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# Antimicrobial Irrigation Difference in Implant-Based Reconstruction: Triple-Antibiotic Solution *versus* Chlorhexidine-Gluconate Based Solution

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## Abstract

**Background:** Antimicrobial irrigation solutions are a widely practiced method to reduce infection and capsular contracture following mastectomy in implant-based breast reconstruction. This study compares the postoperative outcomes between a Triple Antibiotic Solution (TAS) and a 0.05% Chlorhexidine gluconate solution (CHG).

**Methods:** A multi-institutional retrospective cohort study was conducted, reviewing 304 breast reconstructions in 171 patients between April 2020 and July 2024. Patients were divided into two groups based on the use of TAS or CHG for implant irrigation. Postoperative complications, including hematoma, capsular contracture, infection, and the need for secondary procedures, were assessed at ≤30 and ≥60 days. Comparative statistical analysis was performed using t-tests, Wilcoxon rank-sum tests, Chi-squared tests, and multivariate regression.

**Results:** Of the 304 breast reconstructions, TAS was used in 249 breasts and CHG in 55 breasts. There were no statistically significant differences between the TAS and CHG groups in <30-day complications such as seroma [1 (0.4%) *vs.* 0 (0%), p=0.82], surgical site infection [2 (0.8%) *vs.* 0 (0%), p=0.67], or unplanned return to the operating room [16 (6.4%) *vs.* 2 (3.6%), p=0.34]. Similarly, no significant differences were observed between TAS and CHG groups in ≥60-day outcomes, including capsular contracture [5 (2%) *vs.* 2 (3.6%), p=0.37].

**Conclusion:** TAS and CHG had no significant differences in rates of post-operative complications in IBR. Given the higher cost of chlorhexidine-based solutions and the absence of clear clinical superiority, TAS may present a more cost-effective option for IBR. Further prospective studies are warranted to establish optimal irrigation protocols in reconstructive breast surgery.

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## Introduction

Implant-based Breast Reconstruction (IBR) is a valuable reconstructive procedure for those undergoing oncologic mastectomy. Considerations of a successful operation include implant type, placement, and infection prophylaxis [1,2]. Capsular contracture, implant malposition, and implant infection following an implant placement can lead to revisions [3-5]. Past studies have reported implant-related infections for aesthetic breast augmentation to range from 1.1% to 2.5%. For IBR, the rate is cited to be slightly higher at 1% to 35% [6-8]

Efforts aimed at preventing complications such as infection or capsular contracture include utilizing irrigation solutions [2]. Studies have shown that the routine usage of antimicrobial pocket irrigation and implant soaking agents have led to decreased rates of implant-associated infection and subsequent capsular contracture [9,10]. The most widely used irrigation solutions include triple antibiotics regimens, iodine-based solutions, and 0.05% Chlorhexidine gluconate (CHG) formulations [11].

Current literature lacks evidence-based consensus on the optimal irrigation and implant-soaking solution for the reconstructive population [12]. There still remains skepticism within the surgical community that CHG formulations offer comparable efficacy to antibiotic solutions in

preventing or reducing such complications [11] This study aimed to compare post-operative outcomes including rate of infection in a cohort of patients undergoing IBR with chlorhexidine-based solution and triple antibiotic solution.

## Methods

### Study design and data collection

After Institutional Board Approval (MedStar Health Research institution 2018-173), a multi-institution retrospective cohort study of consecutive patients undergoing IBR following mastectomy between April 2020 and July 2024 was conducted. All mastectomies were performed by MedStar breast surgeons (L.M.D.L.C., J.D.S., P.B.S., C.F.E., I.T.G.), and all IBR were performed by two senior authors (K.L.F. and S.J.). Patients over the age of 18 who underwent IBR for oncologic reconstruction were included. Patients undergoing breast augmentation with implants were not included.

Electronic medical records were reviewed for patient characteristics, oncologic and surgical history, operative details, and postoperative outcomes. Patient characteristics included age, sex, race, BMI, comorbidities such as hypertension or diabetes, smoking and alcohol history, and psychiatric history. Breast oncologic history was collected including chemotherapy and radiation therapy. Additional surgical details were also collected including breast resection type, incision type, implant placement location, implant texture, use of drains, use of acellular dermal matrix, lymph node dissection, and operative duration.

Patients were categorized into two groups based on the antibiotic solution used during the patients' reconstructive surgery: Triple-Antibiotic Solution (TAS) or 0.05% Chlorhexidine gluconate (CHG). Routinely, all breast pockets were irrigated first with sterile betadine and then two to three times with TAS or CHG solution. The breast implant was simultaneously bathed in the same type of irrigation solution used to irrigate the pocket. The primary outcomes are comprised of post-operative clinical outcomes. Postoperative complications such as hematoma, capsular contracture, surgical site infection, and secondary procedures were collected. Clinical records were evaluated postoperatively for complications at ≤ 30 days and ≥ 60 days. Time until follow-up was also obtained for each patient.

### Statistical analysis

Comparative analyses were conducted between the TAS and CHG groups. STATA version 18.0 (StataCorp, College Station, TX) was used to conduct paired t-tests, and Wilcoxon rank-sum tests, and univariate Chi-squared tests to analyze normally distributed continuous, non-normally distributed continuous, and categorical data, respectively. Fisher's exact test was used for cell counts less than five. A P value <0.05. determined statistical significance. To determine the effects of possible confounding variables identified in patient and surgical characteristic analysis, univariate regression analysis was performed. Variables that were identified as significant co-variates from univariate regression analysis were used to create multivariable models.

## Results

A total of 304 breasts in 171 patients met inclusion criteria. TAS was used in 249 IBR (81.9%) and CHG was used in 55 IBR (18.1%). At the time of surgery, median age was 51 (Interquartile Range [IQR], 9) for the TAS group versus 49 (IQR, 12) for the CHG group (p=0.73). Median body mass index was similar (p=0.86) between TAS [25 (IQR 6.87)] and CHG [25.64 (IQR 7.64)] groups. Distribution of race varied significantly between groups, with both the TAS and CHG cohort identifying as White (p=0.004). Median Charlson Comorbidity Index for TAS and CHG groups were both 2 (IQR, 1). Patient characteristics are summarized in Table 1.

Table 2 summarizes surgical and oncologic histories between the TAS and CHG cohorts. A higher number of breasts in the TAS cohort, compared to the CHG cohort, had prior breast reduction (n=2, 0.8% *vs.* n=0, 0%, p=0.02) and prior breast reconstruction (n=27, 10.8% *vs.* n=4, 7.3%, p=0.02). Prior lumpectomy in breasts between the TAS and CHG cohorts was 9 (3.6%) *vs.* 2 (3.6%), respectively (p=0.02). There was a lower proportion of breasts in the TAS cohort that had previous excisional biopsy compared to the TAS cohort (n=11, 4.4% *vs.* n=7, 12.73%, p=0.02). Concerning chemotherapy history, of the TAS cohort, 31 (12.9%) breasts received neoadjuvant chemotherapy, 91 (38%) received adjuvant chemotherapy, and 17 (7.1%) received both. Of the CHG cohort, 7 (13.5%) breasts received neoadjuvant chemotherapy, 6 (11.5%) received adjuvant chemotherapy, and 2 (3.9%) received both. There was a significant difference in chemotherapy history between TAS and CHG groups (p=0.001). Radiation history was similar between TAS and CHG groups: respectively, 8 (3.5%) *vs.* 1 (1.9%) breast received neoadjuvant radiation, 62 (25.9%) *vs.* 6 (11.5%) received adjuvant radiation, and 1 (0.4%) *vs.* 0 (0%) received both (p=0.09).

### Operative details

Details of the index surgical procedure (Mastectomy and subsequent IBR) are summarized in Table 3. Mastectomy type varied across groups (p=0.001): of the TAS breasts, 156 (61.5%) received nipple sparing mastectomy, 78 (31.6%) received a skin sparing mastectomy, 5 (2%) received a simple mastectomy, 2 (0.8%) received a modified radical mastectomy and of the CHG breasts, 44 (80%) received a nipple sparing mastectomy, 6 (10.9%) received a skin sparing mastectomy, and 5 (9.1%) received a simple mastectomy. Regarding the incision type, of the TAS cohort, 202 (81.1%) of breasts had an inframammary fold incision, 15 (6%) had an elliptical incision, 24 (9.6%) had a wise pattern incision, and 1 (0.4%) had a circumareolar incision. Of the CHG cohort, 51 (92.7%) of breasts had an inframammary fold incision and 4 (7.27%) had a wise pattern incision. There was no significant difference between incision types (p=0.19). Mastectomy weight was similar between TAS and CHG breasts: 305 grams (IQR 304.5) *vs.* 242.5 grams (IQR 262), respectively (p=0.14). Drains were placed in all patients of the TAS and CHG cohorts: 249 (100%) *vs.* 55 (100%), respectively.

Duration of surgery was similar between TAS and CHG cohorts: 205 minutes (IQR 100) *vs.* 157 minutes (IQR 170), respectively. The majority of IBR were performed as Direct-to-Implant (DTI) for both cohorts: 226 (90.8%) of TAS breasts, and 50 (90.91%) of CHG breasts. Most implants were of the brand MENTOR (Mentor Worldwide, city, state): 242 (97.2%) of TAS cohort implants and 55 (100%) of CHG cohort implants. The majority of the implant type was silicone for both cohorts: 239 (95.9%) implants in the TAS group and 55 (100%) implants in the CHG group. Most of the implants' texture was smooth: 247 (99.2%) implants in the TAS cohort and 55 (100%) implants in the CHG cohort. Additionally, most implants in both cohorts were placed in the pre-pectoral plane: 217 (87.2%) implants in the TAS group and 52 (94.6%) implants in the CHG group (p=0.09). ADM was used at a significantly higher rate in the TAS group compared to CHG group: 217 (87.1%) *vs.* 15 (27.2%), respectively (p=0.01). The

**Table 1:** Patient characteristic and demographic information of implant-based reconstruction. Bold p-values indicate statistical significance (p<0.05).

| Patient Characteristics | Antimicrobial Solution | | | |
|---|---|---|---|---|
| | Total Population | Triple Antibiotic Solution | 0.05% Chlorhexidine-Gluconate Solution | p value |
| | n = 171 | n = 141 (82.5) | n = 30 (17.5) | |
| Race | | | | **0.004** |
| African American | 45 (26.3%) | 37 (26.2%) | 8 (26.7%) | |
| White | 94 (54.9%) | 83 (58.9%) | 11 (36.7%) | |
| Hispanic | 1 (0.58%) | 1 (0.1%) | 0 (0%) | |
| Asian | 7 (4.09%) | 6 (0.4%) | 1 (3.3%) | |
| Other | 24 (14%) | 14 (9.93%) | 10 (33%) | |
| Age, years | | | | |
| (median (IQR)) | 50 (18) | 51 (9) | 49 (12) | 0.73 |
| Body Mass Index | | | | |
| (median (IQR)) | 25.27 (7.22) | 25.1 (7.19) | 25.93 (7.51) | 0.86 |
| Charlson Comorbidity Index | | | | |
| (median (IQR)) | 2 (1) | 2 (1) | 2 (1) | 0.83 |
| Diabetes Mellitus | 0 (0%) | 0 (0%) | 0 (0%) | 0.65 |
| Metastatic malignancy | 8 (4.68%) | 8 (5.67%) | 0 (0%) | 0.234 |
| Congestive Heart Failure | 5 (2.92%) | 4 (2.84%) | 1 (3.33%) | 0.624 |
| Chronic Obstructive Pulmonary Disease | 2 (1.17%) | 2 (1.42%) | 0 (0%) | 0.679 |
| Cerebrovascular Accident | 2 (1.17%) | 2 (1.42%) | 0 (0%) | 0.679 |
| Dementia | 2 (1.17%) | 2 (1.42%) | 0 (0%) | 0.679 |
| Connective Tissue Disease | 7 (4.09%) | 6 (4.26%) | 1 (3.33%) | 0.645 |
| Pneumonia <30 days before Surgery | 1 (0.58%) | 1 (0.71%) | 0 (0) | 0.825 |
| Hypertension | 36 (21.05%) | 31 (22%) | 5 (16.7%) | 0.354 |
| Dyslipidemia | 39 (22.81%) | 32 (22.7%) | 7 (23.3%) | 0.554 |
| End Stage Renal Disease | 3 (1.75%) | 1 (0.71) | 2 (6.67) | 0.08 |
| Obesity | 39 (22.81%) | 33 (23.4%) | 6 (20%) | 0.687 |
| Marijuana use | 7 (4.09%) | 6 (4.26%) | 1 (3.33%) | 0.645 |
| Former Smoker | 30 (17.54%) | 25 (17.73%) | 5 (16.67%) | 0.564 |
| Current Smoker | 9 (5.26%) | 5 (3.55%) | 4 (13.33%) | 0.052 |
| >2 Alcohol drinks/day | 4 (2.34%) | 4 (2.84%) | 0 (0%) | 0.46 |
| Active Oral Steroid use | 14 (8.19%) | 12 (8.51%) | 2 (6.67%) | 1 |
| Psychiatric Diagnosis | 60 (35.09%) | 52 (36.88%) | 8 (26.67%) | 0.19 |
| Major Depressive Disorder | 35 (20.47%) | 31 (21.9) | 4 (13.3) | 0.21 |
| Generalized Anxiety Disorder | 41 (23.98%) | 35 (24.8) | 6 (20) | 0.38 |
| Active Psychiatric Medication | 48 (28.07%) | 43 (30.5) | 5 (16.7) | 0.09 |

majority of IBR used Dermacell (Stryker): 154 (61.9%) of breasts in the TAS cohort compared to 10 (18.2%) of breasts in the CHG cohort.

## Implant outcomes and complications

Incidence of ≤30-day complications are summarized in Table 4. Between groups, there was no significant difference in ≤30-day seroma formation [1 (0.4%) *vs.* 0 (0%), p=0.82], hematoma formation [8 (3.2%) *vs.* 0 (0%), p=0.2], dehiscence [5 (2%) *vs.* 0 (0%)], delayed healing [13 (5.2%) *vs.* 2 (3.6%), p=0.47], mastectomy flap necrosis [13 (5.2%) *vs.* 2 (3.6%), p=0.47], cellulitis [7 (2.8%) *vs.* 0 (0%), p=0.24], surgical site infection [2 (0.8%) *vs.* 0 (0%), p=0.67], or unplanned return to the operating room [16 (6.4%) *vs.* 2 (3.6%), p=0.34], respectively. Table 4 also displays incidence of ≥60-day complications. Likewise, there was no significant difference in ≥60-day seroma formation [4 (1.6%) *vs.* 0 (0%), p=0.45], hematoma formation [1 (0.4%) *vs.* 0 (0%), p=0.82], dehiscence [9 (3.6%) *vs.* 1 (1.8%), p=0.43], mastectomy flap necrosis [4 (1.6%) *vs.* 0 (0%), p=0.45], cellulitis [4 (1.6%) *vs.* 0 (0%), p=0.447], surgical site infection [6 (2.4%) *vs.* 1 (1.8%), p=0.63], unplanned implant removal [20 (8.1%) *vs.* 1 (1.8%), p=0.08], capsular contracture [5 (2%) *vs.* 2 (3.6%), p=0.37], respectively. There were no cases of red breast syndrome or breast implant-associated anaplastic large-cell lymphoma at any time point. Time to follow up was similar between groups: TAS patients' follow up was 31 days (IQR 15) and CHG patients' follow up was 32 days (IQR 14), (p=0.896).

Results of univariate regression analysis of all collected variables on ≤30-day postoperative complications, ≥60-day postoperative

**Table 2:** Surgical and oncologic history of implant-based reconstruction, by breast. Bold p-values indicate statistical significance (p<0.05).

| Surgical and Oncologic History | Antimicrobial Solution | | | |
|---|---|---|---|---|
| | Total Breasts (n = 304) | Triple Antibiotic Solution (n = 249) | 0.05% Chlorhexidine-Gluconate Solution (n = 55) | p value |
| Surgical History | | | | **0.022** |
| Breast Reduction | 2 (3.13%) | 2 (0.8%) | 0 (0%) | |
| Breast Recon | 2 (3.13%) | 27 (10.84%) | 4 (7.27%) | |
| Lumpectomy | 11 (17.19%) | 9 (3.61%) | 2 (3.62%) | |
| Excisional Biopsy | 18 (28.13%) | 11 (4.42%) | 7 (12.73%) | |
| Chemo | | | | **0.001** |
| Adjuvant | 97 (33.33%) | 91 (38%) | 6 (11.54%) | |
| Neoadjuvant | 38 (13.06%) | 31 (12.97%) | 7 (13.46%) | |
| Both | 19 (6.53%) | 17 (7.11%) | 2 (3.85%) | |
| XRT | | | | 0.09 |
| Neoadjuvant | 9 (3.09%) | 8 (3.35%) | 1 (1.92%) | |
| Adjuvant | 68 (23.37%) | 62 (25.94%) | 6 (11.54%) | |
| Both | 1 (0.34%) | 1 (0.42%) | 0 (0%) | |

**Table 3:** Operative details of implant-based reconstructions, by breast. Bold p-values indicate statistical significance (p<0.05).

| Operative Details | Antimicrobial Solution | | | |
|---|---|---|---|---|
| | Total Breasts (n = 304) | Triple Antibiotic Solution (n = 249) | 0.05% Chlorhexidine-Gluconate Solution (n = 55) | p value |
| **Initial breast surgery** | | | | **0.001** |
| Nipple Sparing Mastectomy | 200 (65.79%) | 156 (62.7%) | 44 (80%) | |
| Skin Sparing Mastectomy | 84 (27.63%) | 78 (31.3%) | 6 (10.91%) | |
| Simple Mastectomy | 10 (3.29%) | 5 (2.02%) | 5 (9.09%) | |
| Modified Radical Mastectomy | 2 (0.66%) | 2 (0.81%) | 0 (0%) | |
| Other | 8 (2.63%) | 8 (3.24%) | 0 (0%) | |
| **Incision type** | | | | 0.19 |
| Inframmamry fold | 253 (83.22%) | 202 (81.12%) | 51 (92.73%) | |
| Elliptical | 15 (4.93%) | 15 (6.02%) | 0 (0%) | |
| Wise Pattern | 28 (9.21%) | 24 (9.64%) | 4 (7.27%) | |
| Other | 7 (2.3%) | 7 (2.81%) | 0 (0%) | |
| Circumareolar | 1 (0.33%) | 1 (0.4%) | 0 (0%) | |
| Sentinel Lymph Node Biopsy | 112 (34.54%) | 88 (35.3%) | 17 (30.91%) | 0.48 |
| Axillary Lymph Node Dissection | 20 (6.57%) | 24 (9.64%) | 3 (5.45%) | 0.48 |
| Drains Usage | 304 (100%) | 249 (100%) | 55 (100%) | 0.81 |
| Operation duration (minutes) | 192 (105.5) | 205 (100) | 157 (170) | **0.002** |
| Direct to implant | 276 (90.79%) | 226 (90.76%) | 50 (90.91%) | 0.605 |
| **Implant brand** | | | | 1 |
| Allergen | 3 (0.99%) | 3 (1.2%) | 0 (0%) | |
| Mentor | 297 (97.7%) | 242 (97.2%) | 55 (100%) | |
| Sientra | 2 (0.66%) | 2 (0.8%) | 0 (0%) | |
| Other | 2 (0.66%) | 2 (0.8%) | 0 (0%) | |
| **Implant type** | | | | 0.13 |
| Silicone | 294 (96.71%) | 239 (95.98%) | 55 (100%) | |
| Saline | 10 (3.29%) | 10 (4.02%) | 0 (0%) | |
| **Implant texture** | | | | 0.67 |
| Smooth | 302 (99.34%) | 247 (99.2%) | 55 (100%) | |
| Textured | 2 (0.66%) | 2 (0.8%) | 0 (0%) | |

| | | | | |
|---|---|---|---|---|
| **Implant Placement** | | | | 0.09 |
| Pre-pectoral | 269 (88.49%) | 217 (87.15%) | 52 (94.55%) | |
| Retro-pectoral | 35 (11.51%) | 32 (12.85%) | 3 (5.45%) | |
| **Acellular Dermal Matrix** | | | | **0.01** |
| Surgimed | 60 (19.74%) | 60 (24.1%) | 0 (0%) | |
| Alloderm | 8 (2.63%) | 3 (1.2%) | 5 (9.09%) | |
| Dermacell | 164 (53.95%) | 154 (61.54%) | 10 (18.18%) | |

**Table 4:** 30-day and 60-day postoperative complications, by breast. Bold p-values indicate statistical significance (p<0.05).

| Complication Details | Antimicrobial Solution | | | |
|---|---|---|---|---|
| | Total Breasts | Triple Antibiotic Solution | 0.05% Chlorhexidine-Gluconate Solution | p value |
| **<30 days post op complication** | 51 (16.78%) | 46 (18.47%) | 5 (9.09%) | 0.09 |
| Seroma | 1 (0.33%) | 1 (0.4%) | 0 (0%) | 0.82 |
| Hematoma | 8 (2.63%) | 8 (3.21%) | 0 (0%) | 0.2 |
| Dehiscence | 5 (1.64%) | 5 (2.01%) | 0 (0%) | 0.37 |
| Delayed healing | 14 (4.61%) | 13 (5.2%) | 2 (3.64%) | 0.47 |
| Mastectomy flap necrosis | 15 (4.93%) | 13 (5.22%) | 2 (3.64%) | 0.47 |
| Red breast syndrome | 0 (0%) | 0 (0%) | 0 (0%) | 0 |
| Cellulitis | 7 (2.3%) | 7 (2.81%) | 0 (0%) | 0.244 |
| Surgical Site Infection | 2 (0.66%) | 2 (0.8%) | 0 (0%) | 0.67 |
| Unplanned Return to OR | 18 (5.92%) | 16 (6.43%) | 2 (3.64%) | 0.335 |
| **>60 day postop complication** | 32 (10.56%) | 29 (11.69%) | 3 (5.45%) | 0.13 |
| Seroma | 4 (1.32%) | 4 (1.61%) | 0 (0%) | 0.447 |
| Hematoma | 1 (0.33%) | 1 (0.4%) | 0 (0%) | 0.818 |
| Dehiscence | 10 (3.3%) | 9 (3.63%) | 1 (1.82%) | 0.431 |
| Mastectomy flap necrosis | 4 (1.32%) | 4 (1.61%) | 0 (0%) | 0.447 |
| Red breast syndrome | 0 (0%) | 0 (0%) | 0 (0%) | 0 |
| Cellulitis | 4 (1.32%) | 4 (1.61%) | 0 (0%) | 0.447 |
| Surgical Site Infection | 7 (2.31%) | 6 (2.42%) | 1 (1.82%) | 0.63 |
| Unplanned implant removal | 21 (6.93%) | 20 (8.06%) | 1 (1.82%) | 0.078 |
| Capsular contracture | 7 (2.31%) | 5 (2.02%) | 2 (3.64%) | 0.073 |
| Degree of capsular contracture (mean (stdev)) | 1.86 (±1.07) | 1.4 (±0.89) | 3 (±0) | 0.062 |
| Breast Implant Associated ALCL | 0 (0%) | 0 (0%) | 0 (0%) | 0 |
| Cancer Recurrence | 6 (1.98%) | 6 (2.42%) | 0 (0%) | 0.3 |
| **Days to follow up (median (IQR))** | 31 (15) | 31 (15) | 32 (14) | 0.896 |

complications, and capsular contracture is displayed supplemental Table 1. Operative duration was a significant co-variate to ≤30 day and ≥60-day postoperative complications. Simple mastectomy was a significant co-variate to ≥60-day postoperative complication and capsular contracture. Type of irrigation solution was not a significant variable for either <30 day or >60-day complications. Results of multivariate regression analysis is displayed in supplemental table 2. ADM use was not a significant variable for <30-day complications, >60-day complications, or capsular contracture.

## Discussion

In our study of 304 breasts undergoing IBR for oncologic purposes, we determined that there were no significant differences between TAS and CHG in terms of post-operative complications or rate of infection. This study contributes to the ongoing discussion regarding implant irrigation solution. The use of antimicrobial irrigation solutions is ubiquitous throughout surgical specialties and their effectiveness is well reported [13-15]. Specific to breast reconstruction, antimicrobial implant soaking agents and breast pocket irrigation are methods used to prevent infection, capsular contracture, and return to the operating room, amongst other postoperative complications. Both TAS and CHG solutions have been shown to be effective antimicrobial irrigation agents in various implant-based surgeries but have not been compared in the setting of IBR [13,16].

With an incidence of 10.6%, capsular contracture leads to excessive pain and deformity and possible need for revision [3] Adams et al. demonstrated that the use of triple-antibiotic solution reduced incidence of grade III/IV capsular contracture in patients receiving implants for aesthetic and reconstructive indicaitons [17]. In our study, we found relatively low rates of this complication (total 2.31%; TAS

**Supplementary Table 1:**

| | Supplement Table 1: Univariate Regression Analysis | | |
|---|---|---|---|
| | ≤30 Day Complications | ≥60 Day Complications | Capsular Contracture |
| Age | 0.012 (0.527) | 0.011 (0.634) | 0.012 (0.796) |
| Diabetes Mellitus | 0.513 (0.369) | 0.979 (0.326) | - |
| Body Mass Index | 0.029 (0.251) | 0.011 (0.76) | 0.125 (0.191) |
| Hyperlipidemia | 0.167 (0.7) | 0.514 (0.396) | 0.79 (0.515) |
| **Surgical History** | | | |
| Breast Reduction | - | - | - |
| Breast Recon | - | - | - |
| Lumpectomy | - | - | - |
| Excisional Biopsy | 1.215 (0.315) | - | - |
| **Chemotherapy** | | | |
| Adjuvant | 0.517 (0.585) | 1.21 (0.447) | - |
| Neoadjuvant | 1.172 (0.427) | - | - |
| Both | - | - | - |
| **Radiation Therapy** | | | |
| Neoadjuvant | - | - | - |
| Adjuvant | 0.601 (0.556) | 1.21 (0.447) | - |
| Both | - | - | - |
| Direct to Implant | 0.066 (0.927) | - | - |
| **Initial breast surgery** | | | |
| NSM | - | - | - |
| SSM | 0.001 (0.998) | **1.506 (0.005)** | 0.062 (0.959) |
| Simple Mastectomy | 0.343 (0.737) | **2.487 (0.022)** | **3.832 (0.046)** |
| MRM | - | - | - |
| Other | - | - | - |
| **Incision type** | | | |
| Inframammary fold | - | 1.172 (0.142) | |
| Elliptical | 1.236 (0.309) | - | - |
| Wise Pattern | - | 0.76 (0.216) | - |
| Other | 0.63 (0.222) | - | 2.354 (0.074) |
| Circumareolar | 0.294 (0.796) | - | - |
| Axillary Lymph Node Dissection | 0.637 (0.355) | 0.112 (0.894) | 1.304 (0.381) |
| Operative duration | **0.005 (0.022)** | **0.007 (0.01)** | 0.002 (0.768) |
| Implant Brand | | | |
| Allergen | - | - | - |
| Mentor | 2.072 (0.267) | 0.12 (0.941) | - |
| Sientra | - | - | - |
| Other | - | - | - |
| Implant Type | 0.99 (0.44) | 1.458 (0.159) | - |
| Implant Placement | 0.837 (0.097) | 0.099 (0.889) | - |
| **Acellular Dermal Matrix** | | | |
| Surgimed | 0.471 (0.442) | 0.955 (0.326) | 0.537 (0.783) |
| Alloderm | 1.548 (0.114) | 2.19 (0.106) | - |
| Dermacell | 0.685 (0.186) | 0.875 (0.344) | 1.223 (0.483) |
| Antimicrobial solution | 0.716 (0.159) | 0.713 (0.267) | 1.054 (0.255) |

Significance set at p<0.05. Categorical variables listed as Odds Ratio (p-value) and continuous variables listed as Coefficient (p-value). Statistical analysis completed using linear logistic or linear regression, as appropriate.

**Supplementary Table 2:**

| | Supplemental Table 2: Confounding Variable Multivariate Regression Analysis | | |
|---|---|---|---|
| | <30 Day Complications | >60 Day Complications | Capsular Contracture |
| **Initial breast surgery** | | | |
| Skin Sparing Mastectomy | 1.164 (0.663) | **5.479 (0.001)** | 1.569 (0.634) |
| Simple Mastectomy | 1.876 (0.461) | **12.876 (0.002)** | **24.775 (0.003)** |
| Operative duration | **1.005 (0.024)** | **0.005 (0.021)** | 1.006 (0.164) |
| Implant Placement | 1.741 (0.296) | 0.555 (0.334) | - |
| Acellular Dermal Matrix Use | 1.059 (0.252) | 0.057 (0.753) | 1.177 (0.654) |
| Antimicrobial Solution | 0.650 (0.394) | 0.430 (0.556) | 1.715 (0.617) |
| Significance set at p<0.05. Categorical variables listed as Odds Ratio (p-value) and continuous variables listed as Coefficient (p-value). Statistical analysis completed using multivariate logistic or linear regression, as appropriate. | | | |

2.02%; CHG 3.64%). Studies report a multitude of factors contribute to this complication, including concurrent implant infection, prior radiation or chemotherapy, and patient demographics such as age and comorbidities [18,19]. TAS has been previously shown to reduce incidence of capsular contracture three-fold in IBR [17]. However, in our current study we demonstrate similar outcomes between TAS and CHG use in regard to seroma, hematoma, dehiscence, surgical site infection, and capsular contracture. With the use of both solutions, we achieved very low complication rates overall.

In addition to antimicrobial solutions used, other factors may have a more important effect on the incidence of short and long-term postoperative complications. Amongst both TAS and CHG cohorts, the most common incision performed was along the inframammary fold. Literature has demonstrated that the inframammary fold offers a stable anatomical location for incision placement that minimizes the incidence of trauma and inflammation, factors known to contribute to capsular contracture [20,21]. In addition, the vast majority of IBR performed in both TAS and CHG cohorts had implants placed in the pre-pectoral space. Placement of implants in the pre-pectoral space has been shown to have comparable rates of capsular contracture, prosthesis failure, and animation deformity when compared to subpectoral IBR [10,22].

In general, ADMs are used to decrease implant exposure, decrease rippling, and may enhance aesthetic results [23] Additionally, ADMs are thought to alter the reactive processes at the tissue-implant interface, potentially reducing rates or delaying onset of contracture [3]. However, ADMs usage may lead to increased risk of seroma formation, infection, or red breast syndrome [23,24]. While the usage of ADM was significantly higher in the TAS cohort, there were no significant differences in notable postoperative outcomes. Given that the literature presents conflicting views regarding the incidence of infection with ADM while simultaneously highlighting its efficacy in reducing capsular contracture, its usage alone may not be sufficient in being associated with complications in our cohort [25,26]. Furthermore, our regression analysis did not yield any significance in ADM usage to short or long-term postoperative outcomes.

Patients that are female, obese, have preexisting diabetes mellitus, smoking, and history neoadjuvant chemotherapy or radiation, and prior breast therapy have been associated with increased infection rates [27-29]. Despite a balanced cohort with no significant difference in incidence of diabetes, smoking, obesity, in TAS or CHG patients, significantly more TAS patients underwent both neoadjuvant and adjuvant chemotherapy or just adjuvant chemotherapy compared to CHG patients. Furthermore, there were significantly more patients who underwent radiation (neoadjuvant, adjuvant, or both) therapy in the TAS cohort. These differences may contribute to the higher rates of postoperative complications found in the TAS cohort, although the difference in complication rate was not significant.

While implant type, whether silicone or saline, has not been significantly associated with infection, longer operation duration, lymph node dissection, and direct usage of implants during reconstruction have been shown to have a positive association [30]. Though the difference was not statistically significant, the median duration of surgery was 205 mins in the TSA group and 157 mins for the CHG group. Regardless, longer surgical times have been linked to increased risk of infection due to prolonged tissue exposure and anesthetic use, which could partially explain the higher, yet non-significant, postoperative complication rates in the TAS cohort [31]. On our regression analysis, we found that operative duration was a significant co-variate to both short and long-term postoperative complications, supporting that operative duration may have played a role in incidence of complications. Moreover, literature supports the association between lymph node dissection and seroma formation and delayed wound healing [32,33]. Patients in the TAS cohort did have more axillary lymph node dissections than the CHG cohort which may have also contributed to the TAS cohort's higher postoperative complication rates of seroma and dehiscence. However, there was no statistically significant difference in rates of axillary lymph node dissection nor short- and long- term seroma or dehiscence rates. While a favored method for immediate aesthetic outcomes, DTI has also been linked to higher rates of infection and capsular contracture in part due to the absence of a tissue expander phase [34]. While DTI reconstruction was extremely common in both cohorts (90.8% TAS, 90.91% CHG), the low rates of infection in both groups may suggest that both irrigation solutions offer effective and sufficient prophylaxis in the context of DTI.

Expanding from a medical perspective, the cost considerations of irrigation solution choice should also be considered given ambiguous surgical advantage. CHG tends to be more expensive than triple-antibiotic solutions. Research from other institutions has shown triple antibiotic solution to cost $20.43 per Bacitracin (50,000U) + cefazolin (1g) + gentamicin (80mg) mixed with 1-L normal saline, while chlorhexidine costs $35.95 for a 950 mL solution [35]. A separate consideration is that CHG does not require mixing solutions together and is thus easier to use. Surgical staff unfamiliar with mixing the triple antibiotic solution may lead to a time consuming and confusing process to achieve an appropriate irrigation solution. This barrier to use can be exacerbated if a surgeon does not work with the

same dedicated surgical staff or operates at multiple hospitals. Given similar prevention in complication rates, cost and efficiency may be given more weight when considering which irrigation solution to use in practice.

Adverse side effects of the solutions are uncommon yet play an important role in decision-making when providing optimal patient care. In February of 2017, the United States Food and Drug Administration (FDA) issued a warning regarding a rare allergic reaction to Chlorhexidine-containing skin aseptic products [36]. Specifically, the FDA had identified 52 cases of anaphylaxis with use of CHG products applied to the skin, with 43 cases reported worldwide between January 1969 and June 2015 [36]. Given the potentially severe and devastating allergic reactions to CHG or antibiotics in TAS, caution must continue to be taken to minimize preventable adverse reactions when either irrigation solution is used. In our study, there was no incidence of allergic reactions to either TAS or CHG.

## Limitations

The nature of this study design being a retrospective multi-institution study is an inherent limitation. There may be inconsistencies in documentation or patient follow-up in the electronic medical record which may influence data collection and subsequent analysis. Additionally, the sample size of patients in the CHG cohort was smaller compared to the TAS cohort which may amplify the detection of significant difference between cohorts. However, our study found no significant difference in our primary outcomes between both cohorts.

## Conclusion

Routine breast pocket irrigation and implant soaking continues to be used as effective infection prophylaxis in implant-based breast reconstructive surgery. We found that there was no significant difference between use of triple antibiotic solution and chlorhexidine-based solution in rates of short- and long-term postoperative infection, capsular contracture, and return to the operating room.

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