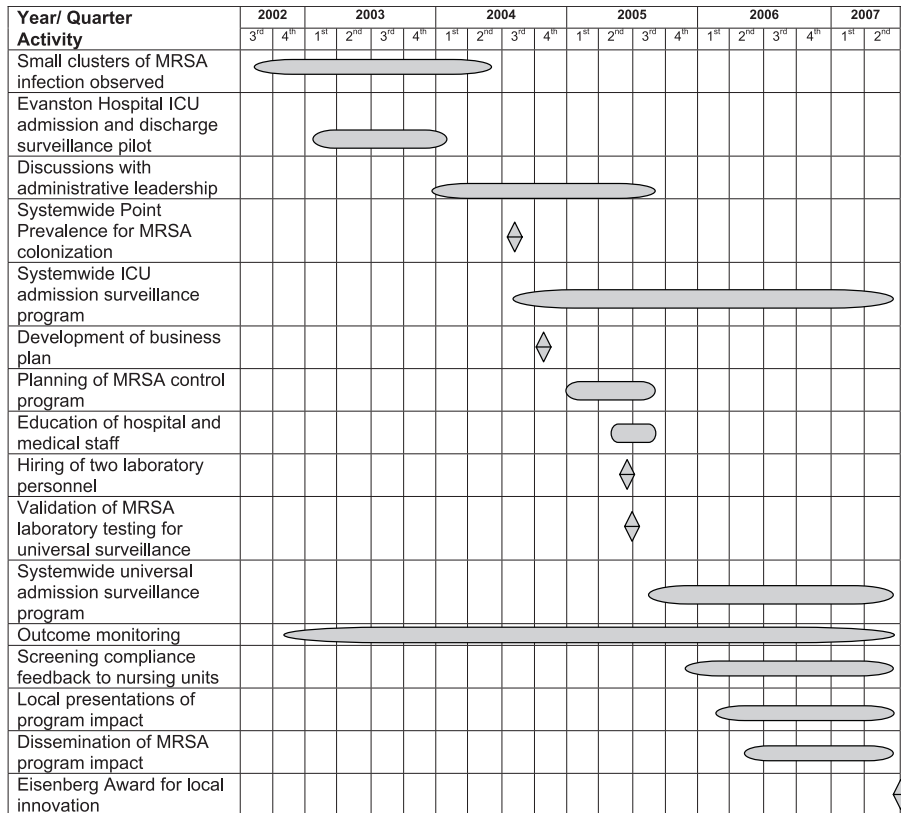
‡ Completed in August 2007; the inpatient MRSA colonization rate was 5.9%.

sustained since. MRSA BSIs were reduced by 80%.<sup>17</sup> In addition, the systemwide electronic surveillance service, which allowed comparison with similar health care organizations across the United States (representing a total of 950,000 persons admitted in a three-year period), demonstrated that ENH, the only organization performing universal MRSA admission surveillance, was the sole health care system to achieve a statistically significant reduction in MRSA BSIs—when our first intervention year (August 2005 through July 2006) was compared with the previous two baseline years.<sup>18</sup>

### EXTENT OF MRSA TRANSMISSION

Importantly, we found that the risk of MRSA infection was more than 10-fold higher in MRSA–colonized patients than in those never colonized,<sup>19</sup> supporting the premise that reducing transmission and the reservoir of MRSA–colonized patients will ultimately reduce MRSA HAIs. Jennigan and colleagues have estimated the rate of

### Schematic Time Line for Important Events in the ENH MRSA Infection Reduction Program



**Figure 1.** The overall time line integrates the important events in the methicillin-resistant Staphylococcus aureus (MRSA) infection education program at Evanston Northwestern Hospital (ENH). ICU, intensive care unit.

MRSA transmission by a nonisolated carrier to be 0.14 patients per day, 16-fold higher than when contact isolation is used.<sup>20</sup> Using his formula, we found a 13.4-fold reduction in MRSA transmission in our setting with universal surveillance. Thus, because the majority of MRSA carriers remain undetected without surveillance, it seems clear that if a reduction in MRSA transmission is a goal (to reduce infection), some form of expanded surveillance is required.

#### FINANCIAL IMPACT

We used a conservative model to assess the financial impact of the MRSA infection reduction program.

Calculation of the program's net cost was straightforward and amounted to \$600,000 per year—a substantial investment. The principal cost was incurred for laboratory supplies and personnel. Because no personnel were added outside the laboratory, no additional costs were included in this calculation. In addition, because isolation costs are approximately \$30 per day and the standard is to isolate patients with antibiotic-resistant pathogens, any “excess cost” for this part of the program was considered usual infection control practice and not part of the actual surveillance program. The overall number of isolated patients increased by only 20%, which amounted to an additional annual expense of \$44,000; this was minimal in comparison to the testing cost, and, therefore, no additional cost was assigned to this part of the program. The program cost thus represented a net expense of \$15 to \$16 per admission.

Measuring cost reduction was more challenging. The median time to a patient developing an MRSA HAI was 8 days. We compared the cost of care for patients with an MRSA HAI and patients in the same diagnosis-related group without an MRSA HAI who remained in the hospital for at least 8 days. In a two-year period, this calculation encompassed 178 infected patients (those with bloodstream infection, skin or soft tissue infection, respiratory tract infection, and urinary tract infection) and a control group of 5,976 patients. In this comparison, patients with an MRSA infection had an excess medical expense of \$23,783. Eliminating 50 of these infections during the first year resulted in a reduction of nearly

\$1,200,000 in medical expenditures, which was at least cost neutral. The positive financial impact was accompanied by an impressive medical result by the end of the first year—overall MRSA BSIs were 80% lower than the baseline year.<sup>17</sup>

## Discussion

The amount of MRSA detection needed for a program to realize clinical benefits is an important question that drives cost and likely relates to local characteristics. During our initial planning, we determined that we could ask each patient a series of questions and capture 80% of the MRSA patients by screening 50% of the admissions. However, we decided that we wanted to capture as close to 100% of the MRSA-colonized patients as possible, and, from an operational point of view, it was simpler to perform MRSA surveillance testing on all admissions rather than structure our electronic medical record to prompt the nurses and patient care technicians to ask and record a series of questions for determining who would be nasally screened. In contrast, the ICU admission surveillance at all three hospitals in the year before we instituted universal admission surveillance did not achieve a significant reduction in MRSA disease. Our tracking of MRSA-colonized patients during our first year of universal surveillance demonstrated that only 28% of colonized patients were detected during ICU-only surveillance, which would not have been sufficient to effect a reduction in MRSA HAI disease in our population. Given the intermediate size and community-based nature of our hospitals, our experience may be representative of many hospitals and health care organizations.

Our experience also demonstrated that rapid testing followed by isolation of MRSA-positive patients is sufficient to cause a major reduction in MRSA disease and did not require (preemptive) isolation of tested patients until their test results were complete. This serves as an option for health care organizations that are interested in developing an aggressive MRSA control intervention. A seven-step guide to our MRSA infection control program is provided in Table 3 (right).

## Summary and Conclusion

PCR-based testing offers superiority to culture in reduction of unisolated days. The ICU-based surveillance inter-

Table 3. Seven Steps to Developing the ENH MRSA Control Program\*

1. Determine if an MRSA problem may exist by an observational risk assessment.  
–For example, determine the number of MRSA health care-associated bloodstream infections for the hospital, and if it exceeds 1 per 10,000 admissions consider that as an indication that a potential problem exists
2. Plan a definitive assessment of MRSA risk.  
–For example, plan a point prevalence or admission prevalence survey to measure nasal colonization with MRSA, and if it exceeds 3% consider that as an indication a problem exists.
3. Meet with organization leadership and present the data from step number 1 and the plans for step number 2, with the purpose being leadership agreement that if a risk for MRSA is demonstrated to be present in their patient population then an intervention will be developed and implemented.  
–If agreement is reached, perform step number 2, and if a risk is identified go on to step number 4 (if no risk is identified, then disseminate the information regarding what has been done and that no MRSA risk is present).
4. Ask one of the organization leaders to partner in planning an MRSA control program and to coordinate a series of meetings with all the stakeholders to accomplish the planning process.
5. Develop a business plan for the MRSA control program.
6. Develop all needed informational and training documents for the new program, determine what outcome measures will be followed, and practice all the planned program elements to make sure they are ready for deployment.
7. Launch the MRSA control program, begin real-time monitoring of the outcome measures, and frequently disseminate the progress being made in reducing MRSA infections.

\* ENH, Evanston Northwestern Healthcare; MRSA, methicillin-resistant *Staphylococcus aureus*.

vention had little impact after one year with surveillance compliance at 67%. However, once compliance improved, surveillance was expanded to the entire hospital and decolonization was implemented, MRSA BSIs were significantly reduced. Our experience parallels that of the European countries and other United States facilities that have

implemented aggressive MRSA control measures. All successful programs have included active surveillance testing and barrier precautions.

Finally, according to the Centers for Disease Control and Prevention's just-released report on invasive MRSA, since most MRSA infections are associated with health care contact,<sup>21</sup> strategies to prevent and control MRSA among inpatients still may have a positive impact on infection, as demonstrated by our intervention. **1**

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