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Is Preoperative Nasal Povidone-Iodine as Efficient and Cost-Effective as Standard Methicillin-Resistant *Staphylococcus aureus* Screening Protocol in Total Joint Arthroplasty?

Erick G. Torres, MD [a], Jill M. Lindmair-Snell, MSN, RN, CIC [a], Justin W. Langan, MD [a], Brian G. Burnikel, MD [b]

[a] Greenville Health System, Greenville, South Carolina
[b] Steadman Hawkins Clinic of the Carolinas, Greenville Health System, Greenville, South Carolina

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ABSTRACT

The purpose of this study was to compare nasal povidone-iodine swab for total joint arthroplasty patients to methicillin-resistant *Staphylococcus aureus* (MRSA) screening on the incidence of 90-day postoperative surgical site infections in total knee and hip arthroplasties as well as the cost-effectiveness. This is a single-center retrospective review of primary or revision total knee or hip arthroplasty patients. There were 849 patients screened for MRSA and 1004 patients in the nasal swab groups, both with an infection rate of 0.8%. The mean cost for the nasal swab was $27.21 (SD, 0), significantly different ($P \leq .01$) than the mean cost for MRSA screens, $121.16 (SD, 26.18). There were significant cost savings with no difference in infection rates; therefore, nasal povidone-iodine swab antiseptic is financially and clinically successful.

Surgical site infections (SSIs) after total joint arthroplasty are a significant source of morbidity and mortality, decrease health-related quality of life, prolong hospital stay, and significantly increase health care costs [1-6]. One of the major causes of SSIs, methicillin-resistant *Staphylococcus aureus* (MRSA), poses a major challenge for surgeons and infection control personnel [7,8]. Nasal colonization with *S aureus* is a known risk factor for developing an SSI, up to 9 times higher than a noncarrier (SSI) [1,9-12]. Studies show that as high as 30% of the population is colonized with *S aureus* in the nares [13]. In addition, genotyping studies reveal that as high as 80% of *S aureus* infections are caused by the patient's own nasal flora [14]. The consequences of an SSI can be detrimental both medically and financially. They can prolong hospital stays by a median of 2 weeks, nearly double rehospitalization rates, as well as increase health care costs by more than 300% [2]. In a multicenter study analyzing hospital charges, preventing a single case of SSI due to MRSA can save hospitals and the health care system up to $60,000 [15]. Many hospital policies and protocols have been implemented around the world to help reduce these infections. Some of these include, but are not limited to, MRSA screening, chlorhexidine gluconate baths, preoperative chlorhexidine wipes, mupirocin nasal treatment, perioperative and intraoperative antibiotics, sterile technique, and povidone-iodine soaks intraoperatively.

Intranasal MRSA screening with subsequent mupirocin treatment has become a widespread method of lowering MRSA burden and subsequent SSIs [1,7,9,11,12]. Several possible pitfalls with this treatment exist. First, there is concern about the compliance of the mupirocin treatment protocol. Decolonization relies on patient compliance with both the purchase of mupirocin treatment and use in an outpatient setting. Prior studies have reported that there are a number of patients that skip the mupirocin treatment because of the cost, as it is not routinely covered by insurance [16]. Furthermore, there is concern regarding repeated exposure to mupirocin and the development of resistance [17-20]. In addition, there is potential for MRSA recolonization after completion of decolonization treatment as well as the potential for those initially negative on the screening to convert to positive carriers preoperatively. Finally, the MRSA screening protocol only screens and treats for MRSA and not methicillin-sensitive *S aureus* (MSSA), which also poses a risk factor for developing an SSI after a total joint arthroplasty [21].

Recent reports suggest that preoperative nasal application of a povidone-iodine solution may, in fact, be more efficacious than nasal mupirocin at preventing SSIs [16]. The 3 M skin and nasal antiseptic product has been studied and found to kill 99.5% of *S aureus* within 1 hour and maintained the 99.5% kill for at least 12 hours postpreparation [22]. Furthermore, the nasal antiseptic alone has also been shown to kill

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Reprint requests: Brian Burnikel, MD, Steadman Hawkins Clinic of the Carolinas, Greenville Health System, 200 Patewood Drive, Suite C100, Greenville, SC 29615.

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99.2% of total bacteria within 1 hour and maintain a 98.8% kill for at least 12 hours postpreparation [22]. Although the effectiveness of the antiseptic has been shown in prior clinical studies, there is minimal research comparing the incidence of SSI with the use of the 3 M nasal product vs the standard and widely accepted use of MRSA screening and subsequent mupirocin treatment. Phillip's data suggest fewer deep infections resulted in patients who received the povidone-iodine solution compared to a mupirocin group, although there were limitations to the study [16].

In May of 2013, our institution changed protocol from MRSA screening and treatment to universal application of 3 M nasal povidone-iodine swab. Before this change in protocol, every patient scheduled for a total joint arthroplasty was cultured for MRSA approximately 2 weeks before surgery and if positive, was treated with a 5-day course of nasal mupirocin to both nostrils. With our new change in protocol, patients are no longer screened, cultured, or treated. Patients are now universally swabbed to both nostrils using povidone-iodine regardless of MRSA status. This occurs upon arrival to the preoperative holding area, typically 1 hour before operation. In both protocols, patients are instructed to perform chlorhexidine gluconate baths for 5 days before surgery.

The purpose of this study was to assess whether the change in our preoperative MRSA screening and treatment protocol has resulted in an increased incidence of postoperative SSIs in primary and revision total knee and hip arthroplasties. The secondary purpose was to assess whether the change to povidone-iodine nasal antiseptic in the new protocol was cost-effective when compared to the prior MRSA screening and treatment.

Materials and Methods

This is a single-center retrospective analysis that received institutional review board approval. We evaluated consecutive patients who underwent either a primary or revision total knee arthroplasty (TKA) or total hip arthroplasty (THA) by 4 orthopedic surgeons from 2011 to 2014. Two cohorts were used, the first being consecutive patients who underwent TKA or THA from November 2011 to April 2013 using the prior MRSA screening and treatment protocol and the second being consecutive patients who underwent the above procedure after the implementation of the povidone-iodine nasal swab from May 2013 to October 2014. The primary study end point was SSI within the 3 months after surgery. Superficial, deep, and organ space infections were included. Patients were excluded if 90-day follow-up was not available. Secondary outcome consisted of a cost analysis regarding the 2 different protocols.

In the first cohort, an MRSA screening protocol was used. Any patient undergoing a TKA or THA from November 2011 to April 2013 was screened for MRSA. Patients found to be MRSA positive via cultures were treated with nasal mupirocin ointment twice a day for 5 days along with chlorhexidine gluconate baths for 5 days before surgery and a chlorhexidine gluconate wipe in preoperation on the operative leg. Patients were then retested upon completion of the treatment. If patient remained positive at time of surgery, he/she was placed on contact precautions for MRSA colonization.

The second cohort was not screened for MRSA and, therefore, was not treated with mupirocin. The group received povidone-iodine solution 5% (3 M Nasal Antiseptic) antiseptic nasal swabs to both nostrils approximately 1 hour before surgery. The patient's nostrils were prepped for 30 seconds each using separate applicators by the preoperative nursing staff. This process was then repeated using 2 additional applicators for a total application time of 1 minute per naris (2 minutes total). Patient was also instructed to undergo chlorhexidine gluconate baths for 5 days before surgery along with a chlorhexidine gluconate wipe in preoperation on the operative leg.

As part of our institution's perioperative antibiotic protocol, every patient undergoing a surgical intervention receives a weight-based intravenous dosage of cefazolin before skin incision. If the patient has a penicillin allergy, depending on the described reaction, he or she receives either a test dose followed by full dose of cefazolin, or they receive 600 mg clindamycin. This protocol was not breached, and no vancomycin was administered regardless of MRSA history or screening results.

The rate of SSIs in total joint replacement procedures was measured according to the CDC National Healthcare Safety Network 2014 Manual. Surgical site infection rates were calculated and compared with the historical control period immediately preceding the start of the nasal povidone-iodine implementation. Our primary outcome was SSI within 90 days of the index procedure. In addition, a cost analysis was performed to compare the 3 M nasal swab with our prior institution protocol of MRSA screening and mupirocin treatment through the use of average wholesale price.

Statistical Analysis

We compared infection rates between the study group and the control group using the Fisher exact test in hopes of determining a significant difference between treatment methods. A cost analysis was used to compare the price of each cohort.

Results

A total of 1853 patients who underwent total hip and knee arthroplasties were included in the study. The incidence rate of infections was less than 1% in both groups. There were a total of 849 patients in the MRSA screening group, with 6 infections (0.8%). Of those, 292 were total knees and 557 total hips. There were 1004 patients in the povidone-iodine group, with 8 patients having postoperative SSIs (also 0.8%). Of that group, 294 were total hip arthroplasties and 710 were total knee arthroplasties. We did not have any patients develop a reaction or be intolerant of the nasal povidone-iodine swabs. We also did not have any patients have a history of iodine allergy. There was not a significant difference in SSI rates in the 2 groups, with $P = 1.0$. In the MRSA screening group, 41 patients tested positive via culture. In the 3 M group, 47 patients either had a history of positive culture swab in the past or a history of MRSA infection. Given the distribution of data, a Mann-Whitney *U* test was used in lieu of a *t* test. Of the 6 infections in the MRSA screening group, only 1 had tested positive for MRSA on screen. That patient was compliant with the mupirocin therapy, and decolonization was confirmed upon reculture before surgery. This patient ultimately had MRSA SSI. Two of these 6 infections were revision THA. Four of these 6 infections were noted to be noncompliant with chlorhexidine gluconate baths for 5 days before surgery. Taking a closer look at the speciation and sensitivities of those 6 infections, 3 of them were MSSA, 1 was MRSA, 1 was *Staphylococcus epidermidis*, and 1 grew no cultures but was noted to be on oral antibiotics. In the 3 M group, 2 of the 8 infections had a history of MRSA colonization or infection in the past. Two of these 8 infections were revision cases, one being a TKA and the other a THA. One patient was noted to be noncompliant with the chlorhexidine gluconate baths for 5 days before surgery. With regard to the speciation and sensitivities of those 8 infections, 5 of them were MSSA, 1 was MRSA, 1 was *S epidermidis*, and 1 was *Corynebacterium striatum*.

The mean cost per case for the MRSA screening group was $121.16 (SD, 26.18), whereas the mean cost per case for the povidone-iodine nasal swab antiseptic group was $27.21 (SD, 0). This difference was statistically significant ($P \leq .01$). These values were derived using average wholesale price. In our prior protocol, every patient was charged $106.00 for the cost of MRSA screening and culture. Those that tested positive were then charged $161.19 for the complete nasal mupirocin course (5-day application to both nostrils, 10 applications total). This is an out-of-pocket cost to the patient. The cost for the povidone-