Surgical site infection and predictors among adults in specialized hospital: prospective observational study

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Research article

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Abstract

Introduction: Health-care-associated infection (HAI) is a major global safety issue for patients, health care managers and health-care professionals. One of HAI is surgical site infection (SSI). SSI is refers to an infection that occurs after surgery in the part of the body where surgery took place. It arises following surgery and is specifically related to the surgical site. It is estimated that SSIs account between 10-30% of all HAIs. Objective: The objectives of this study was to quantify the rate of wound infection and identify determinant factors Method: Prospective observational study was conducted from January to June 05/2019. All adult patients who met inclusion criteria were included in the study. The data was obtained either directly from the patient, or by observations or from the patient's file. All patients were followed daily before, during and after operation for 30 days starting from the date of operation. Wound infection was detected at bedside and post-discharge surveillance. Chi-square test was computed to evaluate adequacy of cells for regression analysis. Independent predictors identified using binary logistic regression analysis and statistical significance was considered at $p<0.05$. Results: Two hundred eighty patients were included with mean age of 42.5±11 and 157(56.1%) patients were females. Caesarean section is the most common type of surgery. The rate of wound infection was found to be 80 (28.57%). The highest SSI rate was observed in gastrointestinal surgery 28(35.0). More than half of the cases were developed in health institution and patients having clean contaminated wound share the highest number. Majority of patients were undergoing emergency surgery with mean duration of surgery 1.8±0.65 hours. Multivariate analysis revealed that seven variables were significantly associated with the prevalence of wound infection; namely patient's body mass index (P=0.037), age (P=0.046), history of previous surgery (P=0.04), preoperative hospital stay (p=0.0091), wound class (p=0.01) and history of steroid use (p= 0.027). Conclusion: In this study the rate of wound infection was high with patient's physical status, duration of surgery, previous steroid use being strong predictor of infection. Life style modification is important to reduce body mass index and health professionals should counsel them.

Background

Health-care-associated infection (HAI) is a major global safety concern for both patients and health-care professionals (1). One of HAI is surgical site infection (SSI). SSI is refers to an infection that occurs at any time after surgery in the part of the body where surgical procedure took place. SSI can sometimes be superficial infections involving the skin only. Other surgical site infections are more serious and can involve tissues under the skin, organs, or implanted material(2).

It arises following surgery and is specifically related to the surgical site. It is estimated that SSIs account between 10-30% of all HAIs(3). The present study in India, revealed 12.5% prevalence of SSI in department of general surgery(4).

Despite advances have been made in infection control practices, including improved operating room ventilation, sterilization methods, barriers, surgical technique and availability of antimicrobial prophylaxis, SSIs remain a substantial cause of morbidity, prolonged hospitalization, and death. SSI is associated with a mortality rate of 3%, and 75% of SSI associated deaths are directly attributable to the SSI(5)

The rate of wound infection was 18.8%, 17.8% and 13.4% among patients operated on for the removal of the prostate gland, gallbladder, and benign or malignant breast tumors respectively(6).

SSI is an ongoing problem in surgical practice. It lead to patient dissatisfaction, delayed wound healing, increased risk of incisional hernias, extended length of hospital stay, and an increased risk of other Nosocomial complications. Furthermore, there is an increased expense associated with SSI(7). Center of disease control (CDC) estimates an additional cost of $2,734 to $26,019 to the American health care system per SSI, with an annual figure estimated between $130million and $845million(8).

There are different types of risk, that is, patient related, length of hospital stay, procedure, site of surgery, type of surgery(elective versus emergency), choice of antimicrobial prophylaxis, duration of the operation, wound contamination class, hospital setting and surgical team practice.

Previously a few studies conducted in Ethiopia. These studies were focused only clean and clean contaminated and contaminated and dirty wound were not covered. Moreover the previous studies lack information about caesarean section associated SSI. It is important to identify these risk factors in order to analyze SSI outcomes by subgroup, to identify high-risk patients, and to control for differences in the patient level risk. This will allow for better understanding the true risk of SSI at the facility. The purpose of this study is to assess the prevalence and risk factors with SSI in patients who undergo general surgical procedures.

Methods

This study was conducted at Worabe Cohomprensive specialized hospital (WCSH), Ethiopia. This hospital was established by government in 2014. The hospital is currently has more than three hundred beds. It covers all the major specialties including medical, pediatrics, surgery, obstetrics and gynaecology, paediatric surgery, psychiatry and orthopaedics. This study was conducted specifically at surgical ward (elective, emergency and gynecology and obstetrics surgery) service from January to 05/2019-June 30/2019G.C. All adult with age 18 and above, patients who are a candidate for surgical procedures and willing to participate were included in the study. Patients who use antibiotic/s for non prophylactic purposes on the same day of surgery, patient had antibiotic/s and stopped it within 48 hours before surgery, patients having diagnosis suggestive of a preoperative infectious disease, patient already recruited in the study and again scheduled for surgery during the study period, patients that did not complete the follow up period and died before completion of one month period after surgery were excluded from the study. Finally all adult patients who satisfy the inclusion criteria were candidate as a subject for the study.

As shown in Fig. 1, all adult patients who met inclusion criteria and presented to hospital in the data collection period were recruited**.**

Data collection procedure and analysis

The data was obtained either directly from the patient, or by observations or from the patient's file. Relevant information about each patient like patient demographics, previous surgery, wound class (clan, clean-contaminated, contaminated and dirty), type of incision (superficial or deep/involved organ) , type of surgery (emergency, elective and gynecology and obstetrics), duration of surgical procedure, co-morbidities, duration of illness, time of prophylaxis administered, duration of prophylaxis, presence of intra operative dose, length of hospital stay before surgery and after surgery were recorded using structured questionnaire. All patients were followed daily before, during and after operation for 30 days starting from the date of operation. Supplementary information and clarifications on some patient's medical information were obtained through discussion with respective nurses and physician. With the data collection process, the principal investigator involved to evaluate appropriateness of collected data.

Before actual data collection, pre-test was done on 14 patients who were not included in the final analysis in order to check if there is missed variables, if it is unreadable and if difficulty of understanding and some modification were done accordingly. Data was collected by two BSc nurses using a pre-coded questionnaire after three days training about how to filter relevant information from the patient and how to give signals for the patient when SSI happens. One surgeon was invited to train data collators on how to identify SSI.

Wound infection was detected at bedside and post-discharge surveillance. Bedside surveillance involved the patient during hospital admission and after surgery till the patient was discharged. Post-discharge SSI was identified for up to one month after discharge by means of telephone phoning and data collectors were convince the patient to report to the hospital when there is sign of SSI (after full information is deliver to the patient about sign of SSI).

Data was entered into a computer using Epi data 3.1software and analyzed with STATA version 14.2. Before analysis, presence of co linearity between independent factor (having less than 3.4 variance inflation factor) and model fitness (with Hosmer lemeshow p-value 0.323) were checked. Chi-square statistics were used to check adequacy of cells for binary logistic regression. Independent predictors of outcome and strength of association between dependent and independent variables was identified by using binary logistic regression analysis and P-value < 0.25 entered to multiple regression. Finally, p-value < 0.05 was considered as significant. Descriptive statistics was used to characterize asthma control and independent variables. Results of the study were organized in the form of frequencies and percentages. The data was summarized and described using tables and figures.

Results

Sociodemographic characteristics of participants

In this study two hundred eighty patients were included. Overall response rate was 97.64%. One hundred fifty seven patients (56.1%) were females. The mean age was 42.5±11 years with the maximum number of patients being in the age group of 30-50 years. Majority of patients were with BMI<30kg/m^2 and the mean body mass index is 20.5±5.4. Regarding residence more than half of the participants were from rural area. Only 8 (2.85%) patients received blood transfusion prior to surgery. Most of the participants have no co morbidity. Eighty seven patients (31.07%) had previous admission and went to surgery with the same complaint. Twelve patients (4.28%) were currently smokers (table 1).

As shown in figure 2, caesarean section was the most frequently performed surgery 68(24.28%), followed by gastrointestinal 58(20.71%) whereas patients undergo urologic surgery were the least frequently performed surgery 27(2.16%). The highest SSI rate was observed in gastrointestinal surgery 28(35.0) whereas the lowest was observed in caesarean section 6(7.5 %).

Clean contaminated is the dominant wound class in our study which is about 27% followed by contaminated wound 26.4%. Dirty wound accounted 20% of total patients undergo surgery (fig 3). One hundred ninety one (68.3%) of patients were under go elective surgery while the rest were undergo emergency surgery (table 1). In our study, ceftriaxone is the only drug used for surgical prophylaxis.

Incidence of SSI

In this study, 28.57% (95% CI: 22.1-30.3) of patients were developed SSI. Among this patients who have dirty wound share 12%. More than half of the patients, who developed SSI, were developed in the hospital and the rest developed after discharge. The mean duration of operation was 1.8±0.65 hours.

Age (COR=0.56, 95%CI: 0.23-0.96, p=0.018), residence (COR=1.96, 95%CI: 1.83-4.4, p=0.044), preoperative hospital stay (COR=1.89, 95%CI: 1.061-11.17, p=0.041) and duration of prophylaxis (COR=0.29, 95%CI: 0.13-0.79, p=0.034) were identified significant predictors of SSI in Bivariate analysis but did not reach significant predictors after adjusting confounders (table 2).

After adjusting confounding factors using multivariate binary logistic analysis eight variables were identified as a significant predictors. Younger patients were less likely develop infection as compared to elderly patients whose age greater than seventy years old (AOR= 0.74, 95CI: 0.58-.092, p=0.046). Patients having BMI greater than 30kg/m^2 are about two times more likely prone to develop infection(SSI) as compared to whose BMI is less than 30kg/m^2(AOR=1.68,95%CI: 1.09-8.74, p=0.037). Previous surgery also one of the significant predictors to develop infection (AOR=2.77, 95%CI: 1.83-6.43, p=0.04) which is about three times more likely develop infection in comparison with patients have no previous experience of surgical procedure. Lengths of preoperative hospital stay determine the incidence of infection (AOR=1.32, 95CI: 1.04-6.83, p=0.0091). Patients having history of steroid use are more likely to develop SSI (table 2).

Discussion

This study describes overall incidence rate of SSI and associated risk factors. This study suggested that substantial number of patients developed SSI (28.57%) with maximum number of patients developed in the health institution/before discharge. Previous studies done in different countries including Ethiopia (9), Cameron (10), Brazil (11) and Nepal (12) are not go hand in hand. This discrepancy could be unlike previous studies, in our study, we included dirty and contaminated wounds which are more prone to develop infection. In addition, it might be because of health facility related and absence of adequately trained health professionals. Moreover, types of instruments and suture material being used, technique of wound closure could be possible reasons as evidenced by previous study (13). All these might be the reasons why we find out high incidence rate of SSIs compared to previous studies.

Regarding the type of surgery done, the most common surgical procedure performed was caesarean section and with less frequently developed SSI. In present study, the incidence of SSIs was highest in dirty wound followed by contaminated wounds and the lowest rate was observed in clean wound. This finding is in agreement with previous study in Cameron (10), India (14), Nepal (12) and India (15) in which, patients who had dirty wound were more likely developed SSI as compared to patients having clean, clean contaminated and contaminated. Dirty and contaminated wound creates conducive environment for bacterial proliferation. Patients undergoing gastrointestinal surgery share large numbers among patients who developed infection.

In present study, patients who had history of surgical procedures were about three times more likely to develop SSIs compared with patients who had no previous exposure for surgical procedure/s which was in line with other study in Ethiopia (9) in which patients who had history of surgical procedures were 3.64 times more likely to develop SSIs and Brazil (16). We also found prolonged operation is risk factor for SSIs which also in line with previous reports (14), India(4), Rwanda (17), Brazil (11), Indonesia (18) and Finland (19)in which procedures that lasts more than 2 hours prone to develop SSI. This high incidence associated with prolonged duration of surgery might be because wound is exposed to external environment and pave the road for microorganisms to enter the wound. In this study preoperative use of steroid is significantly associated with SSI. Steroid is responsible to suppress immunity and easily exposed to infection. It is contradict with the study done by Sehgal et al (7). The difference might be the duration of steroid treatment.

The increased rate of SSI found in this study with increase in preoperative hospital stay. Patients who stay more than one week were more likely develop as compared to those less than one week. This is because patients who stay in the hospital for long time have high probability to exposed Nosocomial infection including resistant microorganism.

The occurrence of SSI is significantly associated with age. Patients with age less than 30 years old were less likely developed infection compared with patients with age > 70 years. The result was in agreement with other study (9) confirming that as age increases the risk of SSI occurrence increases. The reason behind might be as age increases blood flow decrease which prolong wound healing time and creates good opportunity for microorganism growth. Not only this, the occurrence of chronic disease increases as age increases that decrease the immunity of the patient, both of which synergistically predispose the patient to have SSIs.

We found that patients with BMI < $30kg/m^2$ were 1.68 times less likely to develop SSI as compared to patients having BMI≥$30kg/m^2$. This may be a result of the standard dose of prophylactic antibiotics

achieve inadequate tissue concentrations in obese patients; tissue perfusion is compromised, contribute poor wound healing and suppress immunity. Furthermore, incision time for obese patients may be longer and therefore involve more tissue becoming exposed to bacteria. This showed that health professionals better to counsel patients about life style modification so as to reduce their weight.

We found that patients who have co-morbidity were not significantly associated with SSIs. It is contradict with the study done in Ethiopia (9). As different studies showed that presence of co-morbidity suppress immunity and lead to the patient easily infected. However, in our study, it is not significant predictor. Observed cases with co-morbidity were low in our case and previous studies majority of patients with diabetes mellitus (highly compromise immunity) that might be possible reason for co-morbidity not to be independent predictor for SSIs.

In this study, administration of surgical prophylaxis before 1 hour of surgery done was observed to be independent predictor for development of SSIs. The result is in agreement with previous study Ethiopia (9) administration of first dose surgical antimicrobial prophylaxis before 1 hour of skin incision increased SSIs risk by 11.10 times compared with administration of first dose of surgical antimicrobial prophylaxis within 1 hour of skin incision. If the first dose of surgical antimicrobial prophylaxis administered 1hour earlier to before starting surgery, then the tissue as and serum concentration of antimicrobials is suboptimal to prevent the occurrence of SSI. However, co-morbidity, administration of antibiotics more than 24hours, sex and operator had no significant impact on development of SSI. This suggests that administration of antibiotics for more than 24 hours have no value rather it could lead to increment of health care costs and drug resistance.

Limitation: acknowledgment of limitation is very important for future researchers. Our study is not cover the sanitary profile of health facility and hygiene related practice of health professionals during patient care.

Conclusions

Present study provided information on incidence and risk factors for SSI occurrences. It revealed that the rate of SSI is about 28%. Caesarean section is the most common surgical procedure with the lowest rate of infection. Dirty wound is most commonly developed SSI than other types of wound. Majority of patients developed infection in the hospital. Increasing age and BMI, duration of surgery, lengths of hospital stay, previous surgery are associated with high rate of infection. Moreover, dirty wound, time of prophylaxis and previous use of steroids were identified as significant predictors. Co-morbidity, cigarette smoking and administration of antibiotics beyond 24 hours have no impact on SSI. Therefore, prolonged administration of antibiotics prophylaxis is not beneficial rather it increase cost and resistance of microorganisms. Health professionals should educate the patient about life style modification and reduced the length of preoperative hospital stay.

Abbreviations

CDC: Center of disease control; HAI: Hospital acquired infection; SSI: Surgical site infection; WCSH: Worabe comprehensive specialized hospital

Declarations

Ethical considerations: Ethical issue was secured from drug and therapeutics committee of WCSH. Drug and therapeutics committee communicated with department of surgery and gynecology and obstetrics. Verbal consent from respective physicians and nurses (working in the hospital) was secured to extract data from medical charts if necessary. Written consent with verbal explanation for illiterates was secured to extract data. Privacy and confidentiality were ensured during patient interview and review of patient charts.

Consent for publication: not applicable

Availability of data and materials: all data analyzed during this study was available for publication.

Competing interest: The authors declare that they have no competing interests.

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Author's contribution: Conceptualization: Bezie Kebede.

Formal analysis: Biset Asredaw and Bezie Kebede.

Investigation: Bezie Kebede and Bisset Asredaw.

Methodology: Bezie Kebede and Biset Asredaw.

Writing – original draft: Bezie Kebede.

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Tables

Table 1: Socio-demographic characteristics of participants, Surgical ward, WCH, Ethiopia, 2019

Socio-demographic characteristics of patient	Category	Number	Percent	Mean + SD	Range
Sex	Male	123	43.9		
	Female	157	56.1		
Age group	19-30	81	28.9	42.5±11	19-78
	31-50	107	38.2		
	51-70	73	26.0		
	>70	19	6.9		
Co morbidity	Yes	26	9.28		
	No	254	90.72		
Body mass index	<30kg/m^2	221	78.9	20.5±5.4	17.6-33.5
	≥30kg/m^2	59	21.0		
Residence	Urban	135	48.22		
	Rural	145	51.78		
Current cigarette smoking	Yes	12	4.28		
	No	268	95.72		
Previous surgery	Yes	87	30.07		
	No	193	69.93		
Preoperative blood transfusion	Yes	8	2.85		
	No	272	97.15		
Preoperative hospital stay	≤7 days	178	63.6	8±4.3	3-17
	>7 days	102	36.4		
Type of surgery	Elective	85	30.35%		
	Emergency	127	45.35		
	Gyne &Ob	68	24.3		

Gyne &obes= gynecology and obstetrics

Table: 2 Bivariate and multivariate binary logistic regression analysis for predictors of SSI, WCSH, Ethiopia, 2018

Variables		Bivariate analysis				Multivariate analysis	
		SSI		CB(CI)	P-value	AOR(CI)	p-value
		Yes (%)	No (%)				
Gender	Male	33(41.25)	90(45.0)	0.82(0.305-3.21)	0.31		
	Female	47(58.75)	110(55.0)	1	1		
Age	19-30	10(12.5)	71(35.5)	0.56(0.23-0.96)	**0.018**	0.74(0.58-0.92)	**0.046**
	31-50	30(37.5)	77(38.5)	0.7(0.72-1.9)	0.180	0.27(0.507-0.79)	0.42
	51-70	29(36.25)	44(22.0)	1.23(0.67-10.12)	0.43	0.67(0.45-4.56)	0.078
	>70	11(13.75)	8(4.0)	1	1	1	1
Cigarette smoking	Yes	3(3.75)	9(4.5)	0.23(0.54-2.43)	0.45		
	No	77(96.25)	191(95.5)	1	1		
Residence	Rural	23(28.75)	112(56.0)	1.96(1.83-4.4)	**0.044**	2.93(0.87-8.1)	0.23
	Urban	57(71.25)	88(44.0)	1	1	1	1
Co morbidity	Yes	9(11.25)	17(8.5)	1.4(1.02-.7.084)	0.237	2.21(2.15-12.406)	0.38
	No	71(89.75)	183(91.5)	1	1	1	1
Body mass index	<30kg/m^2	24(30.0)	35(17.5)	2.83(1.76-12.87)	0.203	1.68(1.09-8.74)	**0.037**
	≥30kg/m^2	56(70.0)	165(82.5)	1	1	1	1
Preoperative blood transfusion	Yes	3(3.75)	5(2.5)	0.57(0.34-4.4)	0.67		
	No	77(96.25)	196(97.5)	1	1		
Previous surgery	Yes	34(42.5)	53(26.5)	2.43(1.36-8.33)	0.122	2.77(1.81-6.43)	**0.04**
	No	46(57.5)	147(73.5)	1	1	1	1
Preoperative hospital stay	>7 days	38(47.5)	64(32.0)	1.89(1.061-11.17)	**0.041**	1.32(1.04-6.83)	**0.0091**
	≤7 days	42(52.5)	136(68.0)	1	1	1	
Intraoperative dose	Yes	5(6.25)	9(4.5)	2.65(0.78-3.91)	0.54		
	No	75(93.75)	191(95.5)	1	1		
Wound class	Clean	13(16.25)	59(29.5)	0.016(0.013-076)	0.21	0.13(0.102-0.79)	**0.01**

	Clean-contaminated	18(22.5)	60(30.0)	1.12(1.03-3.8)	0.04	1.8(0.45-7.6)	0.42
	Contaminated	28(35.0)	46(23.0)	0.72(0.23-084)	0.17	0.54(0.12-0.94)	0.049
	Dirty	21(26.25)	32(17.5)	1	1	1	1
Duration of prophylaxis	≤24 hours >24 hours	48(60.0) 32(40.0)	115(57.7) 85(42.3)	0.29(0.13-0.79) 1	**0.034** 1	0.5(0.34-1.8) 1	0.06
Duration of surgery	≤1 hour >1 hour	55(68.75) 25(31.25)	125(62.5) 75(37.5)	0.31(0.01-0.87) 1	0.21 1	0.17(0.14-0.54) 1	**0.03** 1
Type of surgery	Elective Emergency Gyne&obes	26(32.5) 32(40.0) 22(27.5)	59(29.5) 95(47.5) 46(23.0)	1.54(0.24-13.6) 1	0.98 1		
Who is operator?	Surgeon Resident	33(41.25) 47(58.75)	98(49.0) 102(51.0)	1.83(1.71-16.21) 1	0.35 1		
Previous steroid use	Yes No	39(48.75) 41(51.25)	78(39.0) 122(62.0)	2.104(1.98-14.62) 1	0.15 1	1.6(1.03-8.5) 1	**0.027** 1
Time of prophylaxis	Within 1hr. Before 1hr.	22(27.5) 58(72.5)	103(51.5) 97(48.5)	0.35(0.32-2.30) 1	0.21 1	0.72(0.15-0.961) 1	**0.025**

COR: crude odds ratio, AOR: adjusted odds ratio, CI=confidence interval, Gyne &obes= gynecology and obstetrics

Figures

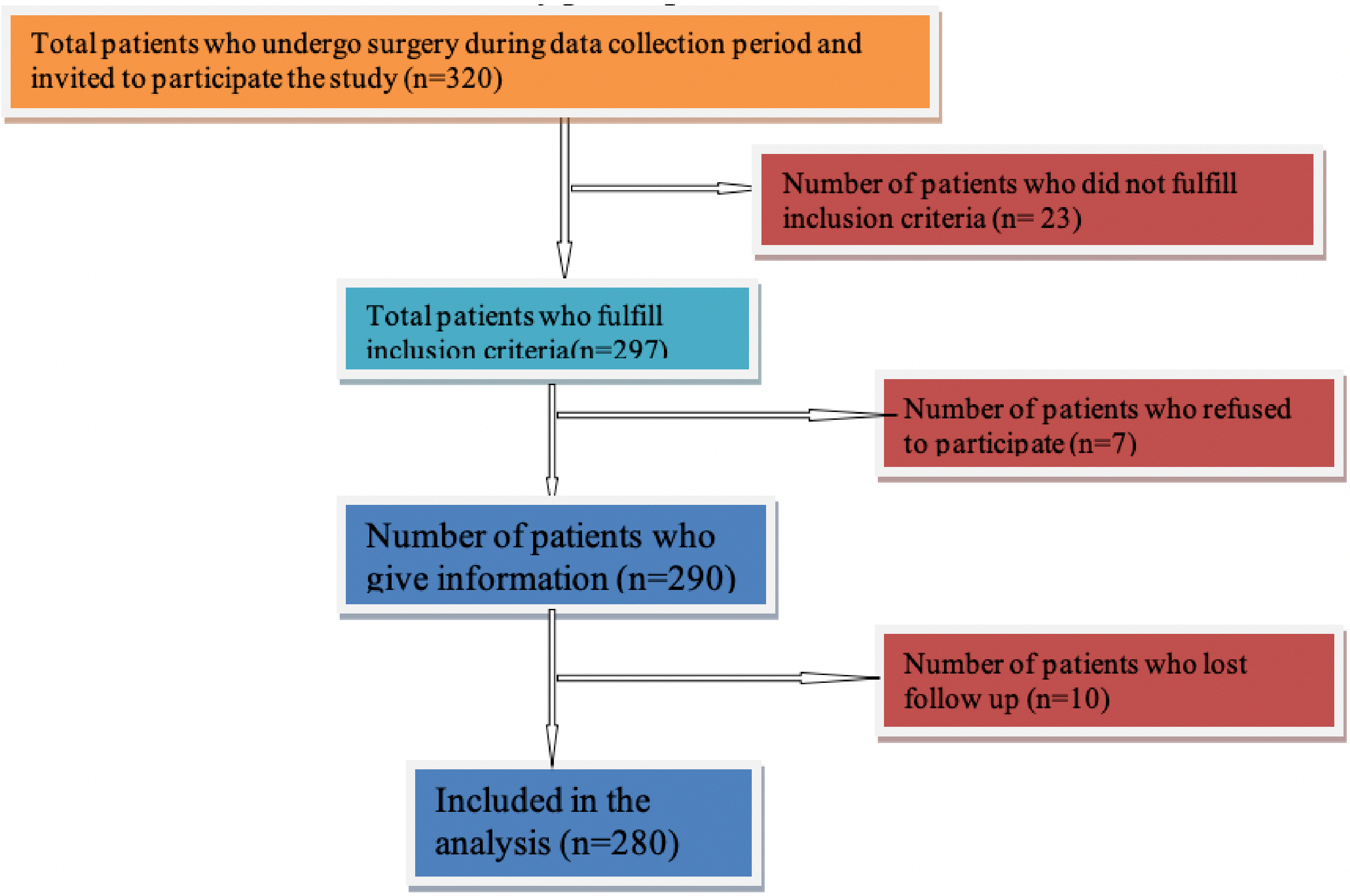

Figure 1

Selection of study participants

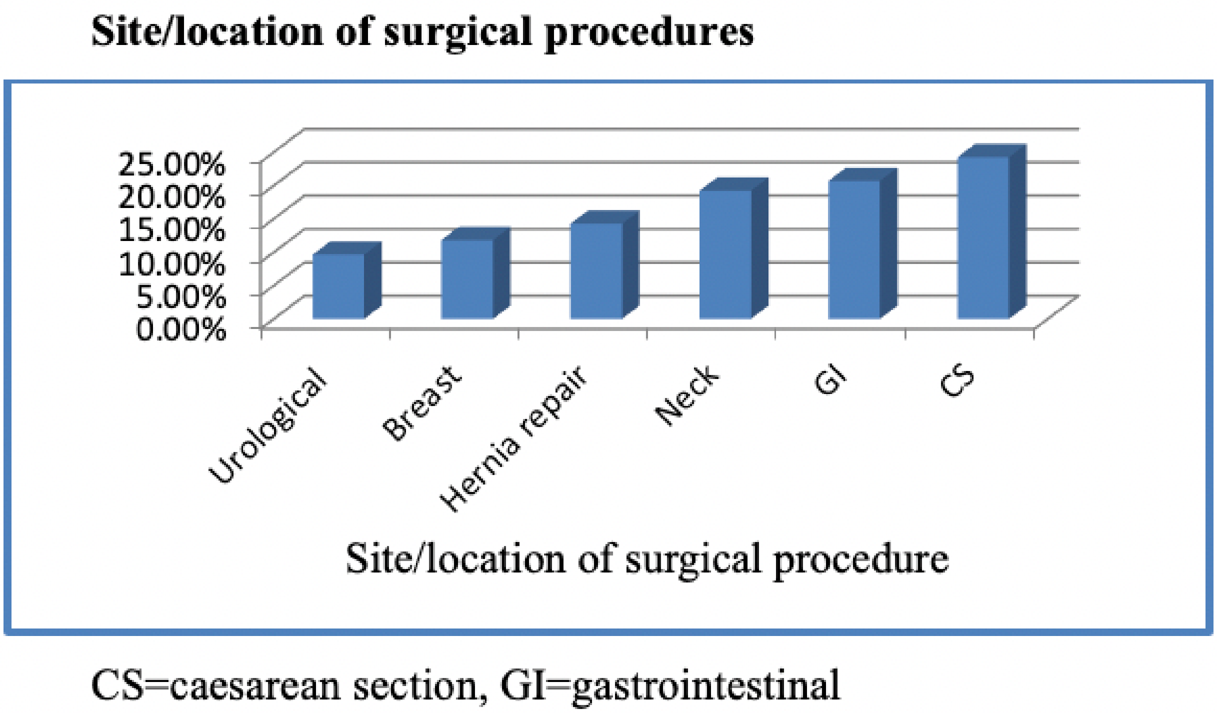

Figure 2

Site/location of surgical procedures

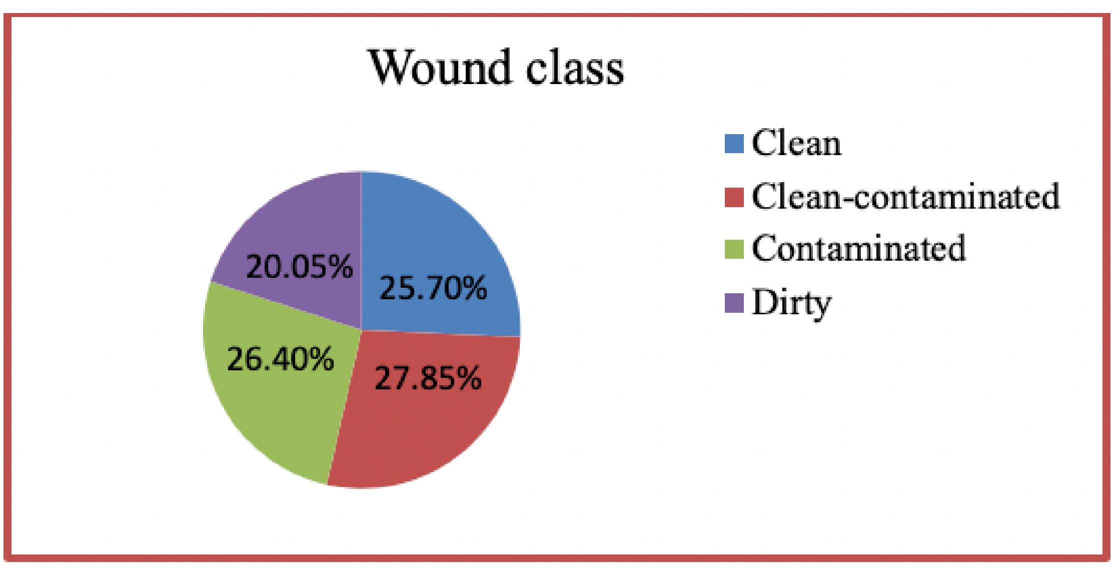

Figure 3

Wound class