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Risk factors for surgical site infection in breast surgery

Aims and objectives: The aim of this paper is to study risks for surgical site infection in breast surgery. The objectives were to measure the association of postoperative infection with patient- and procedure-related factors.

Background: The infection rate in breast surgery is expected to be low but it varies a lot. The variation is recommended to be assessed by measuring procedure-related factors.

Design: A retrospective chart review of 982 breast surgery patients was completed.

Method: The data on patient demographics, procedure types, patient and surgery-related factors were collected. A multivariate logistic regression model for all breast operations (N=982), lumpectomies (n=700) and mastectomies (n=282) was performed.

Results: The infection-rate was 6.7%. In a multivariate logistic regression model for all operations, a contaminated or dirty wound; high American Society of Anesthesiologists score; high body mass index; use of surgical drains; and re-operation predicted increased infection risk. In lumpectomies high body mass index and use of surgical drains predicted increased risk. In mastectomies, the significant predictor was re-operation.

Conclusions: The surgical site infection rate was high. In addition to the two classical risks (high wound-class and anaesthesia risk) high body mass index; re-operation; and use of surgical drain increased the infection risk among all patients.

Relevance to clinical practice: In breast surgery careful assessment, documentation and adherence to aseptic practices are important with all patients. Patients with heavy weight need special attention. The need for antimicrobial prophylaxis in re-operations, and the need of surgical drains in lumpectomies are important to consider carefully.

Keywords: Breast surgery, patient-related risk factors, procedure-related risk factors, surgical site infection, mastectomy, lumpectomy

Introduction

This paper describes some results of a quality improvement program aiming to improve aseptic practices (AP) in surgeries of one Finnish university hospital (Aholaakko 2011). During the program the Association of Operating Room Nurses (AORN 1999) recommendations were culturally validated and documented with evidence base. The AP was defined as means of minimizing wound contamination during invasive procedures. The AP was classified by six subcategories: (1) preparation of the personnel and (2) preparation of the patient for the surgery; (3) central services; (4) environmental services; (5) aseptic behaviour and (6) aseptic technique during creation, maintenance and discharge of the sterile field. The breast surgery patients were defined as a target patient group and the postoperative surgical site infection (SSI) rate was used as an outcome indicator of the program. There was no statistically significant improvement in it after the program. This paper describes the patient-related and procedure-related risk factors for the SSI after breast surgery.

Background

Breast surgery is classified as “clean” surgery in which the expectation of SSI is low (Centers for Disease Control and Prevention 2004, Alexander *et al.* 2011, de Blacam *et al*. 2012). The SSI rates after mastectomies varied from 1.7% to 11% so that after a primary mastectomy the rate was from 2.6% to 6.4%, and after reoperation from 7.6% to 11% (Chen *et al*. 1991, Jarvis *et al*. 1998, Gaynes *et al*. 2001, Moro *et al*. 2005, Monge Jodrá *et al.* 2006, Rioux *et al*. 2007). Inadequate wound care was reported among breast cancer patients with a SSI rate of 13.7% to 33.1% (Vilar-Compte *et al*. 2006). The rate was 18.9% after a quality improvement program (Vilar-Compte *et al*. 2009). In the research hospital of

the current study the adherence to the AP-recommendations during breast surgery was varying a lot and it was found as stressful (Aholaakko 2011).

Complications like SSI cause readmissions and subsequent surgeries with increased hospital costs and considerable patient distress (Olsen *et al.* 2008, de Blacam *et al*. 2012). Procedure-related factors are recommended to be measured if large variation exists in SSI rate between hospitals (Geubbels *et al.* 2006).

Risk factors in breast surgery and universal patient-related SSI risk factors (high wound class, high American Society of Anesthesiologists ASA-score, and long duration of operation) were found as controversial (NNIS 2002, Miner *et al.* 2004, McKibben *et al*. 2005, Prospero *et al*. 2006, Bunn *et al.* 2006, Friedman *et al*. 2007, Rioux *et al*. 2007). The SSI rate was reported as lower in non-cancer than in breast cancer surgery (Olsen *et al.* 2008, Vilar-Compte *et al.* 2009). This may be due to the high-risks of more extensive procedures with drain-usage (Throckmorton *et al.* 2009). Also the preoperative chemo and radiation therapy; hematoma; the body mass index (BMI) 30 kg/m^2 or over; age of 58 or over; and long duration of surgery (160 minutes or more) were defined as SSI-risks (Olsen *et al.* 2008, Vilar-Compte *et al.* 2009).

According to de Blacam *et al*. (2012) the mastectomy patients had more SSIs (3.2%) than lumpectomy patients (1.4%). They tended to have more co-morbidities, like DM, and they were older than lumpectomy patients. The independent SSI risks for both mastectomy and lumpectomy patients were BMI of 25 kg/m^2 or higher, and being a smoker. The independent SSI risk for lumpectomy patients was having a prior operation within 30 days. Among mastectomy patients, the mean age and the mean duration of the hospital stay

was higher for those with infection than for those without infection (Chen *et al.* 1991, Vilar-Compte *et al.* 2006, Olsen *et al.* 2008.)

Prospective randomized studies have shown a clear benefit after the use of antimicrobial prophylaxis (AMP) in elective operations such as breast procedures (Alexander *et al.* 2011). In small scale or clinical studies the benefit was not this clear. In breast surgery without AMP, a single antimicrobial dose administered approximately 30 min before surgery; the SSI risk was reported as 12% (Platt *et al*. 1990). AMP of 24-hours duration compared with post-mastectomy antimicrobials reduced SSI rate from 7.6% to 3.4% (Chen *et al*. 1991). AMP was recommended in mastectomy of cancer patients, but a reduction in SSI rate was not always observed (Bunn *et al.* 2006). No statistically significant SSI reduction was found among patients who received both pre- and postoperative AMP compared to those with preoperative AMP only (Throckmorton *et al.* 2009). According to Wagman *et al*. (1990) the AMP administration 30 min before skin incision did not reduce SSI rate, but prolonged SSI onset.

Perioperative interventions breaking the skin integrity were potential SSI risks. Surgical removal of hair was reported to be associated with SSI when the hair was removed by a razor (Alexander *et al.* 2011). Using the clippers resulted in fewer SSIs than using a razor (Tanner *et al*. 2006, Kjønniksen *et al.* 2002). In mastectomies, all postoperative SSIs were reported after axillary dissection, half of these in the open biopsy site (Wagman *et al.* 1990). Complications were not reported after wire-guided biopsies (Chadwick & Shorthouse 1997). Preoperative marking of tumours with wire or ink was not associated with SSI, but core needle biopsy with older age predicted a SSI risk of 15% (Witt *et al.* 2003).

The postoperative use of closed suction drains might be useful for the removal of fluid from large potential dead spaces, but did not prevent infections (Alexander *et al.* 2011). In general surgery (including mastectomies) the use of surgical drains for longer than five postoperative days increased SSI risk (Moro *et al*. 2005). The use of surgical drains increased pain and prolongs hospital stay after mastectomy and lumpectomy, but no difference in SSI rate was reported (Jain *et al.* 2004). After lumpectomy or mastectomy, SSI did not occur with the use of surgical drains unless the fluid volume was under 50 ml (Oertli *et al.* 1994). The pre- and postoperative administration of AMP did not reduce the SSI rate of patients with nine days median length of time to drain removal when compared with those who received preoperative AMP only (Throckmorton *et al.* 2009).

In the present study, we focused on the risks for SSI in breast surgery. Our objectives were to measure if the SSI after lumpectomy or mastectomy was associated with: (1) patient-related factors and 2) procedure-related factors.

Methods

Data collection

Data regarding breast surgery (N=1042) was collected from January 1999 to November 2000 and from January 2002 to March 2003 in two hospitals of Helsinki University Central Hospitals (HUCH). The documents of one patient were unavailable, and those from another patient were incomplete. Patient charts were delivered according to computer-based lists. All surgery related documents were reviewed. Data was also searched from computer-based operation statistics. The type of surgery was identified by using the name, national identity code, procedure codes and diagnosis of the patient. The registered SSIs

that occurred within 30 days after the operation were diagnosed by a physician according to the classical symptoms of infection: purulent drainage; spontaneously dehisced incision; or wound opened by a surgeon, and classified as “superficial”, “deep incisional”, or “organ space” (Emori *et al*. 1991, Crowe & Cooke 1998, Wilson *et al.* 2004). The Infection Control Nurses of study hospitals validated the registered SSIs from hospital infection registers and confirmed the unregistered SSIs from patient charts and data collection forms together with one of the researchers (T-KA) at the end of data collection.

The following data of patient-related risk factors were collected: age ≥65 years; ASA score of 3–5; presence of diabetes mellitus (DM); presence of re-operation; and a BMI of ≥25 kg/m2, calculated as height in kilograms divided by height in meters squared (de Blacam *et al.* 2012). Preoperative hospital stay of 48 hours or more; administration of AMP defined as a single antimicrobial dose administered 30–60 min before surgery (Platt *et al*. 1990); surgical removal of hair; skin condition; invasive tumour marking; and use of surgical drains were used as procedure-related risk factors. The risk due to the long operating time was identified in the fourth time quartile of observed operations instead of the National Nosocomial Infection Surveillance (NNIS) cut off point of two or three hours (Jarvis *et al*. 1998).

Statistical analysis

Descriptive characteristics of the patients with breast cancer and operations were measured. The patient- and procedure-related characteristics were used as independent variables when calculating the initial risk factors for SSI. All breast operated; lumpectomy; and mastectomy patients with SSIs were compared with those without SSIs. Univariate odds ratios (ORs) were calculated first (Table 1). The dependent variable (SSI) was

dichotomized. It was coded simply 0=no SSI, 1=defined SSI. This caused loss of information, but made it possible to use logistic regression as an analysis method. Using logistic regression instead of general logistic modelling gave a more reliable prediction because the dependent variable did not distribute according to a normal curve. Variables of patient- and procedure-related factors were used as covariates. Dichotomous variables were formed out of some independent variables as the candidate risk factors for SSI. For the multivariate models they were selected on the basis of previous research and significance of univariate analysis. The methodological grounds for this were to improve the reliability of clinical data (Munro 1997, 287-309, Gomm 2004, 139-149).

Separate multivariate logistic regression models for all observed operations, and for lumpectomies and mastectomies, were carried out. The intervals (CI) were reported to demonstrate more clearly the odds ratio and the statistical significance of the results. For the logistic regression, the normality of residuals was tested by probability plots. The homoscedasticy of residuals was explored by plotting residuals. Residuals appeared to be randomly scattered. The -2 Log Likelihood (-2LL) was used as a measure of how well the estimated model fits the data. A good model is one that results in a high likelihood of the observed results. (Munro 1997, 287-309.) Statistical analysis was performed with the SPSS software package version 16.0 (Chicago, IL).

Results

The study consisted of 982 breast operations. The age range of breast surgery patients was 16–97 years, with a mean of 55 (±12.57) years. Ninety-eight percent of patients were female. Six per cent of patients had signs of pre-operative infection. The cancer was diagnosed preoperatively in 61% of subjects. DM rate was four per cent. BMI of the

patients varied from 11 kg/m^2 to 55 kg/m^2.

Eighty-four per cent of patients arrived at the hospital on the day of surgery and one per cent earlier. Fifteen percent visited the hospital day before surgery. Surgical hair removal was documented to perform in 41% of the operations. Preoperatively the patients' skin in surgical site was assessed as intact for 80% of the operations. Signs of preoperative infection were noted in six per cent. Preoperative invasive procedures were performed in 55% of operations. Sentinel puncture was done in 10% of operations, wire marking in 35%, and other punctures (e.g., ink application) in three per cent of operations. Rest of the patients had anaesthesia related punctures.

Antimicrobials were administered in seven per cent of the operations (n=69). In fifteen operations AMP was administered 30 minutes prior incision and in eight operations closer than that. In six operations it was given during incision and in twenty five operations after it. In fourteen operations the time of administration was not documented. AMP was administrated for a reason other than surgery to one patient. The surgeon had influenza.

Of 982 breast operations 700 (72%) were lumpectomies and 282 (28%) mastectomies with or without axillary dissection. Fifty-seven per cent of all patients had an axillary evacuation. The occurrence of re-operations was 28% and that of several re-operations one per cent. Mean operation time was 64.83 (±40.38) min. Operating time comprised a first quartile of 3–32 min, second of 33–58 min, third of 59–86 min and the fourth quartile of 87–502 min. The 75^{th} percentile cut-off time was 87 minutes.

Sixty-six SSIs were identified. The SSI rate among all breast operations was 6.7%; after lumpectomy 4.7%; and after mastectomy 8.9%. The most common SSIs were deep incisional (n=37, 56%), followed by superficial (n=22, 33%) and organ-space (n=7, 11%). In 24% of 769 documents it was possible to define variation of postoperative visits to hospital. Of the patients 111 had more than one postoperative visit. Eighty seven patients visited in surgical ward and 19 (1.9%) in Emergency Room due to SSI. One patient had a health centre visit. Eleven patients (1.1%) had readmission due to SSI and four (0.4%) due to systemic complications.

Patient- and procedure-related initial risk factors for SSI were identified (Table 1). The risk was increased for patients with ASA scores of 3–5 compared with patients with ASA score 1 or 2. If the wound class was “contaminated” or “dirty”, the risk for SSI was higher than for “clean” or “clean contaminated” wounds. Three patients were classified as having a contaminated wound and six as having a dirty wound. The BMI of ≥25 kg/m^2 increased the SSI risk. Re-operated patients had higher SSI risk compared with patients who had one operation.

The multivariate logistic regression models were calculated for all operations, lumpectomies and mastectomies to predict SSI risks (Table 2). In all operations, four patient-related risks were found to be statistically significant. Patients with an ASA score 3–5 had a higher SSI risk compared with healthy patients. Contaminated or dirty wound class predicted an increased SSI risk. Patients with a BMI ≥25 kg/m^2 had a higher risk for SSI compared with patients having normal or low weight. The risk of re-operated patients was higher when compared with patients who had undergone one operation. Re-operation

predicted increased patient-related SSI risk both in lumpectomies and mastectomies. A high BMI increased SSI risk in lumpectomies.

One procedure-related factor was statistically significant. Use of a surgical drain predicted increased risk for SSI in all operations. The risk was statistically significant also in lumpectomies, but not in mastectomies (Table 2).

Discussion

In this study the SSI rate was high when compared with the international recommendations (Olsen *et al.* 2008, Alexander *et al*. 2011). After lumpectomy the rate was 4.7% and 8.9% after mastectomy. This kind of difference was reported earlier (Throckmorton *et al*. 2009) and it was used to justify the procedure-specific follow-up of SSI in this study. The SSI rates in the present study were higher than in most surveillance studies (Jarvis *et al*. 1998, Yokoe *et al.* 1998, NNIS 2002, Monge Jodrá *et al.* 2006), but lower than in the observational studies of Vilar-Compte *et al.* (2006, 2009). The variations in SSI rates may occur due to the differences in data collection. According to Moro *et al*. (2005) the intensity of post-discharge surveillance may in part explain the observed difference in SSI rate.

The classical patient-related risks for SSI (Emori *et al.* 1991) were supported by the results of univariate analysis. In multivariate analysis, the presence of high ASA score; contaminated or dirty wound; and high BMI were the patient-related risk factors in all operations. In lumpectomy (but not in mastectomy), a high BMI was the most predictive patient-related risk. This may be due to the procedure; the small number of mastectomies in the present study; or the used BMI value which was lower than the one used by Vilar-

Compte *et al*. in 2006 and 2009, and Olsen *et al*. (2008). In future studies, in addition to classical SSI risks, it would be important to control the skin condition at the surgical site, as well as the performance of the axillary component of the surgery. This might help to separate patient- and procedure-related risks, and enhance the prediction of SSI risk (Reilly *et al*. 2006).

The importance of procedure-related factors for SSI has been discussed, but consensus concerning the indicators is lacking. In the present study, AMP was administrated to only seven per cent of the patients, which may be too low to improve the SSI rates. In the literature, the association between AMP and SSI is controversial (Miner *et al.* 2004, Geubbels *et al.* 2006, Monge Jodrá *et al.* 2006). Our findings support the recommendation to consider preoperative AMP for the breast cancer patients, especially for those having re-operations (Bunn *et al.* 2006). Re-operation increased the SSI risk in all breast surgery. It was the only statistically significant patient-related risk factor in mastectomies. The high number of readmissions and subsequent surgeries due to SSIs cause increased hospital costs and stress for the patients. High infection rate of mastectomy patients is important to decrease due to the success of the potential post-mastectomy breast-reconstructions. (Olsen *et al.* 2008, Throckmorton *et al*. 2009).

Of the procedure-related factors, surgical removal of hair, invasive interventions, and breaks in skin integrity did not predict the SSI. In this present study surgery nurses documented a high number of problems related to skin integrity, but defined few wounds to be contaminated or dirty. This may represent the real preoperative situation or underestimation of the contaminated or dirty wounds. In future studies it would be beneficial to document the wound class of the operation according to the current situation,

not the type of surgery. This is important when investigating the association between SSI and preoperative interventions with controlled skin integrity. It will be important also when measuring the association between SSI, AMP and the number of re-operations more carefully than in this study.

The NNIS-derived operation time for mastectomy has increased since the 1990s (NNIS 2002, Miner *et al*. 2004). It is criticised as being too long (Friedman *et al.* 2007). The locally calculated procedure specific operating time cut point over 75th percentile is advised to used instead (Moro *et al.* 2005, Prospero *et al.* 2006, Vilar-Compte *et al.* 2006). In this study the operation time, first measured as a continuous, later as a dichotomous variable, was not a statistically significant risk for SSI. The local cut-off time of the 75th percentile (87 minutes) instead of the 2–3 hours operation time recommended by the NNIS (Jarvis *et al*. 1998, NNIS 2002, Friedman *et al.* 2007) was used. Compared to the operation times of this study the NNIS time occurred to be too long. So the results of this current study should be compared to the results of NNIS with care.

Geubbels *et al.* (2006) pointed out that procedure-related SSI risk factors should measure common practices, be valid for various healthcare settings, and be clearly specified. Factors like the use of surgical drains vary according to surgery type. The use of drains is associated with pain and increased hospital stay, but not necessarily with increased rate of SSI (Jain *et al*. 2004, Classe *et al*. 2006). The exposure to open surgical drains for over five days increased the risk of SSI (Moro *et al.* 2005). In the present study, there was an association between the use of closed surgical drains and increased SSI rate in all operations and lumpectomies, but not in mastectomies. This may be due to the difference in size of the study groups. It also may indicate a tangible difference between the groups.

In the future it is important to test these findings in more carefully constructed study groups. The importance of relevant surgical and aseptic techniques with surgical drains during intra- and postoperative care is important to study. Existence of postoperative seroma, type of vacuum used, amount of fluid drained, maintenance of a closed system, and the time of drain removal might be interesting parameters to investigate.

Study limitations

In this study the data from patient documents and hospital statistics was used. It was collected as a routine part of care and reflected the conditions, treatments, and definitions made in clinical settings by many surgical professionals (Gastmeier *et al.* 1999). This possible lack of consistency and under-reporting may cause unreliable judgements (Gomm 2004, 139-149). The missing data excluded 22 patients from the SSI risk analysis. The aim was to collect simple and objective data, but the comparability of the results of present study and those in the literature is limited (Gaynes *et al.* 2001, NNIS 2002, Bunn *et al.* 2006, Monge Jodrá *et al.* 2006, Prospero *et al.* 2006). The broad confidence intervals of some variables (Table 1) meant that the study group was not large and homogenous enough.

Making the dependent variable (SSI) dichotomous caused loss of information, but made it possible to use logistic regression as an analysis method. Using logistic regression instead of general logistic modelling gave a more reliable prediction because the dependent variable did not distribute according to a normal curve. We formed dichotomous variables out of some independent variables. The methodological grounds for this were to improve the reliability of clinical data (Munro 1997, 287-309, Gomm 2004, 139-149).

Ethical considerations

The appropriate hospital authorities gave permission to conduct this study in surgeries of two HUCH hospitals. After the target patient group was identified, the ethical board of HUCH gave their acceptance. Good ethical practice, privacy, and respect of the rights of patients and personnel were undertaken during the study.

Conclusions

The overall SSI rate of observed breast operations was high when compared with international findings. The high ASA score, wound contamination, and re-operation predicted the SSI of all breast operated patients; and the use of drain and high BMI the SSI of lumpectomy patients. Re-operation was the only significant risk factor among all three study groups. It is therefore important to consider AMP for all re-operated breast surgery patients.

The use of surgical drains was identified as a procedure-related SSI risk in all breast operations and lumpectomies, but not in mastectomies. So the use of surgical drains and the other indicators used as procedure-related factors to predict SSI among breast operated patients requires further investigation.

Relevance to clinical practice

According to Alexander *et al.* (2011) the target SSI rate in breast surgery is 0.5%. So the proper implementation of infection prevention guidelines to control the unacceptably high SSI rates is necessary. The findings of this study indicated the importance of more precise definition of the patient- and procedure-related risk factors for SSI in breast surgery. This study revealed also the need for more careful perioperative documentation of clinical aseptic practice and patient status information. In breast surgery careful patient assessment; detailed documentation; and adherence to aseptic practices are important

with all patients. Patients with heavy body weight need special attention. The need for antimicrobial prophylaxis in re-operations, and the management of surgical drains in lumpectomies are important to consider carefully.

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Table 1 Demographic and clinical characteristics of breast surgery patients.

	SSI rate				
	YES n (%)	NO n (%)	Univariate OR	P	CI 95%
Patient-related factors					
Age (years)					
≤65	49 (6.2)	739 (93.8)			
>65	18 (9.4)	173 (90.6)	1.57	.118	0.89–2.76
Total	67 (6.8)	912 (93.2)			
American Society of Anesthesiologists (ASA) score					
1 or 2	47 (5.7)	774 (94.3)			
3–5	20 (12.9)	135 (87.1)	2.44	.002	1.40–4.24
Total	67 (6.9)	909 (93.1)			
Wound class					
1 or 2	62 (6.4)	905 (93.6)	8.34	.001	2.38–29.26
3 or 4	4 (36.4)	7 (63.6)			
Total	66 (6.7)	912 (93.3)			
Diabetes mellitus					
No	64 (6.8)	878 (93.2)			
Yes	3 (7.9)	35 (92.1)	1.18	.792	0.352–3.928
Total	67 (6.8)	913 (93.2)			
Body mass index (kg/m^2)					
<25	20 (4.6)	418 (95.4)			
≥25	40 (9.3)	392 (90.7)	2.13	.007	1.22–3.71
Total	60 (6.9)	810 (93.1)			
Re-operated patient					
No	37 (5.2)	673 (94.8)			
Yes	30 (11)	242 (89.0)	2.25	.002	1.36–3.73
Total	67 (6.8)	915 (93.2)			
Procedure-related factors					
Preoperative hospital stay (h)					
<48	67 (6.9)	907 (93.1)	-	-	-
≥48	0 (0.0)	5 (0.5)			
Total	67 (6.8)	912 (93.2)			
Timing of preoperative antimicrobial prophylaxis (AMP)					
30–60 min before incision	4 (17.4)	19 (82.6)			
No AMP or inadequate timing of AMP	63 (6.6)	895 (93.4)	.334	.053	0.110–0.013
Total	67 (6.8)	914 (93.2)			
Preoperative surgical removal of hair					
No	42 (7.3)	536 (92.7)			
Yes	25 (6.2)	377 (93.8)	0.85	.523	0.51–1.41
Total	67 (6.8)	913 (93.2)			
Preoperative skin condition					
Intact	18 (9.0)	181 (91.0)			
Non-intact	49 (6.3)	730 (93.7)	1.48	.172	0.84–2.65
Total	67 (6.9)	911 (93.1)			
Invasive preoperative tumour marking					
No	45 (6.9)	605 (93.1)			
Yes	22 (6.7)	307 (93.3)	0.96	.890	0.57–1.63
Total	67 (6.8)	912 (93.2)			
Axillary evacuation					
No	22 (5.2)	397 (94.8)			
Yes	45 (8)	517 (92)	1.57	.093	0.93–2.66
Total	67 (6.8)	914 (93.2)			
Surgical drain					
No	10 (3)	325 (97)			
Yes	57 (8.8)	590 (91.2)	3.14	.001	1.58–6.23
Total	67 (6.8)	915 (93.2)			
Duration of surgery (min)					
<87	45 (6.2)	680 (93.8)			
≥87	22 (9)	222 (91)	1.50	.137	0.88–2.55
Total	67 (6.9)	902 (93.1)			

Table 2 Surgical-site infections among all breast-operated, lumpectomy, and mastectomy patients by patient- and procedure-related factors.

	All breast-operated patients (N=982)			Lumpectomy patients (n=700)			Mastectomy patients (n=282)		
SSI rate (%)	66 (6.7)			33 (4.7)			25 (8.9)		
	OR	P	CI 95%	OR	P	CI 95%	OR	P	CI 95%
Patient-related factors									
ASA score 3–5	2.1	.018	1.13–3.90	2.0	.110	0.54–4.72	1.9	.147	0.79–4.95
Contaminated or dirty wound	6.8	.014	1.47–31.27	4.2	.217	0.43–1.74	11.9	.051	0.99–44.93
BMI ≥25 kg/m^2	1.8	.038	1.03–3.33	2.6	.028	1.11–6.03	1.4	.454	0.59–3.29
Re-operated patient	2.6	.001	1.53–4.61	2.4	.017	1.17–5.04	2.7	.027	1.12–6.39
Procedure-related factors									
Surgical drain	3.3	.003	1.52–7.11	3.2	.008	1.35–7.62	1.3	.857	0.14–10.34
Multivariate model summary	-2LL=388.670			-2LL=230.135			-2LL=155.563		
Missing cases	118			88			30		

ASA: American Society of Anesthesiologists
BMI: Body Mass Index