

MRSA Prevalence in Preoperative *S. aureus* Nasal Culture Isolates is Significantly Different From a Traditional Hospital-wide Antibiogram

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ABSTRACT

Hospital antibiograms, because they are typically derived from samples obtained from hospitalized patients, may overestimate the prevalence of methicillin resistance in *S. aureus* in individuals presenting to the hospital for surgery. Because hospital antibiograms are commonly used to justify empiric perioperative prophylactic antibiotic selection prior to surgery, this may lead to unnecessary treatment with broad-spectrum antibiotics such as vancomycin. In a single-institution study, we observed that in our hospital antibiogram the proportion of *S. aureus* that are methicillin-resistant (MRSA) was significantly higher (45%) than isolates in preoperative nasal cultures obtained at the same hospital in outpatients prior to their lower extremity joint replacement surgery (13%): mean difference 0.32, [95% CI 0.25, 0.39], $p < 0.0001$. These data suggest that hospital antibiograms may overstate the true prevalence of MRSA in those at risk for MRSA surgical site infections who present from the outpatient setting.

KEYWORDS: antibiogram, antibiotic prophylaxis, arthroplasty, surgery, microbial colonization

INTRODUCTION

Surgical site infections (SSI) are potentially catastrophic complications of lower extremity joint replacements. They contribute to increased postoperative morbidity and mortality, and produce a substantial financial burden on the healthcare system. According to National Healthcare Safety Network data, *Staphylococcus aureus* (*S. aureus*) was responsible for 30% of SSIs, and 47% of SSIs following orthopedic procedures. Methicillin-resistant *S. aureus* (MRSA) were found in 44% of SSIs in which *S. aureus* was the causative bacteria.¹

Providers select an agent active against *S. aureus* when prescribing an antibiotic perioperatively and must strongly consider the risk of MRSA SSI. To assist with this decision, they often rely on institution-specific data regarding the incidence of SSI involving methicillin-resistant gram-positive bacteria. Alternatively, they may rely on a hospital-wide antibiogram, which provides data on institution-specific bacterial resistance patterns. Antibiograms include the antibiotic susceptibilities of bacteria cultured from samples

collected by that institution's laboratories each year.² Samples which make up these antibiograms are often collected primarily from inpatients, which could over-represent the prevalence of local antibacterial resistance. We hypothesized that the hospital-wide antibiogram at The Miriam Hospital, a 247-bed teaching hospital, may overstate the true proportion of *S. aureus* which is methicillin-resistant in a population at risk for MRSA SSI. We propose that an antibiogram composed specifically from *S. aureus* nasal cultures from patients undergoing lower extremity joint replacement would more accurately reflect the prevalence of the burden of colonization with methicillin-resistant *S. aureus* in this population.

METHODS

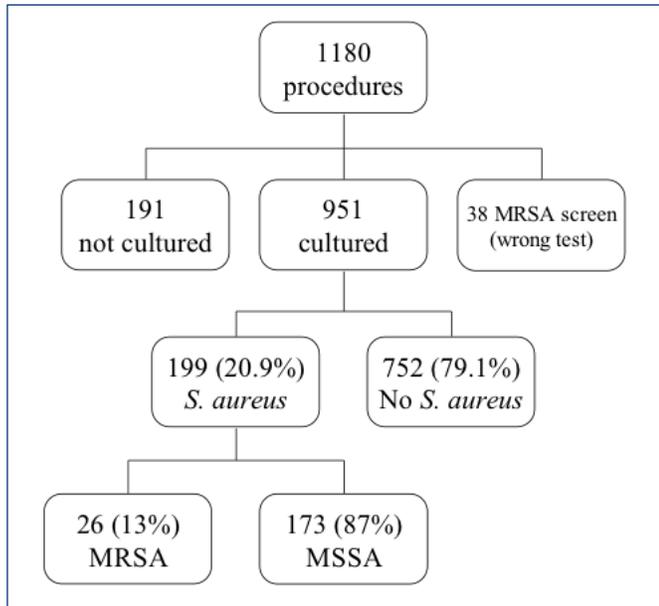
All hip or knee replacements at The Miriam Hospital in 2012 were identified using the TheraDoc™ clinical surveillance software. The following demographic data was then obtained from the hospital EMR for each corresponding patient: age, gender. Preoperative *S. aureus* testing date was collected along with testing method and result. Only results from culture-based nasal *S. aureus* (methicillin-susceptible and methicillin-resistant) testing were included in the study. Some patients underwent more than one joint replacement during the year. For these patients, intervals between subsequent surgeries were considered re-colonization opportunities. The hospital-wide antibiogram, accessed from the Microbiology Laboratory, was developed using a patient-based algorithm; it includes the first isolate per patient during 2012. The hospital-wide antibiogram does not include results from MRSA screening. Stata/SE™ version 12 software was used for statistical analysis.

This study was part of a quality improvement project and did not meet the definition of research. Hence, it was exempt from the need of approval of an institutional review board.

RESULTS

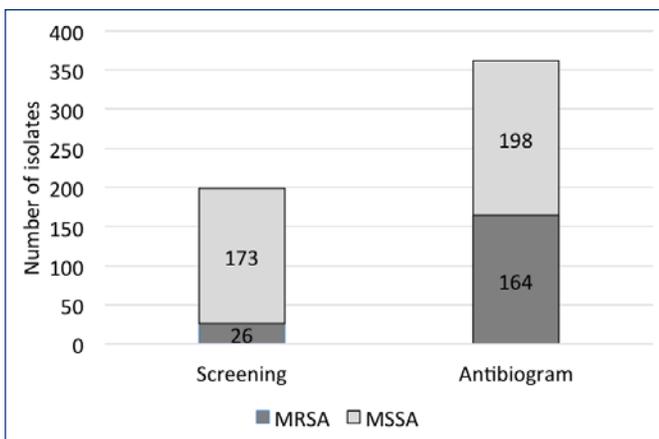
There were 1180 procedures among 1129 patients: 749 knee replacements and 431 hip replacements. 64% of patients in these procedures were women, 36% men. Mean and median ages were 67 and 66, respectively. For 81% (951) of these procedures, patients underwent nasal *S. aureus* culturing

Figure 1. Preoperative *S. aureus* nasal culture results among 1180 total joint replacement surgeries during 2012.



prior to surgery. Results from 38 tests using MRSA screens (of which 2 were positive), which did not detect MSSA, were not included in the data analysis. For 191 procedures, there was no preoperative *S. aureus* testing performed. The mean interval between culturing and surgery was 24.7 days, with a median of 26 days. 199 (21%) of nasal cultures were positive for *S. aureus*. Of those, 26 (13%) were MRSA, the remainder being MSSA. The results of the cultures are summarized in **Figure 1**. The hospital-wide antibiogram contained 362 *S. aureus* isolates; 164 (45%) of these were MRSA, the remainder being MSSA. The proportion of *S. aureus* isolates

Figure 2: Proportion of methicillin-resistance in *S. aureus* isolated in lower extremity joint replacement preoperative screening nasal culture (n=199), compared to isolates in hospital-wide antibiogram (n=362).



MSSA = methicillin-sensitive *S. aureus*. MRSA = Methicillin-resistant *S. aureus*. Proportions were compared using two-sample test of proportions, difference was 0.32, [95% CI 0.25, 0.39], p < 0.0001.

that were found to be MRSA during preoperative culturing was compared to the same proportion in the 2012 Miriam Hospital antibiogram using the two-sample test of proportions (**Figure 2**). The difference was 0.32, [95% CI 0.25, 0.39], p < 0.0001.

DISCUSSION

Several different organizations recommend a first-generation cephalosporin such as cefazolin or vancomycin as first-line for perioperative prophylaxis during orthopedic surgery.³ In these guidelines, vancomycin is not recommended for routine use, but rather for individuals with beta-lactam allergies or risk factors for MRSA. Vancomycin use is also justified in instances of high institutional prevalence of colonization or infection with methicillin-resistant gram-positive bacteria, although no threshold for this has been defined.

Antibiograms are important tools for the empiric treatment of suspected bacterial infections in the hospital setting before specific culture and sensitivity results are available, and for prophylaxis perioperatively to reduce the risk of postoperative SSI. However, these are typically composed of samples isolated mainly from inpatients. The hospital provides a niche for bacteria to become exposed to multiple antibiotics as they travel between patients and the hospital environment; this selective pressure drives resistance. Thus, samples from the inpatient population are not an accurate representation of the bacterial skin flora that put patients at risk of SSIs when they present for surgery from the community. Furthermore, it is more common for bacteria colonies from the patient's own skin, rather than exogenous spread from the hospital environment or providers, to be the inciting organisms for a SSI.⁴ Hospital-wide antibiograms may therefore lead to the overuse or misuse of perioperative antibiotics.

Several novel approaches have been proposed to enhance the utility of hospital-wide antibiograms. These include a "weighted-incidence" antibiogram, which integrates the relative frequency of organisms causing a particular infection with their resistance patterns.⁵ Studies creating hospital unit-specific antibiograms have demonstrated that the percentage of *S. aureus* isolates susceptible to methicillin may be significantly higher in the medical ICU when compared to a hospital-wide antibiogram.^{6,7} One study demonstrated that antibiotic sensitivities can differ significantly when comparing antibiograms developed from bacteria isolated >48 hours after admission (hospital-acquired) and those isolated <48 hours before admission (community acquired).⁸

Our study demonstrates that using susceptibility results of preoperative nasal cultures for *S. aureus* will allow for the more rational selection of empiric antibiotic prophylaxis during lower extremity joint replacement, as compared to using a hospital-wide antibiogram which displays a significantly higher proportion of *S. aureus* which are resistant

to methicillin. Among the 951 patients who underwent nasal culturing for *S. aureus*, only 2.7% had MRSA. This strongly suggests that reliance on a hospital-wide antibiogram, which typically display a significantly higher prevalence of methicillin-resistance in *S. aureus* isolates, will lead to unnecessary use of vancomycin.

Our study has limitations. Our data was obtained from preoperative cultures at one institution, so these may not be generalizable to other institutions or to populations with greater risk factors for MRSA colonization. Swabbing in other locations known to contain *S. aureus* such as the perineum or axillae could potentially improve the sensitivity of the preoperative culturing and provide a larger sample of *S. aureus* isolates, although it is unlikely that this would affect the comparison. Further work to obtain preoperative nasal culturing for *S. aureus* from patients preparing for a wider variety of surgeries would give us a more robust sample size and more demographically diverse patient makeup, thus increasing the utility of our preoperative nasal culture antibiogram. Future studies could also be employed to determine the clinical effectiveness of a preoperative culture antibiogram in preventing *S. aureus* SSI as compared to the traditional hospital-wide antibiogram.

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