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ORIGINAL ARTICLE

Surgical Site Infection: Incidence, Risk Factors, and Outcomes in Gynaecological Surgeries

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ABSTRACT
Background: Surgical-site infection (SSI) is a significant postoperative complication for gynaecological surgery, and can result in delayed wound healing, need for readmission and further surgery, and longer hospitalisation. The risk factors that can be modified must be identified in order to improve perioperative care and minimize postoperative morbidity..
Objective: To determine the incidence, associated risk factors and postoperative outcomes of surgical-site infection among patients undergoing gynaecological surgery.
Material and Methods: This multicentre prospective observational study was conducted at Qazi Hussain Ahmad Medical Complex, Nowshera, and Timergara Medical College/DHQ Teaching Hospital, Timergara, from January 2023 to June 2023. The women were sampled consecutively for a total of 72 women undergoing elective or emergency surgery in the gynaecology ward. Demographic, clinical and operative data was collected. Surgical site infection was observed for 30 days after surgery and while in hospital. Patients infected and non-infected were compared and a binary logistic regression analysis was performed to determine variables independent to the infection. Statistically significant was defined as a p value of < 0.05.
Results: Surgical-site infection developed in 11 of 72 patients, giving an incidence of 15.3%. Superficial incisional infection was the most frequent type, occurring in 7 (63.6%) infected patients, followed by deep incisional infection in 3 (27.3%) and organ-space infection in 1 (9.1%). Diabetes mellitus, obesity, anaemia, emergency surgery, operative duration exceeding 120 minutes, blood loss greater than 500 mL, perioperative transfusion and inappropriate antibiotic prophylaxis were significantly associated with infection. Patients with surgical-site infection had a longer mean hospital stay than those without infection, 9.7 ± 3.8 versus 4.6 ± 2.1 days, respectively (p < 0.001). They also had higher rates of readmission, wound dehiscence, sepsis and reoperation.
Conclusion: Surgical-site infection affected approximately one in seven patients undergoing gynaecological surgery and was associated with important patient-related and operative risk factors. Preoperative optimisation of diabetes, obesity and anaemia, timely antibiotic prophylaxis, careful haemostasis and reduction of prolonged operative time may decrease infection-related morbidity.
Keywords: Surgical-site infection; gynaecological surgery; risk factors; hysterectomy; postoperative complications; wound infection.

INTRODUCTION
Surgical-site infection (SSI) means infection of the surgical incision, deeper soft tissues or organs and spaces that have been operated on. It is one of the most significant healthcare-associated complications after surgery and can happen while patient is in the hospital or after a hospital stay. Surgical-site infection can be restricted to the skin and subcutaneous tissue of the surgical wound (superficial incisional) or may involve the underlying tissues such as the muscle or fascia of the surgical bed (deep incisional) or deeper tissue, such as the organs and tissues of the surgical site (organ-space infection), depending on the anatomical depth. While aseptic technique, antibiotic prophylaxis and peri-operative care have improved, surgical-site infection is still a significant source of morbidity in women undergoing gynaecological procedures[1-3].

Gynaecological surgery involves surgeries performed in the abdomen, vagina and using laparoscopy (a surgical tool) for both benign and malignant conditions. A number of these operations involve inserting through into the genital tract and there are normal microorganisms in that tract and it therefore increases the likelihood of bacterial contamination. Other factors which may affect the risk include the surgical approach, type of wound, length of surgery, level of tissue handling, blood loss, drains and the timing of prophylactic antibiotic use. Open abdominal surgery will have a larger incision and expose more tissue than minimally invasive surgery, potentially leading to more infection in the wound after surgery[4-6].

Other factors related to the patient can also make the person more likely to develop S.S.I. Diabetic mellitus can lead to decreased immune function, and microvascular circulation and wound healing, especially in the perioperative period. Being obese can make surgery more difficult, make it take longer, and can limit the amount of oxygen that reaches the fat tissues. Some other factors that can delay wound healing or lower resistance to infection could be anaemia, old age, smoking, nutrient deficiency, immunodeficiency and prior abdominal surgery. It is an additional difficulty when surgery is urgent as there may not be adequate time to correct these modifiable conditions or to prepare the patient thoroughly for surgery[7-9].

The effects of surgical site infection are not limited to pain, redness and wound drainage. Infected patients might need extended antibiotic therapy, multiple dressings, drainage, debridement, re-operation or suturing. In more severe infections, the wound may open, develop abdominal fluid collections, go septic, require intensive care unit (ICU) admission and death. These complications extend hospital stays, raise the risk of readmission and add costs for the patient and hospital. Good local information on the incidence and risk factors associated with infection is necessary to inform the action plan for prevention[10, 11].

Data describing surgical-site infection after gynaecological surgery in local healthcare settings remain limited, particularly across more than one public-sector teaching hospital. Differences in patient characteristics, infection-control practices, availability of minimally invasive surgery and postoperative surveillance may affect the observed incidence. The present study was therefore conducted to determine the incidence of surgical-site infection, identify associated clinical and operative risk factors, and compare postoperative outcomes among women undergoing gynaecological surgery at two tertiary-care hospitals.

MATERIAL AND METHODS
This multicentre prospective observational study was conducted in the Departments of Gynaecology and Obstetrics at Qazi Hussain Ahmad Medical Complex, Nowshera, and Timergara Medical College/DHQ Teaching Hospital, Timergara. The study was carried out over six months, from January 2023 to June 2023. A total of 72

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women undergoing major or minor gynaecological surgical procedures were enrolled through non-probability consecutive sampling. Ethical approval was obtained from the relevant institutional ethics committees of both participating hospitals before the initiation of data collection. Written informed consent was obtained from every participant, and confidentiality was maintained by assigning a unique study identification number instead of recording patients' names on the data collection form.

Eligibility criteria were an elective or emergency gynaecological surgery in women older than 18 years at the time of surgery. This involved abdominal, vaginal and laparoscopic hysterectomies, myomectomies, ovarian and adnexal surgery, and other open and minimally invasive gynaecological surgeries. Patients were excluded if they had an active infection at the site of surgery prior to surgery, if they had had obstetric surgery like cesarean section prior to surgery, if they had surgery at another hospital prior to referral to the hospital at which the surgery was to be performed, or if they were not able to attend follow-up after surgery. When exposure or outcome information was not assessable, patients taking long-term immunosuppressive therapy or those with incomplete clinical records also were excluded.

The baseline data was obtained by patient interview, medical record and pre-examination. The data collected comprised age, place of residence, body mass index, parity, menopausal status, smoking history, diabetes mellitus, hypertension, anaemia, history of previous abdominal or pelvic surgery, and preoperative haemoglobin, blood glucose and American Society of Anesthesiologists physical status classification. The details of the surgery, such as type and urgency, surgical approach, wound classification, type of incision, duration of surgery, estimated blood loss, receipt of blood transfusion, prophylactic antibiotics and when they were used, placement and use of drains, were included. The body mass index cut-off, which the participating hospitals followed, was used to define obesity, and the clinical diagnosis and reported history were used to define anaemia.

At the time of hospital stay all patients were checked for surgical-site infection and for 30 days after surgery by outpatient follow-up or by looking at hospital records or calling them on the telephone. Patients who had purulent discharge or wound redness, local warmth, swelling, tenderness, separation of wound, abscess, fever with local wound findings, or a positive culture requiring treatment were diagnosed with surgical-site infection. Infections were classified as superficial incisional or deep incisional/organ space infections based on the anatomical depth and clinical characteristics. If clinically indicated, samples were taken from wounds using sterile technique and cultured and tested for antimicrobial sensitivity. Data on the following were gathered: the isolated microorganisms, culture positivity, antibiotic treatment, drainage of wounds, debridement, resuturing, reoperation and admission to intensive care were recorded. Postoperative outcomes were the length of hospital stay, extended hospitalization, wound rupture, re-hospitalization within 30 days, sepsis, reoperation, intensive-care admission and in-hospital death.

Data were entered and analysed using IBM SPSS Statistics. Quantitative variables, including age, body mass index, operative duration and hospital stay, were presented as mean with standard deviation or median with interquartile range, depending on data distribution. Categorical variables were reported as frequencies and percentages. Patients who developed surgical-site infection were compared with those who did not develop infection. The chi-square test or Fisher's exact test was used for categorical variables, while the independent-samples t-test or Mann–Whitney U test was applied to numerical variables. Variables showing a clinically relevant or statistically significant association in the initial analysis were considered for binary logistic regression to identify independent predictors of surgical-site infection. Adjusted odds ratios with 95% confidence intervals were reported, and a p-value below 0.05 was considered statistically significant.

RESULTS

In all a total of 72 patients who had undergone gynaecological surgical operations were included in the study. The mean age of the patients was 45.8 ± 11.6 years, while the mean body mass index was 27.4 ± 4.8 kg/m². Most patients, 43 (59.7%), were aged 40 years or older. Diabetes mellitus was present in 17 (23.6%) patients, hypertension in 21 (29.2%), anaemia in 25 (34.7%), and obesity in 20 (27.8%). 19 (26.4%) patients reported a history of previous abdominal or pelvic surgery.

Abdominal hysterectomy was the most common surgical procedure, performed in 29 (40.3%) women, followed by ovarian or adnexal surgery in 14 (19.4%) women, vaginal hysterectomy in 11 (15.3%) women, myomectomy in 10 (13.9%) women, and laparoscopy in 8 (11.1%) women. Of the procedures performed, 58 (80.6%) were elective, while 14 (19.4%) were done as an emergency. 53 (73.6%) patients had open surgery and 19 (26.4%) patients had minimally invasive surgery or vaginal surgery. The mean operative time was 96.5 ± 31.7 minutes.

The overall incidence of surgical-site infection was 15.3% (11/72 patients). Of these infections, 7 (63.6%) were superficial incisional infections, 3 (27.3%) were deep incisional infections and 1 (9.1%) was an organ space infection. The average time from surgery to diagnosis of infection was 6.8 ± 3.1 days. The most common clinical symptom was wound discharge (9, 81.8%) followed by redness of the wound (8, 72.7%), pain or tenderness of the wound (7, 63.6%), fever (5, 45.5%) and wound dehiscence (3, 27.3%).

Of the 11 patients who developed SSI, 8 (72.7%) had positive wound cultures. The most common microorganism found was Escherichia coli (3 (27.3%) cases). S. aureus was isolated in 2 (18.2%), K. pneumoniae and P. aeruginosa were isolated in 1 (9.1%) patient each while E. species was isolated from 1 (9.1%) patient. Three patients were infected with organisms that could not be cultured.

Patients with diabetes mellitus had a significantly higher percentage of SSI than did patients without diabetes 5 (29.4%) versus 6 (10.9%) respectively (p=0.049). The same was true with regard to obesity, with 6 (30.0%) obese patients having SSI versus 5 (9.6%) non-obese patients (p = 0.028). There was also a significant difference between the infection rate for anaemic patients and non-anaemic patients (7 (28.0%) versus 4 (8.5%) respectively, p = 0.029). There was a higher rate of SSI in the patients undergoing emergency procedures than in the ones undergoing elective procedures, 5 (35.7%) versus 6 (10.3%) (p = 0.017). There was also a higher infection rate in patients undergoing operations exceeding 120 minutes (6 (31.6%) vs. those who underwent operations not exceeding 120 minutes; 5 (9.4%) (p = 0.020). Patients who had blood transfusion were more likely to have an infection than those who had not (5 (38.5%) vs 6 (10.2%); p = 0.012).

Poor postoperative outcomes were observed in patients who developed SSI. They had a mean hospital stay of 9.7 ± 3.8 days versus 4.6 ± 2.1 days for those who did not have SSI (p < 0.001). The rate of readmission within 30 days was 4 (36.4%) of patients who had SSI and 3 (4.9%) patients who had not SSI (p = 0.001)

Table 1: Baseline and clinical characteristics of the patients (n = 72)

Variable	Frequency (%) or Mean ± SD
Age, years	45.8 ± 11.6
Age <40 years	29 (40.3)
Age ≥40 years	43 (59.7)
BMI, kg/m²	27.4 ± 4.8
Obesity	20 (27.8)
Diabetes mellitus	17 (23.6)
Hypertension	21 (29.2)
Anaemia	25 (34.7)
Smoking history	6 (8.3)
Previous abdominal/pelvic surgery	19 (26.4)
ASA class I	27 (37.5)
ASA class II	33 (45.8)
ASA class III	12 (16.7)

Table 2: Operative characteristics of the study participants

Operative variable	Frequency (%) or Mean ± SD
Abdominal hysterectomy	29 (40.3)
Vaginal hysterectomy	11 (15.3)
Laparoscopic hysterectomy	8 (11.1)
Ovarian/adnexal surgery	14 (19.4)
Myomectomy	10 (13.9)
Elective surgery	58 (80.6)
Emergency surgery	14 (19.4)
Open surgical approach	53 (73.6)
Minimally invasive/vaginal approach	19 (26.4)
Operative duration, minutes	96.5 ± 31.7
Operative duration >120 minutes	19 (26.4)
Estimated blood loss >500 mL	16 (22.2)
Perioperative blood transfusion	13 (18.1)
Drain placement	18 (25.0)
Appropriate antibiotic prophylaxis	61 (84.7)

Table 3: Incidence and clinical characteristics of surgical-site infection

SSI-related variable	Frequency (%)
Overall SSI	11 (15.3)
No SSI	61 (84.7)
Superficial incisional SSI	7 (63.6)
Deep incisional SSI	3 (27.3)
Organ-space SSI	1 (9.1)
Wound discharge	9 (81.8)
Wound redness	8 (72.7)
Pain or tenderness	7 (63.6)
Fever	5 (45.5)
Wound dehiscence	3 (27.3)
Abscess or collection	2 (18.2)

Table 4: Microbiological findings among patients with SSI (n = 11)

Microbiological finding	Frequency (%)
Culture-positive infection	8 (72.7)
Culture-negative infection	3 (27.3)
Escherichia coli	3 (27.3)
Staphylococcus aureus	2 (18.2)
Klebsiella pneumoniae	1 (9.1)
Pseudomonas aeruginosa	1 (9.1)
Enterococcus species	1 (9.1)

Table 5: Factors associated with surgical-site infection

Risk factor	SSI, n (%)	No SSI, n (%)	p-value
Age ≥40 years	8 (18.6)	35 (81.4)	0.397
Age <40 years	3 (10.3)	26 (89.7)	
Diabetes mellitus	5 (29.4)	12 (70.6)	0.049
No diabetes mellitus	6 (10.9)	49 (89.1)	
Obesity	6 (30.0)	14 (70.0)	0.028
No obesity	5 (9.6)	47 (90.4)	
Anaemia	7 (28.0)	18 (72.0)	0.029
No anaemia	4 (8.5)	43 (91.5)	
Emergency surgery	5 (35.7)	9 (64.3)	0.017
Elective surgery	6 (10.3)	52 (89.7)	
Open surgery	10 (18.9)	43 (81.1)	0.157
Minimally invasive/vaginal surgery	1 (5.3)	18 (94.7)	
Operative duration >120 minutes	6 (31.6)	13 (68.4)	0.020
Operative duration ≤120 minutes	5 (9.4)	48 (90.6)	
Blood loss >500 mL	5 (31.3)	11 (68.7)	0.041
Blood loss ≤500 mL	6 (10.7)	50 (89.3)	
Blood transfusion	5 (38.5)	8 (61.5)	0.012
No blood transfusion	6 (10.2)	53 (89.8)	
Inappropriate antibiotic prophylaxis	4 (36.4)	7 (63.6)	0.034
Appropriate antibiotic prophylaxis	7 (11.5)	54 (88.5)	

Table 6: Comparison of postoperative outcomes between patients with and without SSI

Outcome	SSI group (n = 11)	No-SSI group (n = 61)	p-value
Hospital stay, days	9.7 ± 3.8	4.6 ± 2.1	<0.001
Prolonged hospital stay	8 (72.7)	10 (16.4)	<0.001
Readmission within 30 days	4 (36.4)	3 (4.9)	0.001
Reoperation	2 (18.2)	1 (1.6)	0.010
Wound dehiscence	3 (27.3)	1 (1.6)	<0.001
Sepsis	2 (18.2)	0 (0.0)	0.002
ICU admission	1 (9.1)	1 (1.6)	0.126
Mortality	0 (0.0)	0 (0.0)	—

Table 7: Multivariable logistic regression analysis of predictors of SSI

Predictor	Adjusted OR	95% CI	p-value
Diabetes mellitus	3.12	1.01–9.68	0.048
Obesity	3.47	1.10–10.94	0.034
Anaemia	2.83	0.91–8.81	0.072
Emergency surgery	4.38	1.25–15.36	0.021
Operative duration >120 minutes	3.96	1.19–13.18	0.025
Perioperative blood transfusion	4.21	1.16–15.28	0.029
Inappropriate antibiotic prophylaxis	3.18	0.89–11.39	0.075

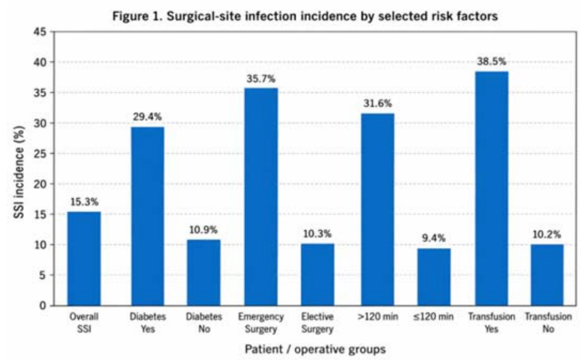

Figure 1: Surgical-site infection incidence according to selected clinical and operative risk factors among patients undergoing gynaecological surgery (n = 72).

In infected patients, 2 (18.2%) required reoperation, whereas 1 (1.6%) of the non-infected patients did (p = 0.010). Two (18.2%) patients who developed SSI also developed sepsis, but no patients in the non-SSI group developed sepsis (p = 0.002). There was no mortality recorded in the period of study.

The presence of diabetes mellitus, obesity, emergency surgery, long operation time and blood transfusion during the operation were independently predictive of SSI on the multivariable binary logistic regression analysis. The adjusted odds ratio for the emergence of infection and the emergency surgery was highest at 4.38. The risk of SSI was more than quadrupled with an operative time >120 minutes, and was more than quadrupled with perioperative blood transfusion.

Overall, the incidence of SSI following gynaecological surgery was 15.3%. Diabetes mellitus, obesity, emergency surgery, prolonged operative duration, excessive blood loss, blood transfusion, and inappropriate antibiotic prophylaxis were significantly associated with infection. Patients who developed SSI experienced longer hospitalization, greater readmission rates, more frequent wound complications, and a higher requirement for additional surgical intervention.

DISCUSSION

The present study found that surgical-site infection occurred in 11 of 72 patients, giving an overall incidence of 15.3% following gynaecological surgery. Superficial incisional infection was the most frequent category, followed by deep incisional and organ-space infection. This pattern is consistent with the recognised classification of SSI, in which superficial infections are generally reported more frequently than deeper infections. However, the incidence observed in this study was higher than the 4.67% overall SSI rate reported in a 2022 study of gynaecological operations and the 7.57% rate reported specifically after hysterectomy. Differences in surveillance methods, patient characteristics, surgical approaches, hospital infection-control practices and the proportion of emergency procedures may explain this variation. Studies relying only on infections detected during hospitalization may also report lower rates than studies using active 30-day follow-up[12, 13].

Diabetes mellitus, obesity and anaemia were significantly associated with SSI in the present study. Patients with diabetes had a much higher rate of infection (29.4%) than non-diabetic patients (10.9%) and obese and anaemic patients had significantly higher infection rates. Diabetes can make an individual more vulnerable to infection in a variety of ways such as impaired leukocytes function, delayed wound healing, inadequate perioperative glycemic control, and diminished microvascular circulation. Obesity can make treatment difficult, can lead to trauma of the tissue and can result in poorly vascularised fat where antibiotics don't penetrate, and less oxygen can reach the tissue. Anaemia can also adversely affect tissue oxygenation and healing processes. Such links with diabetes, obesity and other patient-related comorbidities have been found in previous studies of gynaecological surgery[14, 15].

Other operative characteristics were also found to be significant with regard to infection. SSI rates were significantly higher following emergency surgery, surgeries that lasted > 120 minutes, and surgeries with blood loss > 500 mL. In an emergency situation there may be insufficient time to correct anaemia, glucose abnormalities, active infection or other modifiable risk factors. Longer surgery means longer exposure of tissues, contamination with bacteria and surgical manipulation. High blood loss may lead to decreased tissue perfusion and transfusion may reveal patients with more aggressive procedure or physiological stress. The results are consistent with previous studies of gynaecological surgery, linking longer operative times, greater blood loss, and emergency surgery with postoperative wound infections[16, 17].

Other important factors were peri-operative blood transfusion and inadequate antibiotic prophylaxis. The rate of SSI was 38.5% of those who were transfused and 10.2% of those who were not. Transfusion can cause immune alteration, but it can also be an indicator of massive surgery, blood loss, or poor preoperative status. Appropriate antibiotic prophylaxis was also associated with decreased risk of infection. The success of any prophylaxis is dependent on the choice of appropriate antimicrobial agent for the likely organisms and giving the drug at a time when it will reach the correct concentration in tissues at the time of incision. These findings underscore the need for a preoperative evaluation, prompt administration of prophylactic antibiotics, and prudent judicious haemostasis and avoidance of unnecessary transfusion. Evidence-based SSI-prevention strategies for gynaecological surgery also highlight anti-bacterial prophylaxis, skin preparation, glucose control, temperature control and standardised perioperative care bundles[18-20].

The patients who developed SSI had significantly worse postoperative outcomes. These patients had a length of hospital stay over twice as long as those without infection, and had rates of re-admission, wound dehiscence, sepsis and re-operation rates that were higher than those of patients without infection. These results show that SSI is not a local wound problem but can significantly contribute to morbidity, workload and the need for treatment in a hospital. This lack of mortality in the present study could be due to the small number of patients studied, the early detection and prompt treatment of infection. The limitations of the study were relatively small sample size, short recruitment period and involvement of various types of gynaecological surgeries. The precision of multivariable regression estimates was also affected by the small number of cases of SSI. Future multicenter prospective studies with standardized 30-day surveillance, microbiological analysis and evaluation of antimicrobial resistance are recommended.

CONCLUSION

Surgical-site infection occurred in 15.3% of patients undergoing gynaecological surgery and was mainly superficial incisional in nature. Diabetes mellitus, obesity, anaemia, emergency surgery, prolonged operative duration, excessive blood loss, perioperative transfusion and inappropriate antibiotic prophylaxis were important associated factors. SSI was linked with longer hospitalization, greater readmission, wound dehiscence, sepsis and an increased need for reoperation. Careful preoperative optimisation, appropriate antibiotic prophylaxis, improved glucose and anaemia management, strict aseptic practice, reduction of operative time and minimisation of blood loss may help reduce postoperative infection and improve patient outcomes.

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