RESEARCH BRIEFS

Hospital-Onset Bloodstream Infection Rates After Discontinuing Active Surveillance Cultures for Methicillin-Resistant *Staphylococcus aureus* in a Regional Burn Center

Burn patients are particularly susceptible to staphylococcal infection.[1] Methicillin-resistant *Staphylococcus aureus* (MRSA) is associated with increased resource use and outbreaks, as well as potentially increased morbidity and mortality in this population.[1,2] Efforts to control MRSA in this vulnerable population include hand hygiene, contact isolation precautions, environmental hygiene, positive pressure rooms with high-efficiency particulate air filtration, and active surveillance cultures (ASCs) upon admission.[1,3] At the study institution, ASC for MRSA and placement in contact isolation of patients with positive cultures were implemented in the burn units in the 1980s.[4] The practice was discontinued at the end of August 2014, following the results of a multicenter study in adult critically ill patients that demonstrated that it is possible to achieve control of MRSA without ASCs,[5] even though the study did not include critically ill burn patients, based on the consensus opinion of the infection prevention and control committee. In this study, we describe MRSA rates among hospitalized burn patients before and after this policy change was implemented.

METHODS

The setting was the regional burn center in Parkland Hospital, an 861-bed county tax–supported, tertiary care academic referral center. Patients admitted to the burn center between December 2011 and February 2016 were included in the study. The burn center has a 9-bed intensive care unit (BICU) that admits 28 patients per month on average, an 18-bed acute care unit (BACU) that admits 53 patients per month on average, and a hydrotherapy unit. Patients with burn injuries as well as overflow patients from the medical and surgical intensive care units (ICUs; < 20% of total admissions on average) are admitted to the BICU. Notably, the hospital moved all inpatients, including those in the the burn center, to a new facility in August 2015. MRSA control measures include standard precautions and contact isolation precautions for MRSA colonization or infection. Active surveillance cultures (ASC) were obtained from the nares, axilla, groin, and the burn wound of each patient at admission. Cultures were done using routine bacterial culture method in the microbiology lab until October 2008 when the method was changed to use the MRSA Chromagar (Becton Dickinson, Franklin Lakes, NJ). Decolonization was left to the discretion of the treating physician.

All data were obtained from the Department of Infection Prevention and the microbiology laboratory at Parkland Hospital. We then determined the monthly colonization prevalence at admission and incidence of MRSA hospital-onset bloodstream infection (HO-BSI). 'Hospital-onset' was defined as time of culture > 3 calendar days after admission. Colonization was defined as a positive surveillance culture obtained from any of the surveillance sites.

The ASC period was December 2011–August 2014, during which the ASC program was in place. The follow-up period was September 2014–February 2016, during which the ASC program was no longer in place. The HO-BSI rate was expressed as number of infections per 1,000 patient days, and the rates during the ASC period and the follow-up period were compared for statistically significant difference. The critical level of α was 0.05, and the tests were 2-tailed. This project was undertaken as a Quality Improvement Initiative at Parkland Health and Hospital System, and as such it was not formally supervised by the institutional review board.

RESULTS

During the 33 months from December 2011 to August 2014, in the BICU and BACU, 725 of 4,006 (557 of 2,665 patients in the BICU; 168 of 1,341 patients in the BACU) patients were screened at admission for an overall screening compliance of 18.1%. Of the 725 patients, 60 were found to have MRSA colonization (36 of 557 patients in the BICU; 24 of 168 patients in the BACU) for an admission prevalence of 8.3%. During the same period, the overall incidence of MRSA HO-BSI was 1.23 per 1,000 patient days. The MRSA HO-BSI incidences in the BICU and BACU were 2.59 and 0.31 per 1,000 patient days, respectively. In the 18-month follow-up period from September 2014 to February 2016, when active surveillance cultures were no longer employed as an MRSA control strategy, the overall incidence of MRSA HO-BSI was 1.28 per 1,000 patient days, with incidences of 2.67 and 0.46 per 1,000 patient days in the BICU and BACU, respectively. The difference in incidence during the 2 periods was not statistically significant ($P = .91$). The incidences in the old Parkland Hospital were 3.72 and 0.50 per 1,000 patient days in the BICU and BACU, respectively. The incidences in the new Parkland Hospital were 0.75 and 0.41 per 1,000 patient days in the BICU and BACU, respectively ($P = .09$ for BICU and .91 for BACU) (Table 1).

DISCUSSION

In our observational study, standard precautions alone were sufficient to keep the incidence of MRSA HO-BSI at a relatively low rate of 1.28 per 1,000 patient days. Our finding is consistent with previous publications noting the lack of data

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TABLE 1. Rates of Hospital-Onset MRSA Bloodstream Infections Before and After Discontinuation of Active Surveillance Cultures

Data Source	No. of HO-BSIs	No. of Patient Days	No. HO-BSIs per 1,000 Patient Days	*P* Value
ASC period (Dec 2011 to Aug 2014)	20	16,244	1.23	
Follow-up period (Sep 2014 to Feb 2016)	13	10,187	1.28	.91
BICU				
ASC Period	17	6,555	2.59	
Follow-up Period	10	3,747	2.67	.93
BACU				
ASC Period	3	9,689	0.31	
Follow-up Period	3	6,440	0.46	.63

NOTE. MRSA, methicillin-resistant *Staphylococcus aureus*; HO-BSI, hospital-onset bloodstream infection; ASC, active surveillance culture; BICU, burn intensive care unit; BACU, burn acute-care unit.

demonstrating a reduction in MRSA infections in burn patients[3,4,6–8] using ASC, particularly in non-outbreak situations. The MRSA incidence did not change after the move to a new hospital building. Our incidence reported here is lower than the rates reported in the study by Johnson et al,[9] which reported a reduction in the incidence of MRSA BSI from 7.45 to 2.4 per 1,000 patient days when a universal decolonization protocol was implemented in a burn unit. The admission prevalence of 8.3% in our burn center is similar to the prevalence of 9.3% reported by Kaiser et al.[1] Our admission surveillance compliance of 18.1% in the BICU is within the range of 5%–21% reported by a study in which 12 BICUs across the country were examined.[10] We conclude that active surveillance cultures and contact isolation of colonized patients may not be critical to reducing incidence of HO-BSI caused by MRSA.

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Reducing the Rate of Surgical Site Infections After Breast Surgery With the Use of Larger Volumes of 4% Chlorhexidine Gluconate Solution as Preoperative Antiseptic Showering

Surgical site infections (SSIs) increase morbidity and mortality in patients and contribute to significant clinical and economic burden.[1,2] Breast surgery has one of the highest SSI rates (2.8%–38.3%) especially in patients undergoing mastectomies.[2–4] Recommendations for SSI prevention practices include showering or bathing with an antiseptic agent before the operative day.[1,5] Preoperative showering with 4% chlorhexidine gluconate has broad antiseptic activities, reduces skin microbial colony counts, and is associated with significantly fewer SSIs compared to iodine.[6–8] Exact concentration, volume, and number of applications for optimal chlorhexidine use have not been established.[5]

At Riverside University Health System Medical Center, breast surgeries had the highest SSI rates (2.1%–8.6%) from January 2011 to June 2014. Our preoperative antiseptic showering consisted of only 15-mL soap packages of 4% chlorhexidine gluconate product (HIBICLENS, Molnlycke Health Care US, LLC, Norcross, GA) daily for 3 days. We hypothesized that each 15-mL volume was insufficient to achieve maximal antiseptic concentrations, especially for obese patients with larger breasts. An intervention was implemented to have all breast surgical patients shower or bathe with 118-mL solution bottles of 4% chlorhexidine gluconate product for application on breasts daily for 3 days prior to surgery starting in July 2014.

A retrospective chart review of patients who underwent breast surgery from January 2011 to December 2015, identified through the National Healthcare Safety Network database, was conducted at our institution. We compared SSI rates of patients before and after the use of larger volumes of 4% chlorhexidine gluconate product. Multiple regression analyses were used to identify independent risk factors for SSIs. All statistical analyses were performed using Epi Info 7.0 (Centers for Disease Control and Prevention, Atlanta, GA).

A total of 829 patients underwent breast surgery during the study period, and 31 patients (3.7%) were identified with SSIs. Breast surgery comprised of 246 mastectomy procedures (30%) and 583 non-mastectomy procedures (70%). All patient received intravenous antimicrobial prophylaxis before surgery, and all surgeries were performed by senior faculty surgeons. In total, 807 patients (97%) were women and 65% were diagnosed with breast cancer. All SSI patients were female with breast cancer diagnoses. Demographic and clinical characteristics of infected and non-infected patients undergoing mastectomy and non-mastectomy surgery are shown in Table 1.

Our study results show that larger volumes of 4% chlorhexidine gluconate product significantly reduced SSI rates in mastectomy patients (n = 24 [13.1%] vs n = 2 [3.2%]; $P = .027$); however, they did not significantly reduce the rate of SSIs in non-mastectomy surgery (n = 2 [0.45%] vs n = 3 [2.1%]; $P = .18$) and in all breast surgeries (n = 26 [4.2%] vs n = 5 [2.4%]; $P = .25$). Infected patients underwent simple or modified radical mastectomy followed by tissue expander placement; they were subjected to a longer duration of surgery; and they had a higher body mass index (BMI). Using multiple logistic regression analyses, the independent risk factors for SSIs among mastectomy surgery were BMI (OR, 1.1172; 95% CI, 1.0348–1.2062; $P = .0046$), tissue expander placement (OR, 9.751; 95% CI, 3.2542–29.2181; $P < .0001$), and smaller volumes of 4% chlorhexidine gluconate product (OR, 6.5487; 95% CI, 1.3113–32.7052; $P < .022$).

Most SSIs (68%) were deep and organ space infections, which are reflective of invasive disease. Surprisingly, we found that gram-negative organisms were the predominant cause (58%) of these deep and organ SSIs. All cultures from superficial SSIs (32%) showed *Staphylococcus aureus*. Even though *Staphylococcus aureus* is the leading cause of SSIs after breast surgery, our results agree with a study in which gram-negative organisms were most frequently isolated from cultures of breast SSIs.[1,3] This observation could partially be explained by the known decreased activity of chlorhexidine against gram-negative organisms.[9] However, our study results indicate that larger volumes of 4% chlorhexidine enhanced antiseptic activity against gram-negative organisms. Larger volumes did not significantly reduce the rate of SSIs in all breast surgeries. Nonmastectomy procedures comprised of 70% of all breast surgeries in our cohort. We believe that these procedures are considered less invasive with shorter surgery durations and did not include tissue expander placements.

To our knowledge, there are no published studies assessing the relationship between SSIs and simple mastectomy surgery; thus, our unusually high rates of SSIs after simple mastectomy (92%) followed by tissue expander placement (39%) need further exploration and confirmation.

However, we postulate that these patients developed more SSIs due to cross-contamination of bacteria from the skin to the tissue expander during surgical placement. Given that a tissue expander remains in place for 1–2 months, we feel that it is a major contributor to the higher rates of deep and organ SSIs seen after placement. In addition, higher BMI is associated with larger breast size and greater skin surface area for bacterial growth, which may contribute to more SSIs.[10] Studies have shown that repeated preoperative antiseptic showers with 4% chlorhexidine gluconate solution have resulted in significant reductions of skin microbial colony counts before surgery and SSIs.[8] This cross-contamination process may have been reduced with the implementation of the larger-volume solution.

Our study has several limitations. First, it is a retrospective cohort of patients at a single public academic medical center. Further studies are warranted to confirm our findings. Second, we were unable to ascertain the compliance rate of using both

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TABLE 1. Demographic and Clinical Characteristics of Infected and Noninfected Patients Undergoing Breast Surgery

	Mastectomy Surgery			Nonmastectomy Surgery		
	Infected (n = 26)	Noninfected (n = 220)	*P* Value	Infected (n = 5)	Noninfected (n = 578)	*P* Value
Age, y (SD)	55.9 (7.6)	52.5 (10.7)	.11	57.6 (12.1)	47.4 (13.2)	.09
Body mass index, kg/m^2 (SD)	33.0 (6.1)	29.7 (6.0)	.009	27.6 (7.5)	29.2 (6.3)	.57
Hemoglobin A1c, % (SD)	8.3 (1.4)	7.6 (1.8)	.44	N/A	7.3 (1.0)	N/A
Surgery duration, min (SD)	199.5 (158.9)	153.5 (83.0)	.019	96.2 (73.7)	101.4 (102.6)	.9
Tissue expander, %	38.5	6.8	<.0001	20	5.5	.67
Wound class, %	…	…	.38	…	…	<.0001
C	92.3	96.8	…	80	92.2	…
CC	N/A	N/A	…	25	0.52	…
CO	7.7	2.7	…	N/A	3.5	…
D	N/A	0.45	…	N/A	3.8	…
ASA class, %	…	…	.73	…	…	.9
1	3.9	1.8	…	20	15.9	…
2	26.9	31.4	…	40	55.5	…
3	69.2	66.8	…	40	28.0	…
4	N/A	N/A	…	N/A	0.52	…
Surgery type, %	…	…	.0014	…	…	…
Simple	92.3	55.9	…	…	…	…
Modified	7.7	23.6	…	…	…	…
Radical	N/A	20.5	…	…	…	…
Intervention, %	…	…	.027		…	.18
Pre	13.1	86.9	…	0.45	99.6	…
Post	3.2	96.8	…	2.1	97.9	…

NOTE. SD, standard deviation; min, minutes; C, clean; CC, clean-contaminated; CO, contaminated; D, dirty; ASA, American Society of Anesthesiologists; N/A, not applicable.

antiseptic showering regimens of 4% chlorhexidine gluconate before breast surgery. Finally, we did not control for the various operative techniques performed by the surgeons. However, despite our limitations, we believe that larger volumes of 4% chlorhexidine gluconate may be as effective a strategy as preoperative antiseptic showering in reducing the rate of SSIs in patients after mastectomy.

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