

Implementation of a Universal Admission Surveillance and Decolonization Program for Methicillin-Resistant *Staphylococcus aureus* (MRSA) Reduces the Number of MRSA and Total Number of *S. aureus* Isolates Reported by the Clinical Laboratory[▽]

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Our three-hospital system began active surveillance for methicillin-resistant *Staphylococcus aureus* (MRSA) nasal colonization, with decolonization of positive patients, on all admissions starting 1 August 2005. A question not previously addressed is whether reduction of the incidence of MRSA disease would lower the total number of *S. aureus* clinical isolates recovered by the microbiology laboratory that are reported to health care providers. The decreases in the numbers of MRSA and total *S. aureus* clinical isolates for each year after August 2005 were highly statistically significant compared to the numbers in each of the prior 3 years ($P < 0.0001$).

Methicillin-resistant *Staphylococcus aureus* (MRSA) infections are on the rise worldwide (11), and it appears that these isolates do not replace the methicillin-susceptible strains of *S. aureus* (MSSA) as a cause of disease but, rather, add to the total burden of *S. aureus* infection in the population (1, 8). Patients colonized with MRSA have an increased risk of developing MRSA disease (4, 7). Thus, minimizing the spread of MRSA to lower new colonizations is one way to reduce MRSA infection.

To help minimize new colonizations in our health care system, an active surveillance program for the detection of nasal colonization with MRSA was instituted at the NorthShore three-hospital system, consisting of 850 beds and 47 intensive care unit (ICU) beds. Prior to August 2004, a passive surveillance system consisting of isolating patients with previous or current MRSA clinical infections was utilized. In August 2004, a targeted approach of screening all patients admitted to any ICU for nasal colonization with MRSA was implemented. On 1 August 2005, the targeted program was expanded to a universal program that screened all patients on every unit at the time of their admission (9, 10). During universal surveillance, treatment with mupirocin nasal ointment administered twice daily for 5 days was recommended for patients found to be colonized with MRSA. On days 1, 3, and 5 of the mupirocin regimen, the patient was also bathed with chlorhexidine used as a liquid soap. Compliance with screening measures achieved 90% after 12 months and was maintained at or above this level thereafter (9, 10). Measures of outcome, including an evaluation for a reduction of health care-associated MRSA infec-

tions, were performed and reported in a previous work (10). This program significantly reduced MRSA bacteremia, as well as all MRSA health care-associated disease, and had no impact on MSSA bacteremia (9, 10).

Prior to this initiative, it was not possible to determine if lowering the number of MRSA infections would lower total infections from *S. aureus* or if MSSA infections would simply expand to maintain the total incidence of *S. aureus* infections (MRSA plus MSSA) at a stable level. The purpose of this analysis was to determine if total *S. aureus* infections as manifested by clinical laboratory isolates that were reported to the health care provider (clinical isolates) decreased when an effective program to lower MRSA disease was in place. Secondary endpoints were to determine if any observed reduction in total *S. aureus* clinical isolates was primarily due to a change in the number of MRSA or MSSA isolates.

Data on unique isolates recovered from clinical patient samples used for this analysis was generated from the laboratory information system, SoftLab (SCC Soft Computer, Clearwater, FL). Yearly susceptibility reports were compiled for clinical MSSA and MRSA strains from all inpatients (surveillance strains were not included). One isolate per patient per source per month is used in the SoftLab system to compile susceptibility data. A year consisted of the 12-month interval from August to July, to parallel the implementation of the surveillance programs. Data from August 2002 through July 2007 were evaluated (5 years). These data included both community-acquired samples (collected during the first 2 days of admission) and samples considered health care-associated (collected >2 days after admission); this data set represents 88.4% new isolates (3,724 of 4,212 in either data set) associated with clinical samples that were not included in our prior report (10). Significance was determined by the chi square statistic, which was chosen because we had already excluded autocorrelation in this population (10). Admission data used in this statistical

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TABLE 1. Impact of MRSA program on recovery of clinical MSSA and MRSA isolates

Period of observation (no. of annual admissions) ^b	Surveillance type	No. of isolates that were ^a :			% of isolates that were MRSA
		MSSA	MRSA	<i>S. aureus</i>	
August 2002 to July 2003 (42,805)	Passive	408 A	434 C	842 E	52
August 2003 to July 2004 (42,772)	Passive	390	388 C	778 E	50
August 2004 to July 2005 (44,119)	Active, ICU only	395	413 C	808 E	51
August 2005 to July 2006 (45,697)	Active, all units	370 B	277 D	647 F	43
August 2006 to July 2007 (46,318)	Active, all units	394	255 D	649 F	39

^a A versus B, significant at a *P* value of 0.025. No other comparisons of numbers of MSSA isolates within each period of observation were significantly different when comparing numbers before and after universal surveillance. All C versus all D, significant at a *P* value of <0.0001. All E versus all F, significant at a *P* value of <0.0001.

^b The mean length of in-hospital patient stay was available for the last three study periods. It was 3.7 days for the period of August 2004 to July 2005 and 3.8 days for the periods of August 2006 to July 2007.

analysis excluded only normal newborns. The NorthShore University HealthSystem (NorthShore) Institutional Review Board approved this data analysis.

In the 2 years following the introduction of a MRSA nasal surveillance program testing all patients upon hospital admis-

sion, with decolonization of those found positive, the percentage of inpatients with a clinical (i.e., nonsurveillance) isolate of MRSA that was reported to health care providers decreased (Table 1). The decrease for each year after whole-house (universal) surveillance was instituted compared to the number in each of the 3 years prior was statistically significant (*P* < 0.0001). The decrease was due to a decline in the number of MRSA isolates from a 3-year average of 412 isolates prior to universal surveillance to an average of 266 in the 2 years thereafter (Table 1) (*P* < 0.001). The number of MSSA isolates remained constant over the 5-year time period, at approximately 400/year (the single significant difference is discussed later and occurred between the first universal surveillance year and the first baseline year) (Table 1). The composite result was an overall decline in total *S. aureus* isolates recovered from clinically infected samples reported to health care providers that was driven by the decrease in MRSA isolates, and this result for total *S. aureus* isolates was also highly significant (Table 1 and Fig. 1).

The mean ($\pm 95\%$ confidence interval [CI]) percentages of clinical samples by body site from which MRSA was recovered were 52% ($\pm 1.4\%$) for wounds, 13% ($\pm 1\%$) for blood, 13% ($\pm 1\%$) for urine, 18% ($\pm 1.1\%$) for respiratory samples, and 3% ($\pm 0.5\%$) for other sterile body fluids. For MSSA, the mean ($\pm 95\%$ CI) percentages of clinical samples by body site were 58% ($\pm 1.3\%$) for wounds, 14% ($\pm 0.9\%$) for blood, 8% ($\pm 0.7\%$) for urine, 15% ($\pm 0.9\%$) for respiratory samples, and

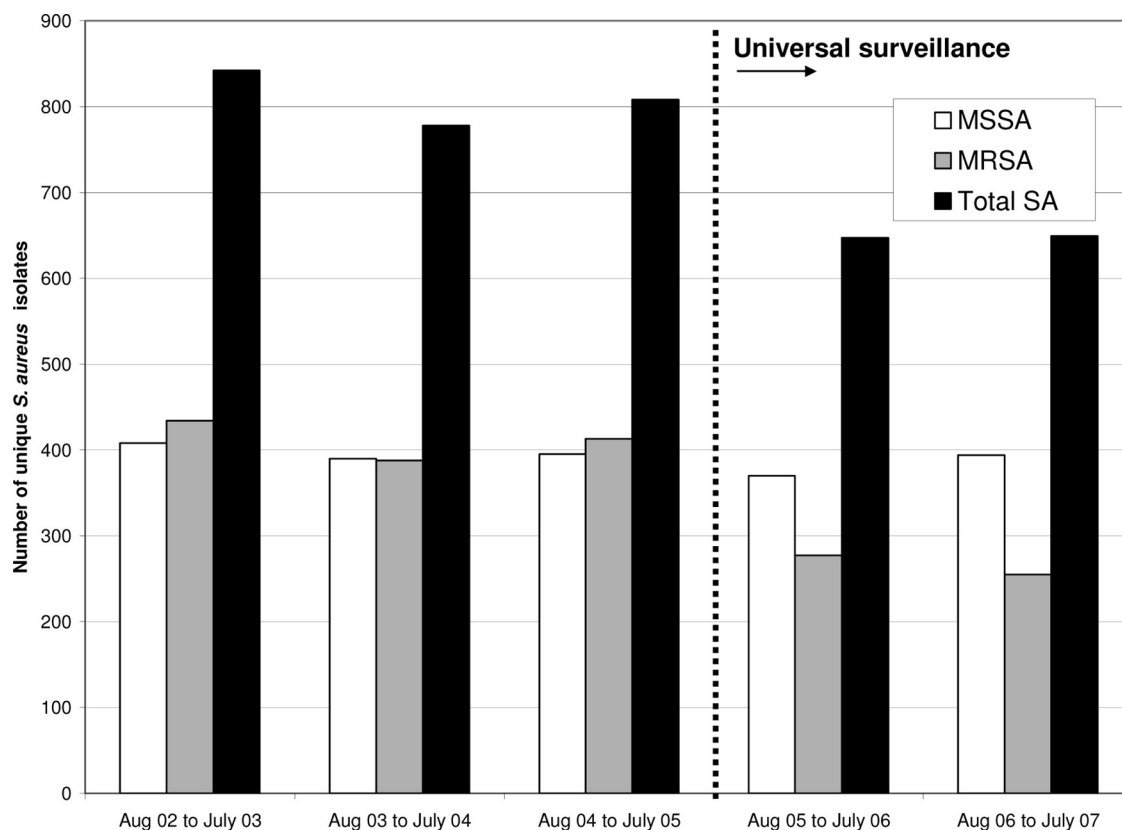


FIG. 1. Annual numbers of inpatients with clinical isolates of *Staphylococcus aureus* (SA) admitted to NorthShore University Health System from August 2002 through July 2007.

6% ($\pm 0.6\%$) for other sterile body fluids. There was no significant change in the percentage of *S. aureus*-positive samples from any given body site for either MRSA or MSSA over the 5 years of this observation.

In the 3-year time period when passive and ICU-targeted surveillance was performed, the number of MRSA and MSSA isolates reported to health care providers remained virtually the same, with MRSA isolates comprising approximately 50% of *S. aureus* isolates recovered from unique clinical specimens. A reduction was observed when surveillance included all patients admitted to the hospital and decolonization was performed on MRSA-positive patients. The number of MSSA infections remained constant throughout the 5-year time period and did not increase to replace the void left by reducing MRSA disease. This is likely due to the fact that general decolonization for MSSA (as in an admission screening and decolonization program) has not been shown to be beneficial (13); decolonization is seen to be beneficial only in selected settings, such as reducing infection in surgical patients at risk for *S. aureus* infection and patients undergoing hemodialysis (5, 6). General decolonization for MSSA is not done at our organization. Thus, we have shown that total *S. aureus* clinical isolates can be reduced solely due to a reduction in MRSA isolates. Theoretically, the total number of *S. aureus* isolates would not have been reduced if MSSA colonization "filled the gap" of the reduced number of MRSA isolates recovered by the laboratory, which has been a concern from the infection control perspective. The numbers of MSSA isolates might have been reduced if no surveillance was performed and all patients in the hospital received *S. aureus* decontamination or if both MRSA and MSSA carriers were identified and both MRSA and MSSA carriers were decolonized, but this was not done as only MRSA was targeted in our intervention program.

The approach we used for MRSA outcome measurement as a tool for determining the impact of a MRSA control program on disease was recently validated by Walker and colleagues over an 8-year period encompassing more than 2.6 million patient days. They reported that bacteremic rates of MRSA disease trended very closely with nonbacteremic rates of MRSA isolate recovery based solely on clinical cultures sent to the microbiology laboratory and that using all MRSA clinical isolates allowed for a faster measure to reach statistically significant changes in MRSA rates when measuring the impact of an intervention than did monitoring bloodstream infection alone (12).

Our study has several limitations. The first is that we discuss the decrease in MRSA isolates reported to health care providers and suggest that this correlates with a decrease in disease. In our previous report of outcomes from universal surveillance for MRSA, clinical isolates were verified as the cause of nosocomial infection by chart review in order to be included in the database, and that investigation revealed a statistically significant decrease in MRSA disease (10). Our data from this earlier study found that review of the 1,194 cases with a positive clinical culture for *S. aureus* demonstrated that the total of those confirmed with actual infection by chart review was 77.1% (our unpublished observations). This strongly suggests that in our new data set, using the same search parameters, there is a high correlation between clinical cultures being positive for *S. aureus* that are reported to health care providers

and actual disease. Our data support the findings reported by Walker and colleagues discussed earlier (12). Additionally, Brossette and colleagues have previously assessed the utility of clinical microbiology laboratory isolate recovery for all pathogens in the detection of health care-associated infections (3). Using a somewhat more complex algorithm, they found the specificity of such use to be 98.4% (95% CI, 97.6 to 99.2%), which further highlights the utility of analyzing clinical microbiology cultures reported to health care providers as a surrogate for actual infection (3). The second limitation is the use of all inpatient isolates from the first day of hospital admission onward to measure health care-associated disease. This is not a true picture of hospital-acquired disease. However, we were limited to the capability of the laboratory information system, which cannot determine if an isolate is from a patient who has already been hospitalized for more than 2 days or was hospitalized in the prior 14 to 30 days. A third limitation is that our study is retrospective and may have missed some patients. However, our laboratory information system has been in use since before the observation periods and we are confident that virtually all the *S. aureus* isolates have been captured. Finally, there was a single significant but unsustained reduction in MSSA isolates that occurred in year 4 of our 5-year observation (Table 1). The small, unsustained reduction in MSSA isolates ($n = 25$), while statistically significant, is overwhelmed by the large (and sustained) decrease in MRSA recovery from the prior year ($n = 136$) and is a good example showing that when one deals with relatively large data sets, an occasional significant but medically meaningless nonsustained trend event can occur.

This investigation is important for at least two reasons. First, it demonstrates that *S. aureus* disease as measured by clinical isolates reported to health care providers can be reduced; such an observation is meaningful to patients in the United States health care system. Second, it suggests that when assessing the financial impact of a MRSA control program, the correct control group for comparison is those patients with no *S. aureus* infection (9), as opposed to those with susceptible *S. aureus* disease (2). Using susceptible *S. aureus* as the financial comparator may well suggest that there is no financial benefit to avoiding MRSA infection (2), an outcome not seen when prevention of MRSA disease is the appropriate control group (89). We believe our report is the first to demonstrate that reducing MRSA infection results in a decrease in total *S. aureus* clinical isolates reported to health care providers and, very likely, in *S. aureus* disease, confirming the concept that MRSA in a population adds to the total burden of *S. aureus* infections by demonstrating the corollary that lowering MRSA has a statistically significant impact on overall potential staphylococcal disease.

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