INTRODUCTION

Infection rates in breast surgery are a considerable cause of morbidity and can lead to multiple secondary complications, compromising the success of surgery. A major category of aesthetic and reconstructive breast operations involve prostheses. These operations are at a higher risk of infections, due to the inclusion of a foreign body.2

There is a limited quantity of literature assessing the appropriate use of antibiotics and antiseptics in implant-based breast surgery. Consequently, there is controversy over the best method to administer antibiotic and antiseptic prophylaxis.

Recently, the Centers for Disease Control and Prevention (CDC) of the United States published guidelines for the prevention of surgical site infections.3 They recommended that surgeons follow established evidence-based protocols for their respective disciplines when using parenteral antibiotic prophylaxis and strongly recommend against providing additional intravenous (IV) antibiotics once incisions are closed.

There are currently no recommendations from the CDC on irrigation of tissues or soaking prosthetic devices in antibiotics.

The CDC recommends that surgeons consider the risk versus benefit trade-off when washing tissues with iodophor solution, as the net benefit is small and the evidence

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**Background:** The usage of antibiotics and antiseptics to washout the breast pocket, or to soak the breast implant during surgery, has come under scrutiny in recent times. Guidelines from the Centers for Disease Control and Prevention give no recommendation for or against the usage of antibiotics in this regard. They do however offer a weak recommendation for washing tissues with iodophor. This systematic review aims to investigate the efficacy and impact of such topical antibiotic or antiseptic usage in reducing infection rates.

**Methods:** A systematic electronic search was performed on the PreMEDLINE, MEDLINE, EMBASE, and CENTRAL (Cochrane) databases from inception to April 2017. Reference search was performed manually through Scopus. Results of the searches were independently screened by 2 reviewers (A.F. and P.H.). Studies involving an implant or tissue expander, with appropriate controls were included. Meta-analyses were performed where possible and data summarized when not.

**Results:** Three retrospective cohort studies were found to fit the review requirements. No randomized control trials were found. These studies covered a period of 1996–2010 for a total of 3,768 women undergoing augmentative surgery. The usage of antibiotics in pocket washout or implant immersion resulted in lower infection rates (RR = 0.52; P = 0.004; 95% CI = 0.34–0.81).

**Conclusions:** There is a clinical benefit in using antibiotics for breast pocket irrigation and implant immersion. However, the quality of the evidence obtained in this review is low; hence, we recommend a randomized control trial for a higher level of evidence on this important issue.
for that benefit is weak. There is no recommendation for
the soaking of prosthetic devices in antiseptics.

In Australia, the New South Wales Ministry of Health has
recently issued a safety notice advising against the use of po-
viodone-iodine for the irrigation or for soaking of prostheses.
The reason for this recommendation is that this practice is
“off label” and is not covered under the indications regis-
tered with the Therapeutic Goods Association of Australia.

Two recent systematic reviews assessed the relationship
of topical agents on implant-related complications. The
review by Yalanis et al. looked at the impact of topical
povidone-iodine on capsular contracture rates, whereas
the review by Huang et al. assessed the impact of topical
antibiotic prophylaxis on capsular contracture and other
implant-related complications. Although Yalanis et al. reported infection rates with topical antibiotics, this was
not a primary outcome of their study. Hence, the need
remains for a systematic review to assess the existing evi-
dence surrounding the use of topical antibiotics and anti-
septic use in breast implant surgery.

Thus, this review aims to provide an evidence-based
clinical tool for surgical-site infection prophylaxis in
breast implant surgery and to help resolve some of the
conjecture surrounding this practice.

**METHODS**

**Search Strategy**

A comprehensive search was performed in August
2016 and repeated in April 2017 on the databases of
PreMEDLINE, MEDLINE, Embase, and Cochrane using
the keywords: breast neoplasms, mastectomy, mamma-
plasty, breast implants, immersion, reconstructive surgical
procedure, submerge, soak, anti-infective agent, iodine
compounds, saline solution, infection, implant capsular
contracture, and postoperative complication. A reference
search was performed using Scopus, and all obtained ar-
ticles were collated and reviewed.

The population examined was all women undergoing
breast surgery, with the intervention being the usage of anti-
biotics or antiseptics in breast pocket irrigation or implant
immersion, and the control being no agent used for the lavage
or bath. The primary outcome examined was infection rates.

**Inclusion and Exclusion Criteria**

The results of the search were independently screened
by 2 reviewers (A.F. and P.H.) for eligibility. The articles
were assessed according to predetermined inclusion and
exclusion criteria. Where disagreement occurred and a
consensus could not be reached by discussion, it was put
to a third party (S.W.) for resolution.

The inclusion criteria for studies to be incorporated
were randomized control trials, prospective trials, retro-
spective studies, breast surgery with the use of implants or
expanders, perioperative antibiotic use, irrigation of the
breast pocket, and/or soaking of implant or expander in
antibiotic solution, and documentation of infection rate.

Publications were excluded if they involved Case studies,
lack of a comparator, experimental animal models, in vitro
models, opinion pieces and letters to the editor, nonqualita-
tive articles, revision breast surgery, or non-English text.

**Assessment and Data Extraction**

Selected articles were evaluated using the Newcastle-
Ottawa Scale for methodological quality. This consists of 8
questions, awarding stars for meeting criteria, for a total of 9
stars. Four stars are available for questions under the selec-
tion criteria, 2 stars available for comparability, and 3 stars
for questions relating to outcomes. Analysis was performed
by A.F and P.H, and disagreements mediated by S.W.

Data from the included studies were extracted and
compiled into a table. It encompassed key points such as
author, date of published article, population, intervention
(pre-, peri-, and postoperative), comparator, outcomes,
type of surgical procedure, patient number, and mean age.

**Data Analysis**

A meta-analysis was performed on the data using Rev-
Man (version 5.3) where applicable, otherwise the data
were summarized and discussed as text. A fixed effect
model was used, and the risk ratio was reported with 95%
confidence intervals. A P value of < 0.05 was set to be sta-
tistically significant.

**RESULTS**

**Search Results**

The search yielded 353 records, of which 70 were re-
moved as duplicates. Two hundred eighty-three records
were screened based on titles and abstracts, and a further
254 were removed for failing to meet the criteria. The re-
mainding 29 full-text articles were assessed for eligibility,
and of these only 3 retrospective cohort studies fulfilled
the review requirements (Fig. 1). No randomized con-
trol trials were found.

Each of these trials looked at populations of women
undergoing aesthetic augmentative breast surgery. A sum-

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**Fig. 1. Summary of search results.**
The study compared 2 groups of 218 patients. The intervention cohort had surgery within 2000 to 2002 and received topical antibiotic therapy, while the control (no topical antibiotic) cohort had their surgeries within 2005 to 2007.

All incisions were peri-areola except for 2 instances of inframmary incisions, and all patients had the submuscular implant pocket created via diathermy under direct vision. The implants used were textured Polytech Silimed double-lumen implants, and each patient received closed-suction drains that were removed within 24 hours postsurgery.

Both groups of women received identical perioperative prophylaxis of 1.5 g IV cefuroxime. The intervention group had their implants submerged in a solution containing 1 g/L of cephalexin and had their breast pockets washed out with the same solution. The control group did not receive any, as the antibiotic used topically on the breast implants was discontinued in Denmark.
Follow-up of these patients beyond 3 months occurred only when adverse events occurred. The mean follow-up times of the intervention and the control groups were 87 and 21.6 months, respectively.

The reported infection rates were 6.7% in the intervention group, and 12.8% in the control group ($P = 0.044$). Infections were diagnosed as having 1 or more of the following: fever, pain, swelling, cellulitis, elevation of leukocytes, and/or C reactive protein.

Infections in the antibiotic-exposed group were treated with antibiotics and expectant treatment, resulting in resolution of infection in all cases. Infections in the non-exposed group were treated similarly; however, 3 cases ultimately required explanation.

Giordano et al. (2013) conducted a retrospective cohort study reviewing the records of 330 consecutive female patients, in the period of 2004–2010, who underwent cosmetic breast augmentation without associated mastopexy or concurrent procedures.

Patients were divided into 2 groups, with the control group being patients treated during 2004–2009 and the intervention group treated during 2009–2010. Both groups received IV cefuroxime perioperatively; however, the intervention group also had their implants and implant pockets bathed in Betadine, gentamicin, and cefuroxime. All patients received postoperative oral antibiotics for 7 days with the intervention group receiving oral cephalexin and the control group oral levofloxacin.

All procedures were performed with an inframammary incision, with the creation of a dual-plane implant pocket through electrocautery under direct vision. Wounds were sutured in layers using absorbable sutures and covered with Micropore tape. Texturized silicone gel implants were used, together with Redon drains.

Mean follow-up time for the intervention and control groups were 22 months (± 3 months) and 24 months (± 13 months), respectively. Follow-ups were planned at 4 weeks and 6 months postoperatively, and only occurred beyond 6 months in the case of adverse events.

There was no statistically significant difference in infection rates between the groups with 2 infections in the intervention group and 3 in the control (1.2% versus 1.8%; $P = 0.65$).

### Effect of Antibiotics on Infection Rates

A summary of the infection rates when antibiotics are used versus when no antibiotics are used is shown in Table 3.

Overall, the effect of antibiotics appears to lower infection rates. A meta-analysis using the Mantel–Haenszel statistical method of the 3 studies shows a risk ratio reduction of 0.52 (95% CI = 0.34–0.81), favoring the usage of antibiotics in either breast pocket irrigation or implant immersion (Fig. 2).

### Effect of Antibiotics on Capsular Contracture (CC)

The studies by Giordano et al. and Pfeiffer et al. also compared CC rates in their antibiotic-exposed and control cohorts, both showing a reduction in the capsular contracture rates when antibiotics are used (Fig. 3). However, the data from the studies are poor, and heterogeneity is high.

### Table 3. Summary of Results of Included Studies of Antibiotic Protocol and Infection Rates

| Study                | Study Design | N   | Follow-up (mo) | Intervention Group | Control Group |
|----------------------|--------------|-----|----------------|-------------------|---------------|
| Araco et al.         | Retrospective | 3,002 | 6               | Antibiotics + povidone-iodine | 15 | 1,902 | 0.8% | Povidone-iodine | 18 | 1,100 | 1.6% | 0.48 |
| Pfeiffer et al.      | Retrospective | 436  | 87 or 21.6      | Antibiotics + epinephrine + saline | 14 | 203 | 6.9% | Saline + epinephrine | 27 | 211 | 12.8% | 0.54 |
| Giordano et al.      | Retrospective | 330  | 23.1           | Antibiotics + povidone-iodine | 2 | 165 | 1.2% | None | 3 | 165 | 1.8% | 0.67 |

**RR**, risk ratio.
DISCUSSION

Postoperative infections are a leading cause of morbidity affecting 1.1–2.5% of patients who have had aesthetic breast augmentations. In the implant-based reconstructive setting, the infection rate is even higher, with tissue expander-related infection rates ranging from 2.5% to 24%.14–19 A systematic review in 2013 reported the infection rate in implant-based reconstructive surgery as 5.78%.20

There are multiple contributors that may be responsible for the higher infection rates in reconstructive patients and these include the disruption of tissue vascularization, greater exposure to endogenous bacteria from mastectomy, lymph node dissection, and adjuvant cancer therapies.21 Given this noteworthy burden of morbidity, it is important to use the correct protocol to minimize adverse outcomes.

This study was unable to find any trials looking at topical antibiotics in reconstructive cases, and it is therefore unable to present direct evidence for reconstructive breast surgery.

The 3 studies assessed in this systematic review suggest that the usage of antibiotics with or without the addition of antiseptics in breast pocket washout or implant irrigation reduces infection rates, with the combined RR of the 3 studies at 0.52 (95% CI = 0.34–0.81; P = 0.004).

These findings are consistent with existing evidence for the impact of topical antibiotics on CC, which is thought to be a surrogate for subclinical infection, immunological responses, and chronic inflammation.22 CC is the most common complication of breast implant surgery, and in the systematic review by Huang et al.,7 the use of topical antibiotics in aesthetic implant surgery was found to be associated with a significantly diminished rate of CC. Topical antibiotics therapy reduced the incidence of CC from 6.81% to 4.86%.7

The effect of antiseptics on CC was similar in the review by Yalanis et al.4 They found that antiseptics reduced CC rates from 8.9% to 2.7%.6

We were not able to assess the independent effect of topical antiseptics on breast implant infections. Giordano et al.9 was the only study to implement different antiseptic protocols for each of their cohorts. They used topical antibiotics with antiseptics in their intervention group and no topical agents in their control group, preventing individual assessment of each topical therapy.

The most common infections after breast surgery are due to endogenous skin flora such as Staphylococcus aureus and Staphylococcus epidermidis.21 Hence, antibiotic prophylaxis should be directed toward these bacteria. This is consistent with current practice, with the IV cephalosporins being the antibiotic of choice in 79% of augmentative breast surgery cases in the United States.25

However, overuse of prophylactic antibiotics has potential hazards, including the selection of multi-drug resistant organisms.26 The routine use of antibiotics is not supported by the results of all current studies, for example, a recent study found that bacteria isolated from infections in a significant portion of implant-based breast reconstructive cases were sensitive to the topical prophylactic antibiotics administered.27

Limitations

The major limitation of this review is the lack of randomized controlled trials or prospective trials. The only reports found were of retrospective studies, which have inherent biases by nature of their design. Additionally, there were several methodological weaknesses in the trials assessed. Direct comparison of these articles was confounded by the differences in operative techniques, study design, antibiotics protocols, and their definitions of an infection.

For example, Giordano (2013) did not separate antibiotics and antiseptic usage, making it difficult to delineate which agent was primarily responsible for reducing infection rates.

Additionally, Araco et al.8 was a descriptive study without a planned control. In their analysis, they looked at several outcomes retrospectively, including topical antibiotics, type of prosthesis, and use of drains. However, these outcomes were not controlled against each other; hence, it is difficult to determine what each individual effect was on infection. Moreover, no rationale was given for why one patient may have received antibiotics while another patient did not, thus introducing an inherent bias into the study.

The definition of infection differed between trials as well. Pfeiffer et al.10 had the highest infection rates of the 5 papers, with 12.8% in the control group and 6.9% in the intervention group. In their study, they did not use any antiseptics to irrigate the pocket or bathe the implant. However, only 3 patients required implant removal, and these were in the control group of 218 patients (1.4%). Their inclusion criteria for what constituted an infection may have been broader than Araco et al.8 and consequently falsely elevated their infection rates.

In this regard, Araco et al.8 reported infection rates of 0.8% and 2% for the intervention versus control groups, respectively, but all infected cases required implant removal. Giordano et al.9 had no cases requiring implant explanation and they were the only group to use postoperative antibiotics.

Additionally, none of the studies included in this review used the Adams’ formula, a technique of using triple antibiotic irrigation of the breast pocket (50,000 U of bacitracin, 1 g of cefazolin, and 80 mg of gentamicin, in 500 ml of saline),28 which is currently a popular choice among surgeons.

Further research is still indicated in this area in the form of a high-quality randomized controlled trial. A more appropriate trial design to delineate the relative merits of topical prophylactic measures for surgical-site infections would include 4 arms, with 1 arm each for the administration of antibiotics, antiseptics, antibiotics and antiseptics, and a control.

CONCLUSIONS

The results of this study suggest there is a clinical benefit in using antibiotics for breast pocket irrigation and
implant immersion. However, given the quality of the evidence obtained in this review, no definite conclusion can be drawn with any certainty. We recommend a randomized control trial to reduce bias and to provide a higher level of evidence on this important issue. Alternatively, should this prove difficult to achieve, a study based on a national database, such as the Australian Breast Device Registry, could perhaps be undertaken to provide higher quality evidence than is currently available.

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