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The effect of extra safety measures on incidence of surgical site infection after alloplastic breast reconstruction

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KEYWORDS

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Safety

Summary Background: This study aimed to evaluate whether the implementation of extra perioperative safety measures and precautions through adopted standard operating procedures (SOPs) to ensure optimal anti-microbial conditions has led to less surgical site infections (SSI) after alloplastic breast reconstruction (BR).

Methods: This retrospective study compared two Cohorts of patients treated before and after the implementation of new SOPs (2009–2014: Cohort 1 versus 2014–2019: Cohort 2). Multivariate logistic regression analyses, adjusting for patient confounders, were implemented to compare SSI incidence between both Cohorts.

Results: Overall, SSI incidence was equal in both groups (10%, $p = 0.545$). The incidence of deep SSI was 9% for Cohort 1 and 5% for Cohort 2 ($p = 0.074$). Incidence of SSI-related explantation was 8% and 5%, respectively ($p = 0.136$). After adjusting for patient confounders, no statistically significant difference was seen between both Cohorts in overall SSI, deep SSI incidence, and explantation due to SSI ($OR_{adjusted}: -0.31, p = 0.452, OR_{adjusted}: 0.16, p = 0.747$ and $OR_{adjusted}: 0.18, p = 0.712$). Higher BMI, smoking, one-stage BR, and immediate BR were associated with the risk for SSI ($p < 0.001, p = 0.036, p < 0.001, p = 0.022$, respectively).

Conclusion: Extra safety measures to assure optimal anti-microbial conditions did not contribute to lower SSI incidence or SSI-related explantation after alloplastic BR. Confounders

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such as BMI, smoking, immediate BR, and one-stage BR were correlated to an increased risk for overall SSI, deep SSI, and SSI-related explantation of TE/implants.

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Introduction

Surgical site infection (SSI) following alloplastic breast reconstruction (BR) is one of the most disastrous complications, since this often leads to loss of the implant and thus destroys the reconstructed breast.¹⁻⁴ Literature shows that 58% of alloplastic BR complicated by implant loss were associated with SSI.⁵ Complications overall, but especially implant loss, have a major impact on patient's quality of life.⁶

The reported incidence of SSI following alloplastic BR varies between 3% and 30%.⁷⁻¹⁰ This percentage is higher than that seen after other breast surgeries using implants; cosmetic augmentation has reported infection rates of 0.9% and 1.7%.^{11,12} Investigation of the pathophysiology of SSIs following alloplastic BR revealed gram-positive bacteria, among which *Staphylococcus* species are mostly observed.¹³ Since 2012, there is more awareness of this and multiple measures have been incorporated in standard operating procedures (SOPs) to ensure optimal anti-microbial conditions.¹⁴⁻¹⁸ Research on SSI after alloplastic BR found the timing and use of preoperative antibiotics administration, an alcohol chlorhexidine skin preparation, hypothermia prevention, minimization of OR-door movements and glove exchange before implantation, and implant and pocket washing to be effective in reducing the incidence of SSI following alloplastic BR.¹⁹ Minimal to no evidence was found for the duration of antibiotic use, methicillin-resistant *Staphylococcus aureus* (MRSA) screening, laminar air flow, nipple shields, and implant type.^{17,19,20} Besides optimal perioperative conditions, various patient and surgical characteristics have been detected as risk factors for SSI.²¹⁻²⁹ Considering the variety in protocols used worldwide, a best practice is yet to be defined.

The aim of this study was to evaluate whether the implementation of extra safety measures and precautions indeed led to a decrease in the incidence of SSI following alloplastic BR. This research evaluates the impact of preoperative antibiotic administration at least half an hour before incision, normal body temperature maintenance, implants rinsing in povidone-iodine solution before implantation, minimal number of people allowed in the operating room (OR), and minimal OR-door movement. We hypothesize that applying these safety measurements reduces the number of SSIs following alloplastic BR and thus reduces the chance of implant loss.

Materials & method

Study design & participants

This retrospective study analyzed and compared two Cohorts of patients treated at our tertiary referral center before (September 2009 until September 2014, Cohort 1) and

after implementation of new SOPs (October 2014 until October 2019, Cohort 2). The Medical Ethics Review board (METc) of the UMCG approved this study and judged that this study fell outside the scope of the Medical Research Involving Human Subjects Act (WMO) (METc2020/251).

All female patients of 18 years and older who underwent initial alloplastic BR between September 2009 and October 2019 (either after mastectomy for breast cancer or following preventive mastectomy) were included. Immediate, meaning mastectomy and BR during the same surgery, and delayed, as in BR on a later date after previous mastectomy. BR could be performed as one-stage and two-stage procedure. One-stage surgery meaning that the definitive breast implant was directly placed. In two-stage surgery, first a tissue expander (TE) was placed, which was filled until the desired or possible breast size was reached, and at a second surgery, the TE was replaced with a definitive implant. Alloplastic BR combined with a latissimus dorsi (LD) or a lateral thoracodorsal (LTD) flap were also included. Women who did not complete their second surgery of the two-stage BR within the studied period of the Cohort were excluded. The same was true for women who started their trajectory in another medical center, and patients with the request for re-BR. Women who underwent one-stage BR with Strattice™ (GDmedical, Eindhoven, The Netherlands) in the context of another research were also excluded.

Procedure and data collection

Using the specific surgical codes for the various types of alloplastic BR, a list of all alloplastic BR surgeries from September 2009 until October 2019 with corresponding patient numbers was requested. Based on inclusion criteria, patient characteristics, surgical procedures, and complications were collected from the electronic patient records. The data were pseudonymized and stored, using a code list, in REDCap (Vanderbilt, Nashville, TN, USA). Every type of alloplastic BR surgery was registered as a new record. The first and second surgery of two-stage surgery were examined separately as two separate records belonging to the same patient. If applicable, in the first record, the surgery of the TE placement was described, and the second record described the surgery during which the TE was replaced with the definitive implant.

Before October 2014, the following safety measures were applied: implant washing in povidone-iodine solution before placement, minimal handling of the implant, sterile glove exchange before handling the implant and perioperative antibiotic use of 1 g cefazolin intravenously half an hour before surgery, and 1 g of intravenously administered cefazolin each six hours for the duration of 24 h postoperatively.

Since October 2014, multiple measures have been added to the SOPs, i.e., rinsing the wound area and cavity with povidone-iodine solution before placement, more attention

to normothermic body temperature maintenance, sterile glove exchange before handling the implant while wearing double sterile gloves, limited number of people (max 8) allowed in the OR, and no OR door movements during the actual surgery. All patients received 1 (expected OR-time less than one hour) or 2 g of cefazolin (Mylan, Amstelveen, The Netherlands) as a prophylactic antibiotic intravenously at least half an hour before incision, which was repeated every six hours for the duration of 24 h in total. When a patient was allergic to cefazolin, an alternative such as clindamycin (Fresenius Kabi, Zeist, The Netherlands) was given.

Outcomes

The primary outcome of this study was the incidence of SSI. SSI was defined using the PREZIES classification. This classification is developed by the National Institute for Public Health and the Environment, the Netherlands.³⁰ The classification is based on the definition of the European centre for Disease Prevention and Control (ECDC).²⁹ PREZIES differentiates superficial SSI, occurring within 30 days after surgery, and deep SSI occurring within 90 days. An infected implant was always defined as a deep SSI, regardless of time.³¹ The secondary outcomes were explantation of TE/implant as a result of SSI and cultured micro-organisms.

Determinants

The following determinants were analyzed in relation to SSI: being part in either Cohort 1 or 2, age at (first) BR operation, BMI, smoking, bilateral BR, one-stage BR, American Society of Anesthesiologists class (ASA),³² adjuvant or neoadjuvant radiotherapy, and chemotherapy. Age was calculated in years on the day of the reconstruction. BMI was calculated in kg/m² and categorized as <25 and ≥25. Smoking status was either yes or no. Smokers included patients who quit smoking less than six months prior to surgery. Bilateral BR was BR of both breasts simultaneously during the same surgery. One-stage BR included those that received a direct implant. Radiotherapy at the reconstructed breast was either pre- or postoperative. Chemotherapy included previous chemotherapy up until one year before reconstruction, neoadjuvant, or adjuvant chemotherapy.

Statistical analysis

Patient characteristics and data regarding to SSI and cultured micro-organisms were summarized using descriptive statistics and compared between both Cohorts. Normally distributed continuous variables were described using means and standard deviation (SD). Non-normally distributed continuous variables and ordinal variables were presented by medians and interquartile ranges (IQR). Dichotomous variables were described by counts and proportions. Overall, deep SSI incidence and incidence of explantation were calculated for all performed surgeries. Separately, overall and deep SSI was calculated on the first (initial) surgery, so excluding the TE exchange for definitive implant surgery. Student's t-tests and Pearson's chi-square tests were used where appropriate.

Multivariate logistic regression was implemented to estimate odds ratios (ORs) and 95% confidence intervals (CIs) in order to evaluate whether the SSI incidence was lower in

Cohort 2 compared to Cohort 1. Based on the literature and institutional experience, SSI was adjusted for the following determinants: age, BMI, ASA score of 2 or 3, smoking, one-stage, bilateral, immediate, chemotherapy, and radiotherapy²¹⁻²⁷. For the regression model, all initial (first) BR surgeries were included. Patients with heterogenic bilateral BR were excluded, i.e., one side immediate with contralateral delayed BR and/or one-stage and contralateral two-stage BR. Analyses were performed on overall SSI incidence, incidence of deep SSI, and explantation of TE/implant as a result of SSI. A p-value ≤ 0.05 was considered statistically significant. Statistical analysis was performed using SPSS 26.0 (IBM, Armonk, NY, USA).

Results

From September 2009 until September 2014 (Cohort 1), using the hospital's specific surgery encoding, we detected in total 265 alloplastic BR surgeries of which 5 surgeries used Strattice™ (GDmedical, Eindhoven, The Netherlands). As such, 260 BR surgeries were included. A total of 190 (190/260=73%) of these were initial surgeries of which in 91 cases (91/190=48%), a TE was placed, and in 94 cases (94/190=49%), a definitive silicone-filled implant was placed. In five cases (5/190=3%), one side was reconstructed using a TE or a TE exchange, and the contralateral side was reconstructed using a direct implant. However, 70 out of 260 (27%) procedures were secondary surgeries in which the TE was exchanged for the definite implant.

From October 2014 until October 2019 (Cohort 2), in total, we detected 350 surgeries of which two were BR surgeries employing Strattice™ (GDmedical, Eindhoven, The Netherlands). In total, 348 BR surgeries were included, of which 210 (210/348=60%) were initial reconstruction surgeries. In 183 cases (183/210=87%), a TE was placed, and in 27 cases (27/210=13%), a direct implant was placed. In three cases, (3/210=1%), one side was reconstructed using a TE or a TE exchange, and the contralateral side was reconstructed using a direct implant. Therefore, 135 out of 348 (39%) procedures were secondary reconstruction surgeries in which the TE was exchanged for the definitive implant. **Figure 1** gives an overview of performed procedures among both Cohorts.

Patient characteristics: Cohort comparison

Mean age was slightly but significantly lower (44 versus 46, $p = 0.041$) and mean BMI was slightly but significantly higher (24.7 versus 25.2, $p = 0.038$) in Cohort 2 compared to Cohort 1. Women in Cohort 1 underwent less often chemotherapy compared to women in Cohort 2 (22% versus 40%, $p = 0.023$). In Cohort 2, relatively more preventive mastectomies were performed (44% versus 32%, $p = 0.005$). Related to that, more nipple-sparing mastectomy's (58% versus 19%, $p < 0.001$) and immediate reconstructions were performed in Cohort 2 (93% versus 42%, $p < 0.001$). In Cohort 1, more one-stage reconstructions were performed than in Cohort 2 (93 versus 25, $p < 0.001$). (**Table 1**)

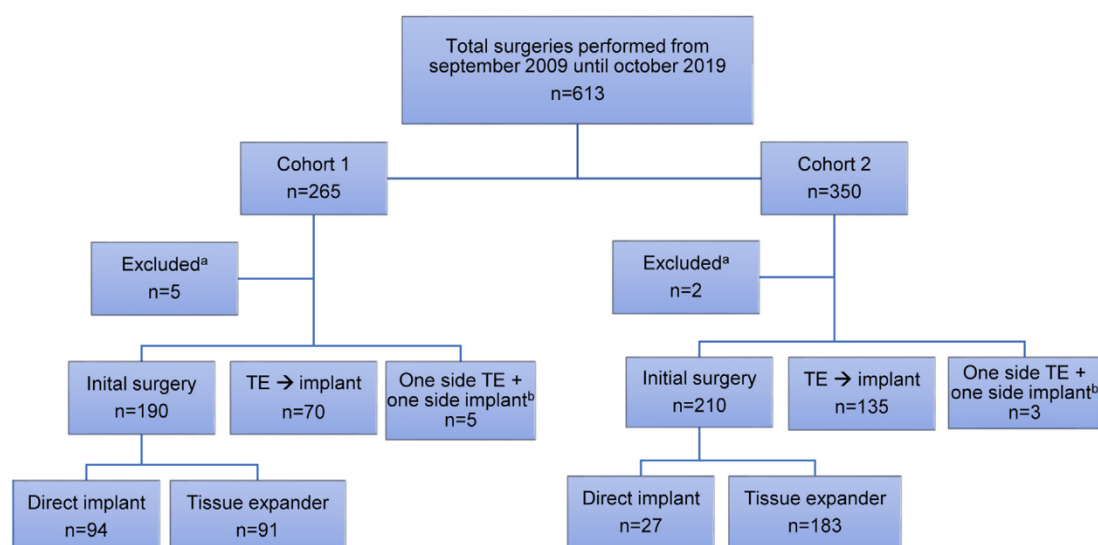


Figure 1 Performed procedures among both Cohorts.

TE=tissue expander, N=number, Cohort 1 = 2009-2014, Cohort 2 = 2014-2019

^aBreast reconstruction with strattice

^bHeterogenetic breast reconstruction, excluded from regression analysis.

Incidence of overall and deep surgical site infections

The incidence of overall SSI among all alloplastic BR surgeries was 10% (27/260) in Cohort 1 and 10% (36/348) in Cohort 2 ($p = 0.545$). The incidence in the initial reconstructive surgery for Cohort 1 was 12% (23/185) versus 13% (28/210) in Cohort 2, ($p = 0.455$). The incidence of deep SSI was 9% (22/260) in Cohort 1 as compared to 5% (18/348) in Cohort 2 ($p = 0.074$). The difference in deep SSI incidence between Cohorts was comparable when merely looking at the first surgery (18/185=10% and 15/210=7%, $p = 0.228$). (Table 2) As a result of SSI, in Cohorts 1 and 2, a comparable percentage of TE/implant removals took place (20/260=8% and 18/348=5%, respectively, $p = 0.136$).

Multivariate logistic regression analysis on the overall SSI incidence among the initial BR surgeries adjusted for, age, BMI, smoking, ASA 2-3, chemotherapy, radiotherapy, one-stage, immediate, and bilateral BR showed no statistically significant difference between both Cohorts ($OR_{adjusted}$: -0.31 95%CI= 0.33; 1.64, $p = 0.452$). Higher BMI, smoking, one-stage BR, and immediate BR were associated with the risk for obtaining a SSI ($p < 0.001$, $p = 0.036$, $p < 0.001$ and $p = 0.022$ respectively). The results were similar for deep SSI ($OR_{adjusted}$: 0.16 95%CI= 0.45; 3.03, $p = 0.747$) and for explantation due to SSI ($OR_{adjusted}$: 0.18 95%CI= 0.46; 3.10, $p = 0.712$). (Table 3)

Cultured micro-organisms

Among the 27 SSIs in Cohort 1, 24 (88%) swabs were taken compared to 23 swabs among 36 SSIs (64%) in Cohort 2, $p = 0.024$. In total, 21 different species were cultured. In both Cohorts, *S. aureus* was cultured most (8/24=33%, Cohort 1 and 10/20=50%, Cohort 2) followed by coagulase-negative staphylococci (3/24=13% and 3/20=15%, respectively). (Table 4)

Discussion

The aim of this study was to assess whether the implementation of extra safety measures and precautions have led to a decrease in the incidence of SSI following alloplastic BR. The incidence of overall SSI was not lower after the implementation of the renewed SOPs (Cohort 2) compared to before (Cohort 1), ($OR_{adjusted}$: -0.31 95%CI= 0.33; 1.64, $p = 0.452$). The same implied for deep SSI ($OR_{adjusted}$: 0.16 95%CI= 0.45; 3.03, $p = 0.747$) and SSI leading to explantation of TE/implants ($OR_{adjusted}$: 0.18 95%CI= 0.46; 3.10, $p = 0.712$).

When comparing both cohorts, we found a noticeable change in the plastic surgeon's preferences to perform less one-stage BR. This change was probably the result of the experiences at the institution and the published research on higher complication rates among one-stage BR. Multivariate analysis confirmed a strong relation between one-stage reconstruction and overall, deep, and explantation due to SSI in this study population ($p < 0.001$).

Another difference between the cohorts is more use of neoadjuvant and adjuvant chemotherapy in Cohort 2 than in Cohort 1 ($p = 0.023$), while in Cohort 2, more preventive mastectomies and BR were performed. This can be explained by the higher numbers of delayed BR in Cohort 1, compared to Cohort 2 ($p < 0.001$). In these cases, chemotherapy was used earlier during the treatment trajectory, while in Cohort 2, the intervals between receiving chemotherapy and BR were shorter.

Comparison to the literature

BMI and smoking are known risk factors for SSI and other (wound) complications in alloplastic BR and surgeries in general.²¹⁻²⁹ Our results on one-stage versus two-stage BR were very much in line with a meta-analysis comparing 2799

Table 1 Characteristics for Cohort 1 (n = 260) and Cohort 2 (n = 348).

Characteristics		Cohort 1 n 260 (%)	Cohort 2 n 348 (%)	P-value
Age in years	Mean (SD)	46 (11)	44 (12)	0.041
Body mass index in kg/m ²	Mean (SD)	25 (4)	25 (5)	0.038
ASA classification	Categories 0-1	132 (51)	192 (55)	0.160
	Categories 2-3	128 (49)	156 (45)	
Smoking ^a	No	55 (21)	72 (21)	0.484
	Yes	205 (79)	276 (80)	
Bilateral reconstruction	No	141 (54)	191 (55)	0.469
	Yes	119 (46)	157 (45)	
Chemotherapy ^b	No	220 (85)	271 (78)	0.023
	Yes	40 (15)	77 (22)	
Radiotherapy ^c	No	204 (78)	271 (78)	0.471
	Yes	56 (22)	77 (22)	
Reconstruction indication left breast	Therapeutic	173 (67)	195 (56)	0.005
	Preventive	87 (34)	153 (44)	
Reconstruction indication left breast	Therapeutic	176 (67)	196 (56)	0.003
	Preventive	84 (32)	152 (44)	
Reconstruction timing	Delayed	140 (54)	23 (6)	<0.001
	Immediate	110 (42)	322 (93)	
	Delayed, contralateral side immediate	10 (4)	3 (1)	
Nipple sparing mastectomy	No	212 (82)	145 (42)	<0.001
	Yes	48 (19)	203 (58)	
Reconstruction technique left breast	No reconstruction	90 (35)	96 (28)	<0.001
	Tissue expander	55 (21)	123 (35)	
	Direct implant	47 (18)	22 (6)	
	LD + TE	-	6 (12)	
	L(T)D + implant	29 (11)	4 (1)	
	TE exchange -> implant	39 (15)	97 (28)	
Reconstruction technique right breast	No reconstruction	74 (29)	95 (27)	<0.001
	Tissue expander	69 (27)	122 (35)	
	Direct implant	46 (18)	18 (5)	
	LD + TE	-	4 (1)	
	L(T)D + implant	18 (7)	7 (2)	
	TE exchange -> implant	53 (20)	102 (30)	
Reconstruction technique both breasts together	Two-stage	159 (61)	318 (91)	<0.001
	One-stage	96 (37)	27 (8)	
	One-stage, contra lateral side two-stage	5 (2)	3 (1)	

SD=standard deviation, ASA= The American Society of Anesthesiologists Classification, LD=latissimus dorsi flap, TE=tissue expander, L(T)D=latissimus dorsi or lateral thoracodorsal flap.

^a No smoking includes quit smoking for more than six months.

^b Neoadjuvant or adjuvant chemotherapy. No includes received chemotherapy more than one year ago.

^c Any radiotherapy (previous, neoadjuvant, adjuvant). No includes received radiotherapy for another medical reason.

one-stage to 2417 two-stage BR surgeries (OR_{adjusted}:1.47, $p < 0.001$, compared to OR_{adjusted}:1.87; $p = 0.04$, respectively).³³ In the literature, chemotherapy, radiotherapy, immediate, and alloplastic BR using a flap are described risk factors for SSI.^{26,29} Chemotherapy and radiotherapy were not associated in the current study. This is possibly due to the relatively small group that underwent chemotherapy (15%) and radiotherapy (22%). The literature is inconsistent about the relationship between immediate BR and SSI. Some

studies find immediate BR to be related to SSI²³, whereas others don't.²¹ In this study, overall SSI incidence was higher among immediate BR (OR_{adjusted}:1.17, $p = 0.022$), but deep SSI incidence was not higher (OR_{adjusted}:0.89, $p = 0.122$). Regarding the cultured micro-organisms, in both Cohorts, *S. aureus* was cultured most (25/65=39%). Staphylococcus aureus is the most frequently identified pathogen in breast implant infections with incidences of 49% and 67% found in the literature.^{34,35}

Table 2 Incidence of overall and deep SSI for Cohort 1 and Cohort 2 homogenic BR.

	Cohort 1 n	SSI n (%)	Cohort 2 n	SSI n (%)	p-value
Overall SSI incidence					
All surgeries	260	27 (10)	348	36 (10)	0.545
Initial surgery	185	23 (12)	210	28 (13)	0.455
TE -> implant exchange surgery	70	2 (3)	135	5 (4)	0.552
Deep SSI incidence					
All surgeries	260	22 (9)	348	18 (5)	0.074
Initial surgery	185	18 (10)	210	15 (7)	0.228
TE -> implant exchange surgery	70	1 (1)	135	1 (1)	0.567

Cohort 0= Cohort 1 from 2009 to 2014 and 1=Cohort 2 from 2015 to 2019, n=number of cases, SSI=surgical site infection, TE=tissue expander, first surgery= TE insertion or direct implant reconstruction, TE-> implant=exchange of TE for the definite implant surgery.

Table 3 Multivariate logistic regression analysis on SSI incidence compared between Cohort 1 and Cohort 2.

	Overall surgical site infection			Deep surgical site infection			Explanation		
	OR	95% C.I.	P-value	OR	95% C.I.	P-value	OR	95% C.I.	P-value
*Cohort 1, yes	-0.31	0.33; 1.64	0.452	0.16	0.45; 3.03	0.747	0.18	0.46; 3.14	0.712
Age	0.02	0.99; 1.06	0.248	0.01	0.97; 1.06	0.600	0.06	0.97; 1.06	0.515
Body mass index	0.12	1.06; 1.21	<0.001	0.13	1.06; 1.23	0.001	0.14	1.07; 1.25	<0.001
+ASA	-0.13	0.44; 1.77	0.723	0.30	0.58; 3.11	0.485	0.38	0.63; 3.44	0.377
Smoking, yes	0.72	1.00; 4.24	0.050	0.89	1.04; 5.72	0.041	0.83	0.95; 5.50	0.065
Bilateral BR, yes	-0.28	0.34; 1.69	0.500	-0.41	0.25; 1.76	0.412	-0.34	0.27; 1.91	0.502
Chemotherapy, yes	-0.58	0.22; 1.43	0.226	-0.42	0.21; 2.04	0.471	-0.35	0.23; 2.22	0.554
Radiotherapy, yes	0.19	0.55; 2.64	0.633	-0.62	0.19; 1.56	0.253	-0.87	0.13; 1.33	0.141
Immediate BR, yes	1.25	1.27; 9.52	0.016	0.89	0.79; 7.52	0.122	1.08	0.91; 9.49	0.073
One-stage BR, yes	-0.31	1.93; 8.63	<0.001	1.37	1.63; 9.54	0.002	1.31	1.52; 9.11	0.004

Italic/bold= p-value below 0.05.

* Cohort 1 = 1, Cohort 2 = 0.

+ ASA= American Society of Anesthesiologists Classification, 0=no=0-1, 1=yes=2-3, BR=Breast reconstruction. CI=Confidence interval.

Strengths and limitations

A major strength of this study is the low chance of selection bias since all women who underwent alloplastic BR between September 2009 and October 2019 were included. Another strength is seen in the usage of the PREZIES classification to score overall and deep SSI.

It can be seen as a limitation of this study that it is retrospective. However, the study has a moderately high sample size (608 surgeries in total) and the documentation and registration of patient data in the electronic patient records are assumed to be highly accurate. A flaw of this research is that, drainage time and drain canister replacement were not noted systematically, while these factors have been associated with SSI in other research works (OR=2.95; 95% CI=1.17-7.47).²¹

Implementations and recommendations

Although this study showed no relation between the implementation of extra safety measures and a drop in SSI incidence, it cannot be ruled out that these measures have contributed to a lower chance of developing SSI. It is still recommended to obtain the best anti-bacterial environment when performing alloplastic BR or implant-

based surgeries in general. Besides that, multiple, preferably prospective multi-center studies should further assess whether the extra safety measures contribute to a lower incidence of SSI and lower rate of reconstruction failure. Women who smoke should be urged to stop smoking at least four weeks before reconstruction, and where possible, women should try to lose weight in order to obtain a healthy BMI (<25).²⁹ Especially in gene carriers, prophylactic BR could be postponed until women have obtained a healthy lifestyle.

One-stage reconstruction seems to be highly related to the development of SSI. We hypothesize that the high SSI incidence among one-stage reconstruction is a result of higher tissue tension leading to reduced blood flow in thin skin flaps as the result of mastectomy. Future research should further investigate blood flow and oxygen levels in dissected skin flaps, for example, using near-infrared cameras, to try to grasp the pathophysiological mechanisms of hypoxia and infection. This could also be used during the expansion phase of two-stage reconstruction to evaluate the quality of the skin perfusion over time. In this way, malperfusion and related hypoxia could be detected and treated early on by removal of the direct implant, which would possibly contribute to lower reconstruction failure rates among two-stage reconstruction. Research has shown the beneficial effects of using this technique in assessing whether a skin

Table 4 Cultured micro-organisms compared between Cohort 1 and Cohort 2.

Micro-organism	Cohort 1 (SSI, n = 26) n (%)	Cohort 2 (SSI, n = 36) n (%)
Number of swabs taken	24 (92)	20 (56)
Negative: no bacterial growth	4 (15)	3 (8)
Gram-positive species	Times cultured	
<i>Staphylococcus aureus</i>	13	12
<i>Coagulase-negative staphylococci</i>	3	3
Aerobic gram-positive mixed flora	6	1
<i>Staphylococcus epidermis</i>	2	
<i>Staphylococcus caprae</i>	1	
<i>Streptococcus anginosus</i>	2	
<i>Propionibacterium acnes</i>	2	
<i>Corynebacterium propinquum</i>	1	
<i>Corynebacterium amycolatum</i>		2
<i>Granulicatella adiacens</i>		1
<i>Propionibacterium magnus</i>		1
Gram-negative species	Times cultured	
<i>Pseudomonas aeruginosa</i>	1	2
<i>Klebsiella oxytoca</i>	1	1
<i>Escherichia coli</i>	1	
<i>Enterobacter cloacae</i> complex	2	1
<i>Maroxella catarrhalis</i>	1	
<i>Citrobacter koseri</i>	1	
<i>Stenotrophomonas maltophilia</i>		1
<i>Acinetobacter</i> species		1
<i>Aeromonas</i> species		1
<i>Prevotella bivia</i>		1
N of different bacteria	15	14

flap is more susceptible to necrosis and its possible consequences.³⁴

Conclusion

This study compared the incidence of SSI of two BR Cohorts, before and after the implementation of extra safety measures to ensure optimal anti-bacterial conditions. The implementation of extra safety did not result in a lower incidence in the observed population. SSI incidence was mostly related to the patients' BMI, smoking, and the performance of immediate and one-stage BR.

Declaration of Competing Interest

None.

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None.

Ethics

The Medical Ethics Review board (METc) of the UMCG approved this study and judged that this study fell outside the scope of the Medical Research Involving Human Subjects Act (WMO) (METc2020/251).

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