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ORIGINAL ARTICLE – BREAST ONCOLOGY

Randomized Trial of Drain Antisepsis After Mastectomy and Immediate Prosthetic Breast Reconstruction

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ABSTRACT

Background. In this 2-site randomized trial, we investigated the effect of antiseptic drain care on bacterial colonization of surgical drains and infection after immediate prosthetic breast reconstruction.

Methods. With IRB approval, we randomized patients undergoing bilateral mastectomy and reconstruction to drain antisepsis (treatment) for one side, with standard drain care (control) for the other. Antisepsis care included both: chlorhexidine disc dressing at drain exit site(s) and irrigation of drain bulbs twice daily with dilute sodium hypochlorite solution. Cultures were obtained from bulb fluid at 1 week and at drain removal, and from the subcutaneous drain tubing at removal. Positive cultures were defined as $\geq 1+$ growth for fluid and >50 CFU for tubing.

Results. Cultures of drain bulb fluid at 1 week (the primary endpoint) were positive in 9.9 % of treatment sides (10 of 101) versus 20.8 % (21 of 101) of control sides ($p = 0.02$). Drain tubing cultures were positive in 0 treated drains versus 6.2 % (6 of 97) of control drains ($p = 0.03$). Surgical site infection occurred within 30 days in 0 antisepsis sides versus 3.8 % (4 of 104) of control sides ($p = 0.13$), and within 1 year in three of 104 (2.9 %) of antisepsis sides versus 6 of 104 (5.8 %) of control sides ($p = 0.45$). Clinical infection occurred within 1 year in 9.7 % (6 of 62) of colonized sides (tubing or fluid) versus 1.5 % (2 of 136) of noncolonized sides ($p = 0.03$).

Conclusions. Simple and inexpensive local antiseptic interventions with a chlorhexidine disc and hypochlorite solution reduce bacterial colonization of drains, and reduced drain colonization was associated with fewer infections.

Surgical site infection (SSI) rates after mastectomy with immediate prosthetic reconstruction are overall low, in the range of 5 %.[1,2] However, SSI in this setting is often devastating, with the majority resulting in implant loss.[1,2] Obesity and smoking are well-known risk factors for SSI in breast surgery; surgical drains and prolonged use are also associated with increased infection risk.[1,3–7]

We have previously shown that antiseptic treatment of surgical drains after mastectomy without reconstruction reduces bacterial colonization.[8] In that study, women undergoing immediate breast reconstruction were excluded due to common utilization of prolonged postoperative antibiotics, which might impact bacterial colonization in drains. Considering the risk of implant loss associated with

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SSI, we performed a prospective, surgeon-blinded, randomized controlled trial to assess effects of simple local antisepsis measures on bacterial colonization of drains and SSI after mastectomy with immediate prosthetic breast reconstruction.

METHODS

Study Population

Following Institutional Review Board approval at both Mayo Clinic and University of California San Francisco, eligible subjects were recruited prospectively from the breast surgical practices between May 2011 and June 2013. Individuals were included if undergoing bilateral mastectomy with reconstruction (either tissue expander or implant) for benign or malignant disease. Ineligibility criteria included: pregnancy, antibiotics within 14 days of surgery, history of breast/chest wall radiation, allergy to chlorhexidine, or autologous tissue reconstruction. A data safety monitoring board reviewed progress and adverse events.

Randomization

Because a paired study design was used (only bilateral procedures), each subject served as her own control. Randomization assigned which side (right or left) would receive the antisepsis interventions, and the contralateral side received standard drain care. Randomization included cancer versus prophylaxis as a stratification factor, in order to balance the proportion of breasts with cancer between the two treatments.

Perioperative Standardization

All subjects received weight-based IV antibiotics within 30 min of incision, with appropriate intraoperative redosing. ChloraPrep (CareFusion Corp., San Diego, CA) skin prep was used for all subjects. Oral antibiotics were continued postoperatively until drains were removed. Showers were encouraged after 48 h.

Drain Care Regimens

Study subjects and family members received personal instruction on drain care on the first postoperative day by the study coordinator and were advised to keep the surgical team blinded to interventions. Drain care instructions were previously described, with antisepsis measures including a chlorhexidine disc (Biopatch; Ethicon, Inc., Somerville, NJ) application to drain sites every 3 days and twice daily irrigation of the drainage bulb with dilute Dakin's solution.[8] Dakin's concentration was 0.0125 % buffered sodium hypochlorite for the first 44 subjects and commercially available 0.125 % for the remaining 60 subjects because of ease in procurement. All drains on a surgical side were treated per assigned study arm.

Follow-up Visits and Cultures

A standardized data collection form was completed at follow-up visits, assessing drainage volume, erythema/skin changes, evidence of infection, and compliance with interventions. Study coordinators removed dressings to maintain surgeon blinding. Patients returned for a mandatory clinical visit and culture of drain bulb fluid at approximately 1 week [postoperative day (POD) 6–10]. Drains were removed when clinically appropriate. On the day of drain removal, both subcutaneous drain tubing and bulb fluid were obtained aseptically for cultures, as previously described.[8] Clinical infections were treated per routine clinical care. Information on late infections was captured with medical record review and telephone follow-up at 1 year.

Microbiology

Cultures were performed as previously described.[8] Growth in bulb fluid was reported as: negative, broth only, or plate growth of 1+, 2+, 3+, 4+. Drain tubing isolates were reported semiquantitatively in colony forming units (CFU) as: <10, 10–19, 20–50, 51–100 or >100. All isolates were identified.

Endpoints and Statistical Power

The primary endpoint was bacterial growth (1 + or greater) in drainage bulb fluid at POD 6–10. The initially planned sample size was 75 patients (150 breasts) to provide 80 % power to detect a difference of 23 versus 7 % colonization in drain bulb fluid at POD 6–10 between antisepsis and control sides (2-sided McNemar test of paired proportions, alpha = 0.05). After a priori planned interim sample size re-estimation, targeted enrollment was increased to 97 patients (194 breasts). Sample size estimates were augmented by $\sim$10 % to allow for attrition.

Drain tubing colonization, defined as >50 CFU, was a secondary endpoint.[8,9] Given the potential limitation of using prespecified cutoffs to define a positive culture, we also performed ordinal quantification analyses for both drain fluid and tubing cultures. In samples colonized with multiple organisms, the highest degree of quantification across all organisms was used to classify the sample for analysis. SSIs included any of the following within

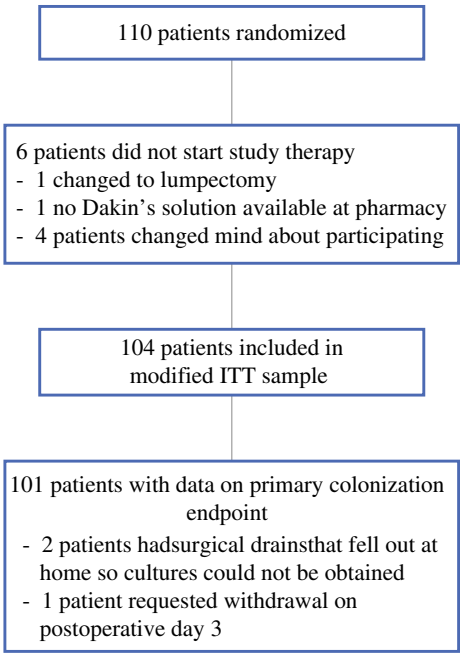

FIG. 1 CONSORT diagram

365 days after operation: purulent drainage, positive aseptically collected culture from the wound, signs of inflammation with opening of incision and absence of a negative culture, or physician diagnosis of infection (which could include cellulitis). Cases of SSI were decided by consensus of the research team without knowledge of the treatment arm. Patients were censored for SSI at the time of additional breast surgical procedure (including tissue expander exchange).

Statistical Analysis

Analysis was modified intent-to-treat (ITT); patients who withdrew or were screen failures before study intervention were excluded from analysis. All patients who completed were included in the analysis. The primary analysis was a paired comparison of binary colonization and SSI endpoints between antisepsis and control sides within patient. A side was positive for colonization if any drain on that side was positive. Comparison of paired proportions was performed using McNemar test or the exact sign test when there were <20 discordant pairs.[10] A secondary per-drain analysis was performed using generalized linear mixed effects models (binomial distribution, logit link) with a fixed effect for intervention (antisepsis or control) and random subject intercepts to account for multiple correlated drains within patient; per-drain models also allowed adjustment for factors that could vary among drains within patient. Analysis of the ordinal degree of colonization was performed using Wilcoxon signed-rank tests to compare maximum quantification between antisepsis and control side. Tests were 2-sided with alpha = 0.05 significance level. Analysis was performed using SAS (Version 9.3). Study data were collected and managed using REDCap electronic data capture tools.[11]

RESULTS

Subjects

A total of 110 patients were enrolled and randomized. Of these, 6 patients withdrew or were screen failures prior to intervention and were excluded from the modified ITT sample ($n = 104$, Fig. 1); 101 (97 %) had data on the primary endpoint. Most subjects had unilateral cancer (69 %), with 8 % bilateral cancer and 23 % without cancer. Acellular dermal matrix was utilized in 74 % of subjects. The paired study design ensured that patient-specific factors (e.g., BMI) were the same for control and antisepsis sides, while randomization resulted in balance across side-specific factors, including acellular dermal matrix (Table 1).

Colonization of Drain Fluid

Cultures of drain bulb fluid at 1 week showed significantly less bacterial colonization from antisepsis sides compared with control sides (Table 2). Using the cutoff of ≥1+ growth for drain fluid, fewer antisepsis sides were positive (10 of 101 = 10 %), compared with 21 % (21 of 101) of control sides ($p = 0.02$). The per drain analysis showed similar results where 11 of 157 antisepsis drains (7 %) showed colonization compared with 25 of 160 control drains (16 %); $p = 0.02$ in both adjusted and unadjusted analysis. Analysis of the maximum ordinal quantification of bacterial growth at 1 week showed 85, 5, 8, and 2 % of antisepsis sides in categories of no growth, broth only, 1+/2+ growth, and 3+/4+ growth, respectively, compared with 71, 8, 19, and 2 % on control sides ($p = 0.009$).

From drains removed after the first visit ($n = 173$), a second culture was obtained at drain removal (median, 14 days; range, 9–50 days). Later cultures showed more colonization than POD 6–10 cultures for both antisepsis (16 vs. 6 %; $p = 0.02$) and control sides (38 vs. 16 %; $p = 0.0003$), and antisepsis sides had persistently less colonization than controls after POD 6–10 (16 vs. 38 %; $p = 0.003$). The midstudy modification to use commercially available Dakin's solution did not affect bulb fluid colonization at POD 6–10: 9.5 % with dilute Dakin's versus 10.2 % with commercially available Dakin's ($p = 0.91$).

TABLE 1 Patient and clinical characteristics in $n = 104$ patients in the modified ITT analysis

Patient-specific factors	$n = 104$
Age, years, median (range)	46 (25–67)
BMI, median (range)	23.8 (17–45.1)
ASA class	
I	19 (18.3 %)
II	77 (74.0 %)
III	8 (7.7 %)
Operative time, h, median (range)	5.1 (2.9–9.3)
Smoking within 4 weeks preop[1], *n* (%)	4 (3.9 %)
Diabetes, *n* (%)	3 (2.9 %)
Neoadjuvant chemotherapy, *n* (%)	32 (30.8 %)
Indication for surgery, *n* (%)	
Unilateral cancer with CPM	72 (69.2 %)
Bilateral prophylactic mastectomy	24 (23.1 %)
Bilateral cancer	8 (7.7 %)
Type of preoperative antibiotic, *n* (%)	
Cefazolin	92 (88.5 %)
Clindamycin	6 (5.8 %)
Levofloxacin	3 (2.9 %)
Vancomycin	3 (2.9 %)

Side-specific factors	Antisepsis	Control
Type of operation, *n* (%)		
Mastectomy only	58 (55.8 %)	61 (58.7 %)
Mastectomy + SLNB	35 (33.7 %)	32 (30.8 %)
Mastectomy + ALND	11 (10.6 %)	11 (10.6 %)
Type of mastectomy, *n* (%)		
Skin-sparing mastectomy	37 (35.6 %)	36 (34.6 %)
Nipple-sparing mastectomy	67 (64.4 %)	68 (65.4 %)
Indication for mastectomy, *n* (%)		
Cancer	46 (44.2 %)	42 (40.4 %)
Risk-reducing	58 (55.8 %)	62 (59.6 %)
Number of drains, *n* (%)		
1	52 (50.0 %)	54 (51.9 %)
2	47 (45.2 %)	42 (40.4 %)
3	5 (4.8 %)	8 (7.7 %)
Type of reconstruction, *n* (%)		
Tissue expander	95 (91.4 %)	95 (91.4 %)
Direct-to-implant	9 (8.7 %)	9 (8.7 %)
Acellular dermal matrix used, *n* (%)	75 (72.1 %)	76 (73.1 %)
Intraoperative fill volume[2], mL, median (range)	150 (0–800)	150 (0–800)
Number of lymph nodes removed[3], median (range)	3 (1–33)	4 (1–36)
Maximum[4] drain duration, days, median (range)	13 (6–50)	13 (6–34)
Adjuvant radiation therapy[5], *n* (%)	7 (6.7 %)	8 (7.7 %)

ALND axillary lymph node dissection, *SLNB* sentinel lymph node biopsy

[1] Smoking within 4 weeks unknown in $n = 1$ patient

[2] Intraoperative fill volume available in $n = 101$ patients and missing in $n = 3$

[3] Among sides with either SLNB or ALND, $n = 46$ antisepsis and $n = 43$ control

[4] Maximum duration across all drains on a given side

[5] Adjuvant radiation therapy within 1 year but prior to tissue expander exchange

Colonization of Drain Tubing

Among 97 subjects with drain tubing cultures, colonization (>50 CFU) was significantly reduced with antisepsis treatment. No antisepsis-treated drains had a positive tubing culture, compared with 6.2 % of control sides (per patient analysis) or 3.9 % of control drains (per drain analysis), p values 0.03 and 0.004, respectively. Treating maximum degree of colonization as an ordinal variable also showed a significant difference between antisepsis and control sides at POD 6–10 ($p = 0.0006$), with frequencies as follows for CFU categories of 0, 1–19, 20–50, 51–100, and >100: 86, 11, 3, 0, and 0 % for antisepsis sides, and 69, 23, 2, 4, and 2 % for control sides.

Colonization and Drain Duration

Bacterial colonization increased in frequency and degree with longer drain duration, both for bulb fluid and drain tubing (Fig. 2). Increased colonization over time was observed for both control and antisepsis sides, but antisepsis sides demonstrated less frequency and degree of colonization at all time points compared with control sides.

Surgical Site Infections

SSI involved nine sides in eight subjects with 1-year of follow-up; four occurred within 30 days. SSIs were less frequent in the 104 antisepsis-treated sides compared with the 104 control sides, both within 30 days (0 vs. 3.8 %) and within 1 year (2.9 vs. 5.8 %), although not statistically significant and limited by the small number of events (Table 2). The four infected sides within 30 days were all control sides; three were limited to cellulitis and the fourth was a deep infection requiring tissue expander (TE) removal (Table 3). Of these four with early SSI, two had

TABLE 2 Outcome comparisons between antisepsis and control sides

	Antisepsis	Control	p value[3]
Per patient comparison between sides			
Primary endpoint			
Drain bulb fluid colonization at POD 6–10[1]	9.9 % (10/101)	20.8 % (21/101)	0.02
Secondary endpoints			
Drain tubing colonization at removal	0 % (0/97)	6.2 % (6/97)	0.03
Drain bulb fluid colonization at removal[2]	19.4 % (14/72)	38.9 % (28/72)	0.003
Surgical site infection within 30 days	0	3.8 % (4/104)	0.13
Surgical site infection within 1 year	2.9 % (3/104)	5.8 % (6/104)	0.45

	Antisepsis	Control	p value[4]	
			Unadjusted	Adjusted[5]
Per drain analysis				
Primary endpoint				
Drain bulb fluid colonization at POD 6–10[1]	7.0 % (11/157)	15.6 % (25/160)	0.02	0.02
Secondary endpoints				
Drain tubing colonization at removal	0 % (0/151)	3.9 % (6/154)	0.004[6]	N/A
Drain bulb fluid colonization at removal[2]	16.5 % (14/85)	37.5 % (33/88)	0.003	0.003

[1] POD 6–10 was the per protocol timeframe for the approximately 1 week culture; although 94 % of visits occurred within this protocol range, the actual visit dates ranged from POD 4–11

[2] Reported here only in those where drain removal was later than primary endpoint collection

[3] p value from McNemar's test for paired proportions or the exact sign test

[4] p value from generalized linear mixed effects model accounting for correlation among multiple drains from the same patient

[5] Adjusted for side- and drain-specific variables: indication (cancer or prophylaxis), operation (mastectomy only, mastectomy + SLNB, mastectomy + ALND), and drain duration

[6] Because of zero events in the antisepsis arm for this endpoint, p value was derived from likelihood-ratio test comparing the intercept only model to the model with intercept and treatment side included

colonization of both fluid and tubing, one had colonization of tubing only, and one had colonization of fluid but was missing tubing cultures. The five additional SSIs (three antisepsis side, two control side) in four patients were observed within 365 days (but prior to any censoring second surgery); four were deep SSIs requiring expander removal.

Correlation of SSI and Drain Colonization

Sides with colonization (per predetermined cutoffs) of either tubing or bulb fluid showed an SSI rate of 9.7 % (6 of 62) at 1 year, compared with 1.5 % (2 of 136) on sides without colonization of bulb fluid or tubing ($p = 0.03$), indicating that bacterial colonization of drain sites is significantly associated with infection. This analysis excluded 1 SSI in a patient without study cultures (drain fell out before POD 6–10). Correlation of organisms at colonization and infection was limited, with clinical infection cultures available in only three of nine SSIs (Table 3). In these three cases, the organism matched study drain culture results in one, which grew *Mycobacterium fortuitum* in drain tubing at removal (POD 26) and the same organism in breast abscess culture (POD 30) and in expander explant (POD 42). The other two infections with positive clinical cultures occurred after POD 30 (both methicillin-susceptible *Staphylococcus aureus).*

Microbiology of Colonization

Microbial isolates are listed in Supplemental Table 1. The most common organism type was *coagulase negative Staphylococcus* species (43 % of fluid cultures and 55 % of tubing cultures).

Intervention Toxicity and Compliance

Contact dermatitis attributable to chlorhexidine disc was observed in seven of 104 patients (6.7 %; 95 % CI 3.3–13.2 %); all resolved after discontinuing the disc (subsequent to primary endpoint collection in each case). Compliance with the protocol was generally excellent with

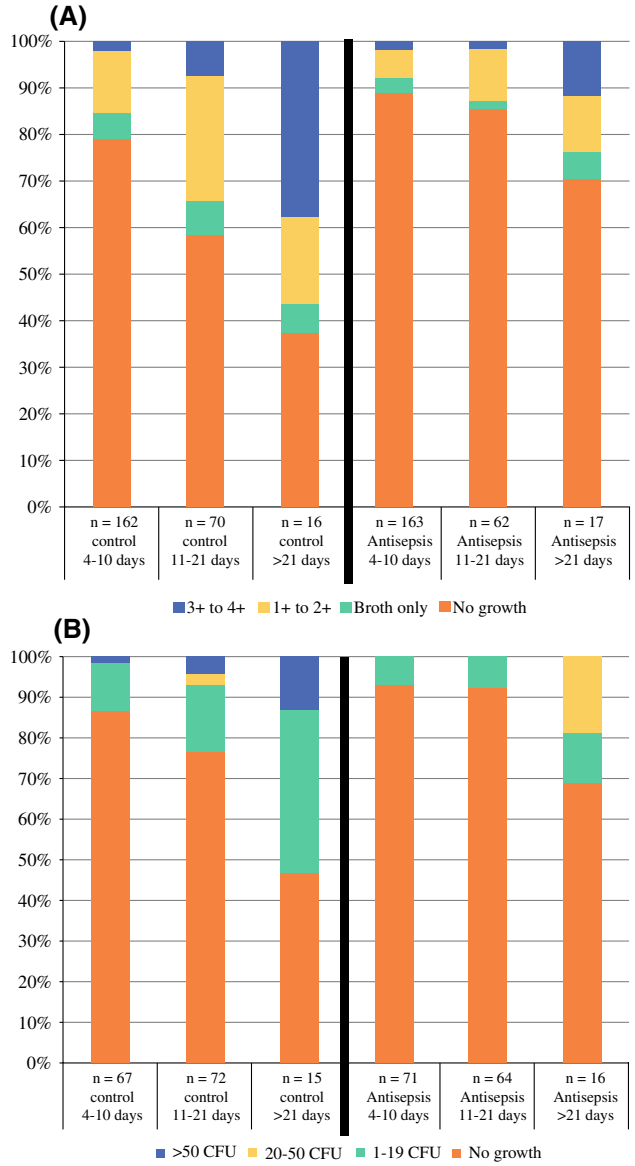

FIG. 2 Ordinal quantification of bacterial growth over time for **a** 490 drain bulb fluid cultures and **b** 305 drain tubing cultures

95 of 104 patients (91 %) having no protocol deviations deemed substantial enough to affect the primary endpoint. The nine substantial protocol deviations included: non-compliance >1 day with any part of study protocol ($n = 7$) and drain inadvertently came out before POD 6–10 culture ($n = 2$).

DISCUSSION

In this study, local antiseptic measures significantly reduced bacterial colonization of surgical drains after mastectomy with implant reconstruction. Bacterial colonization of drains was linked to clinical infection, with significantly fewer SSIs in sides without colonization. This study was not powered to show a difference in SSI; however, fewer SSIs occurred in sides treated with antisepsis measures, both within 30 days and 1 year, although these differences were not statistically significant. A prior study has also demonstrated bacterial colonization of drain fluid after mastectomy, with 33 % of drains colonized at 1 week, and strong concordance of microorganisms across colonization and infection cultures.[12] Overall, these findings strongly implicate a causal relationship between SSI and bacterial colonization of drains, as well as an opportunity for SSI reduction, in women undergoing implant reconstruction.

SSI prevention has gained national attention because of its cost and morbidity. Infection rates after mastectomy and implant reconstruction range from 5 to 19 % in recent literature, high for what is considered a "clean" case and calling for improvement.[1,2,13–15] Our findings were similar: 3.8 % within 30 days and 7.7 % within 1 year. Although a 5 % SSI rate may appear low, the potential result of expander removal due to infection is devastating to the patient. Intravenous catheter related infections are also rare but are reduced with use of a chlorhexidine disc dressing.[16,17] Some cellulitis cases after implant reconstruction may resolve with treatment, but they can predispose to subsequent explantation (i.e., reconstruction failure). In a study of 1952 implant-based reconstructions, cellulitis occurred in 5 % of patients, and 75 % of cellulitis cases required explantation.[1] Therefore, even small reductions in SSI are valuable if achievable at acceptable cost. Based on drain numbers and duration in our study, median drain antisepsis costs were $108 per side. If antisepsis reduces SSI by half, then 40 breast reconstructions would require treatment (estimated cost of $4320) to prevent 1 SSI. The attributable cost of SSI after mastectomy has been estimated as $4091, an underestimate as it did not include the substantial cost of salvage reconstruction.[13] Thus, cost-effectiveness of antisepsis measures seems likely but remains unproven.

One strategy commonly utilized to reduce SSI after implant reconstruction is prolonged use of postoperative antibiotics, but this strategy is unproven and has other risks.[18–21] In contrast, drain antisepsis side effects are infrequent and self-limiting. In comparing the present study to our similar prior study of mastectomy without reconstruction, the key differences are the placement of a prosthetic device and use of postoperative antibiotics. With prolonged antibiotics in the current study, fewer control sides showed colonization at the 1 week time point (21 %) compared with the prior study (65 %), suggesting antibiotics may reduce colonization. However, antisepsis-treated sides had >twofold reduced colonization in both studies. Also, colonization of both fluid and tubing increased with longer drain duration in both studies, underscoring the

TABLE 3 Details of surgical site infections per operated side within 1 year of index operation (includes only SSI cases that occurred before a secondary operation such as tissue expander/implant exchange)

Pt no.	SSI side	POD of SSI onset	Severity of SSI	No. drains on side of SSI		Study bulb fluid culture results at "1 week (POD 6–10) and at drain removal	POD of drain removal and study tubing culture results	Clinical culture results and comments
				Mastx	Axillary			
1	Control	POD 12	Cellulitis	1	0	1 week: 1 + CoNS	POD 9: >100 CFU CoNS	Not obtained; seen at outside hospital
2	Control	POD 14	Cellulitis	2	0	1 week: no growth either drain		Not obtained; cellulitis only
						POD 14: Mastx drain1	POD 14: Mastx drain1	
						No growth	18 CFU CoN	
						POD 17: Mastx drain2	POD 17: Mastx drain2	
						No growth	1 CFU CoNS	
3	Control	POD 14	Cellulitis	2	0	1 week: Mastx drain 1	Cultures missed due to protocol deviation	Not obtained; cellulitis only
						1 + *Stomatococcus mucilaginosus*		
						VGS with unknown quantification		
						1 week: Mastx drain 2		
						Broth only GPB (not Clostridium or Propionibacterium species)		
4	Control	POD 30	Deep SSI requiring TE removal	2	0	1 week: No growth either drain		
						POD 26: Mastx drain1	POD 26: Mastx drain1	POD 30: abscess fluid *M fortuitum*
						4 + *Pseudomonas stutzeri*	51–100 CFU GPB	
						1 + CoNS	*Mycobacterium fortuitum* with unknown quantification	
						POD 29: Mastx drain2	POD 29: Mastx drain2	POD 42: TE explant *M fortuitum*
						4 + *Pseudomonas stutzeri*	No growth	
						4 + *Acinetobacter* species		
						2 + *Enterococcus* species		
5	Antisepsis	POD 34	Cellulitis	1	0	N/A, patient's drain fell out	N/A, patient's drain fell out	Not obtained; cellulitis only
6	Antisepsis	POD 89	Deep SSI requiring TE removal	2	1	POD 4: Mastx drain1	POD 4: Mastx drain1:	POD 89 cultures:
						No growth	No growth	2 + MSSA (breast swab)
						1 week: no growth Mastx drain2 or Axillary drain		3 + MSSA (breast tissue)
						POD 23: Mastx Drain2	POD 23: Mastx drain2	
						No growth	No growth	1 + MSSA (deep breast tissue)
						POD 29: Axillary drain	POD 29: Axillary drain	
						No growth	No growth	

TABLE 3 continued

Pt no.	SSI side	POD of SSI onset	Severity of SSI	No. drains on side of SSI		Study bulb fluid culture results at "1 week (POD 6–10) and at drain removal	POD of drain removal and study tubing culture results	Clinical culture results and comments
				Mastx	Axillary			
7	Antisepsis	POD 165	Deep SSI requiring TE removal	2	0	1 week (POD 7):	POD 7: Mastx drain2	Not obtained
						No growth either drain	No growth	
						POD 9: Mastx Drain1	POD 9: Mastx drain1	
						1 + *Propionibacterium acnes*	No growth	
	Control	POD 165	Deep SSI requiring TE removal	2	1	1 week (POD7):	POD 7: Mastx drain1	Not obtained; SSI occurred after PMRT
						No growth any drain	1 CFU non-spore-forming GPB	
							1 CFU *Streptococcus mitis*	
						POD 13: Axillary drain	POD 13: Axillary drain	
						2 + VGS	No growth	
						1 + CoNS		
						POD 16: Mastx drain2	POD 16: Mastx drain2	
						1 + CoNS		
						1 + *Staphylococcus pasteuri*	No growth	
						1 + *Citrobacter freundii* complex		
						1 + GPB		
8	Control	POD 230	Deep SSI requiring TE removal	1	0	1 week: 1 + VGS		POD 231: Breast swab
						POD 22: Mastx drain	POD 22: Mastx drain	
						3 + *Enterococcus* species		
						2 + *Corynebacterium* species	No growth	No growth
						2 + *Staphylococcus haemolyticus*		POD 232:
						1 + *Acinetobacter* species		Breast fluid, 1 colony MSSA
								Breast capsule, 1 colony MSSA
								SSI occurred after PMRT

CoNS coagulase-negative *Staphylococcus* species, *GPB* gram-positive bacillus, *Mastx* mastectomy, *MSSA* methicillin sensitive *Staphylococcus aureus, PMRT* postmastectomy radiotherapy, *POD* postoperative day, *SSI* surgical site infection, *VGS* viridans group *Streptococcus* species

importance of removing drains at the earliest possible time. These findings are consistent with prior breast surgery investigations confirming increased infection risk with surgical drains and prolonged duration.[5–7]

In summary, we found that local antisepsis using a chlorhexidine disc to each drain site and drain bulb irrigation with Dakin's after mastectomy and implant reconstruction reduces bacterial colonization of drain bulb fluid and tubing. Reduced colonization of drains was associated with decreased frequency of SSI, demonstrating that local antisepsis has potential to reduce infections. The interventions are simple, have little toxicity, and can be adopted after mastectomy with implant reconstruction to lower bacterial colonization. A larger study with SSI as the primary endpoint is needed to confirm efficacy of drain antisepsis toward SSI reduction, its cost-effectiveness, and effects of each individual component (Biopatch and Dakin's irrigation).

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