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IP International Journal of Medical Microbiology and Tropical Diseases

Journal homepage: https://www.ijmmtd.org/

Original Research Article

Microbiological Profile and Risk Assessment of surgical- site infections following Obstetric and Gynecological Surgeries: A study at a rural-based tertiary care hospital

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Abstract

Introduction: Surgical site infections are the second most common cause of maternal mortality after postpartum hemorrhage in obstetrics and gynecology. Surgical site infections account for about 38% of health care-associated infections among patients admitted to the obstetrics and gynecology department.
Aims & Objective: The main aim of the study is to investigate the incidence of surgical site infection following obstetric and gynecological surgeries and evaluate various risk factors. In the present study bacteriological profile and antibiotic susceptibility of various pathogens were analyzed.
Materials and Methods: The present cross-sectional study was carried out at a rural-based tertiary care hospital for the period of 4 years (January 2021 to March 2025) to estimate the rate of surgical site infection in the obstetrics and gynecology department. A total of 1460 patients who underwent various obstetrical and gynecological procedures were included in the study.
Result: Out of a total of 1460 patients, 162 developed surgical site infections. Thus incidence of surgical site infection in our study was 11.09%. Out of all the surgeries, highest surgical site infection rate was among Lower Segment Cesarean Section procedures (24%), followed by vaginal hysterectomy (20.9%). In our study statistical analysis showed that body-mass index (>30kg/m^2), random blood sugar (>140 mg/dL), low hemoglobin level (<7gm/dL), prolonged duration of surgery and longer hospital stay (more than 7 days) were significantly associated with the development of Surgical site infection.
Conclusion: Regular surveillance has to be carried out in our hospital setting to monitor the Surgical site infection rate and ensure proper implementation of infection prevention and control measures.

Keywords: Surgical site infection, Obstetric and gynecological surgery, Enterobacter cloacae.

Received: 17-04-2025; **Accepted:** 15-05-2025; **Available Online**: 28-05-2025

1. Introduction

Surgical site infections are the second most common cause of maternal mortality after postpartum hemorrhage in obstetrics and gynecology.[1,2] Surgical site infections account for about 38% of health care-associated infections among patients admitted to the obstetrics and gynecology department.[3,4] In India SSI rate ranges widely from 2.5% to 41.9%, depending upon hospital environment, the immune status of the patient, associated co-morbidities, and infection control practices.[4] According to World Health Organization data, the rate of SSI among low and middle-income countries is 11.8 episodes of SSI per 100 surgical procedures.[5] The Centers for Disease Control (CDC), USA, have reported an SSI rate of 1.7% for hysterectomy procedures.[4,6] In USA, surgical site infections are the second most common complication in cesarean delivery, with a rate varying between 3 to 15%. The low and middle-income countries have an SSI rate of 10 to 20% following cesarean delivery.[7]

According to NHSN guidelines, surgical site infections are defined as healthcare-associated infections that develop within 30 days of a surgical procedure or within 90 days for a few surgical procedures such as breast, cardiac, and joint surgeries, including implants.[6,13] SSIs are rarely fatal but prolong healing of the incision site and contribute to

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http://doi.org/10.18231/j.ijmmtd.2025.036

postoperative morbidity, an increase in treatment cost, and extend patient stay at the hospital.[1,3]

The source of surgical site infections can be exogenous or endogenous. The invasion of microbes at the surgical site can occur during a surgical procedure (primary infection or after surgery (secondary infection).[4,8] The primary infections are more threatening and appear within five to seven days after surgery. Surgical site infections can be superficial, deep, or organ-spread.[9] The majority of surgical site infections involve skin and subcutaneous tissue, but occasionally develop into necrotizing infections. The surgical site infection typically presents with pain, swelling, pus discharge, hyperthermia, and erythema.[11,12]

The prevention of surgical site infections requires proper implementation of infection control practices.[9,11] All pre-operative, intra-operative, and post-operative bundle care approaches should be strictly followed in order to tackle SSI. In most hospital settings, the SSI rate is usually underestimated due to a lack of follow-up of patients after discharge.[4,6] Thus proper hospital surveillance system has to be established in order to estimate disease burden and health-related effects. To ensure proper post-discharge surveillance, proper training of hospital staff is a must.[6,24] Proper surveillance and feedback are effective ways that can help to reduce the rate of healthcare-related infections.[9]

Many initiatives have been formulated in order to establish standardized methods for data collection on various risk factors associated with SSI and post-discharge 30-day surveillance of patients.[4,8] There are a limited number of studies that have reported the SSI rate from both obstetric and gynecological surgeries simultaneously. The simultaneous reporting of SSI from both departments will help to provide a complete picture of SSI.[10,11,12]

The present study was conducted at a rural-based tertiary care hospital in order to estimate the SSI rate from the obstetric and gynecology department and to study associated risk factors. The present study will also help in developing a surveillance system for proper monitoring of patients post-discharge.

2. Objectives

The main aim of the study is to investigate the incidence of surgical site infection following obstetric and gynecological surgeries and evaluate various risk factors. In the present study bacteriological profile and antibiotic susceptibility of various pathogens were analyzed.

3. Materials and Methods

3.1. Study design

The present cross-sectional study was carried out at a rural-based tertiary care hospital for the period of 4 years (January 2021 to March 2025) to estimate the rate of surgical site infection in the obstetrics and gynecology department. A total of 1460 patients who underwent various obstetrical and gynecological procedures were included in the study.

3.2. Ethical approval

This present study was carried out at rural based tertiary hospital, Vadodara after obtaining ethical approval from institutional committee (SVIEC/ON/MEDI/RP/DEC/23125). Informed consent was obtained from all patient with surgical site infections.

3.3. Inclusion and exclusion criteria

The inclusion criteria included all the patients who have undergone major Obstetrics or Gynecological surgical procedure at our hospital and fulfilled NHSN criteria of SSI. Patient with hospital stay less than 24 hours and undergoing second surgery at same site were excluded from SSI surveillance.

3.4. Data collection

After patient admission, a detailed medical and clinical examination was carried out. Various demographic data, like age, gender, and associated risk factors, were recorded.

3.5. Evaluation of risk factor for SSI

Various risk factors associated with surgical site infections were evaluated such as elevated blood sugar level, preoperative hemoglobin level ,duration of surgical procedure (less or more than one hour) , duration of hospital stay (7 days or more) , ASA rating of patient (Class 1 to 5), body-mass index and parity of patient. All the risk factors were explored for both groups with and without SSI and p value was calculated to establish its significance.

3.6. Post-operative follow-up of patients

After the surgical procedure, all patients were examined for the development of any infection at the wound site, and findings were recorded by a consultant. In the follow-up period (after 72 hours of surgery), post-operative examination was carried out to look for any signs of inflammation, swelling, or pus discharge.

All discharge patients were advised for on-going follow up for a period of one month, and they were counselled to immediately report to a surgeon if they notice any signs of infection at a surgical site.

3.7. Microbiological analysis

3.7.1. Sample collection procedure

In case of surgical site infection, the wound site was cleaned with normal saline, and then the sample was collected with a sterile swab. In case of deep infection, aspirated material was collected. All samples were collected with aseptic precautions and immediately transported to the microbiology laboratory.

3.7.2. Sample processing

For bacterial culture, nutrient agar, blood agar, and MacConkey agar plates were used. All culture plates were incubated at 37ºc under aerobic conditions. All isolated bacteria were identified on the basis of morphological appearance and cultural characteristics by the conventional method, and further species confirmation was done by Vitek 2.

3.7.3. Antibiotic susceptibility test

Further confirmation of bacterial species and antibiotic susceptibility of pathogen was done by Vitek 2 Compact bioMérieux. For interpretation of antibiotic sensitivity Clinical and Laboratory Standards Institute guidelines 2024 were used.

3.8. Statistical methods

To establish association between various risk factors and the development of SSI Chi-square test was used. At 95% confidence interval, a p-value of less than 0.05 was considered statistically significant.

4. Results

The present study was carried out for a period of 4 years in the obstetric and gynecology department for the surveillance of surgical site infections. A total of 1460 patients were included in the present study. Out of a total of 1460 patients, 63.6% belong to the age group 18-40 years and 33.5% to 40-60 years (**Table 1**)

Out of total 1460 patient, 162 developed surgical site infection fulfilling NHSN criteria. Thus incidence of surgical site infection in our study was 11.09%. (**Figure 1**)

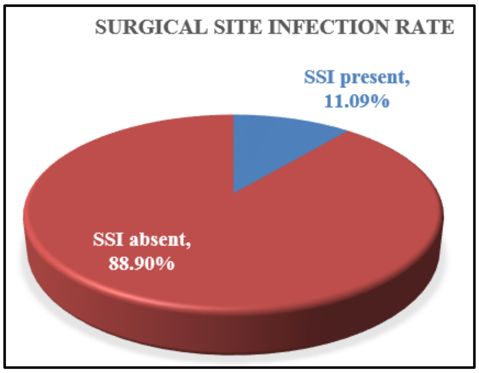

Figure 1: Incidence of surgical site infection

Out of a total of 162 patients with surgical site infection, 112 patients (69.1%) developed superficial surgical site infection, 41 patients (25.3%) developed deep SSI, and 9 patients (5.5%) developed organ-spaced infection.(**Table 2**)

Table 1: Age-wise distribution of patients

Age wise distribution (years)	N=1460	%
18-40	930	63.69%
40-60	490	33.56%
>60	40	2.73%

Table 2: Type of surgical site infection

Type of surgical site infection	N=162
Superficial	112 (69.1%)
Deep	41 (25.3%)
Organ spaced	9 (5.5%)

Table 3: Proportion of SSI among various surgical procedure

Type of surgery	Total (n=1460)	SSI present (n=162)	SSI absent (n=1298)
Exploratory Laparotomy	114	12 (7.4%)	102
Vaginal Hysterectomy	255	34 (20.9%)	221
Total Abdominal Hysterectomy	210	21 (12.9%)	189
Tubal Ligation	25	2 (1.2%)	23
Episiotomy	139	15 (9.2%)	124
Lower Segment Cesarean Section	364	39 (24%)	325
Normal Vaginal Delivery	224	16 (9.8%)	208
Dilation and Curettage	77	12 (7.4%)	65
Myomectomy	32	6 (3.7%)	26
Cervical Biopsy	20	5 (3.08%)	15

Table 4: Evaluation of various risk factors associated with SSI

Factors	Total (n=1460)	SSI (n=162)	non-SSI (n=1298)	Chi-square test	P value
BMI (kg/m^2)					
18.5-24.9	349	40	309	18.39	0.0001 Significant
25-29.9	979	93	886		
>30	132	29	103		
Type of Surgery					
Elective	906	56	850	58.46	0.00001 Significant
Emergency	554	106	448		
Parity					
Primiparous	738	82	656	0.029	0.98 Not significant
Multiparous	556	61	495		
Nonpregnant	166	19	147		
Random blood sugar Level (mg/dL)					
70-140	1098	94	1004	28.84	0.00001 Significant
More than 140	362	68	294		
Haemoglobin Level (g/dL)					
< 7	67	21	46	32.50	0.00001 Significant
7-11	825	94	731		
>11	568	47	521		
Duration of Surgery					
Less than 1 hour	478	36	442	9.15	0.002 Significant
More than 1 hour	982	126	856		
ASA class					
Class 1-2	1336	90	1246	303.03	< 0.00001 Significant
Class 3-5	124	72	52		
Duration of Hospital Stay					
Less than 7 days	1085	97	988	19.90	0.00001 Significant
More than 7 days	375	65	310		

Table 5: Antibiotic sensitivity of Gram positive cocci

Name of Antibiotic	*Staphylococcus aureus* (n=28)
Penicillin	0%
Cefoxitin	39.28%
Vancomycin	92.85%
Linezolid	100%
Erythromycin	71.42%
Clindamycin	64.28%
Levofloxacin	46.15%
Doxycycline	61.53%
Ampicillin	7.6%
Gentamycin	71.42%
Co-trimoxazole	50%
Rifampicin	100%
Daptomycin	100%
Teicoplanin	100%

Table 6: Antibiotic sensitivity of Gram negative bacilli

Antibiotic	*Klebsiella pneumoniae (n=32)*	*Enterobacter cloacae (n=53)*	*E. coli (n=26)*	*Citrobacter spp. (n=3)*	*Proteus spp. (n=7)*
Gentamicin	50%	56.60%	38.46%	66.6%	42.85%
Amikacin	43.75%	60.37%	53.84%	66.6%	57.14%
Meropenem	96.87%	96.22%	100%	100%	100%
Imipenem	93.75%	94.33%	100%	100%	85.71%
Piperacillin/ Tazobactum	65.62%	77.35%	42.3%	66.6%	71.42%
Ceftriaxone	21.87%	20.75%	15.3%	33.3%	14.28%
Cefuroxime	18.75%	16.98%	23.07%	33.3%	28.57%
Cefepime	28.12%	24.52%	30.76%	33.3%	28.57%
Amoxicillin/ clavulanic acid	28.12%	0%	11.53%	66.6%	42.85
Levofloxacin	43.75%	58.49%	61.53%	66.6%	85.71%
Cefoperazone/sulbactam	62.5%	60.37%	53.84%	66.6%	71.42%

Table 7: Antibiotic sensitivity of Gram-negative non-fermenter bacteria

Antibiotic	*Pseudomonas aeruginosa (n=11)*	*Acinetobacter baumannii (n=2)*
Piperacillin/Tazobactum	54.54%	50%
Ceftazidime	36.36%	0%
Cefoperazone/sulbactam	63.63%	100%
Cefepime	18.18%	50%
Imipenem	90.90%	100%
Meropenem	100%	100%
Gentamicin	36.36%	50%
Amikacin	45.45%	50%
Ciprofloxacin	18.18%	50%
Levofloxacin	36.36%	50%

Table 8: Comparison among various studies

Author	SSI Rate (%)	Commonest Type Of Surgical procedure	Most common bacterial isolate
Present study	11.09%	LSCS	*Enterobacter cloacae*
Sayali P Kulkarni et al[18]	9.2%	Total Abdominal hysterectomy	*E. coli*
Ashish Pathak et al[4]	7.84%	Abdominal hysterectomy	---
Divya Fultariya et al[17]	11.04%	LSCS	*Staphylococcus aureus*
Shikha et al.[8]	9%	LSCS	*Staphylococcus aureus*
Bharatnur S et al.[11]	46%	Abdominal hysterectomy	*E. coli*
Surekha Tayade et al.[9]	0.75%	Total Abdominal Hysterectomy	*Staphylococcus aureus*

The obstetric surgical procedures included normal vaginal delivery, lower segment caesarean section (LSCS), dilatation and curettage (for termination of pregnancy), episiotomy and exploratory laparotomy (for ectopic pregnancy). The gynaecological procedure included Vaginal Hysterectomy (for abnormal uterine bleeding, fibroids, uterine prolapse), total abdominal hysterectomy (for fibroids, endometriosis, pelvic organ prolapse), myomectomy, tubal ligation, cervical biopsy (for suspected gynaecological cancers and diagnosis of premalignant condition), dilatation and curettage (for dysmenorrhea) and exploratory laparotomy (for ovarian cancer and pelvic masses). Out of all the surgeries, highest SSI rate was among LSCS procedures (24%), followed by vaginal hysterectomy (20.9%), abdominal hysterectomy (12.9%), vaginal delivery (9.8%), Episiotomy (9.2%) and exploratory laparotomy (7.4%).(**Table 3**)

In our study statistical analysis showed that body-mass index (>30kg/m^2), random blood sugar (>140 mg/dL), low hemoglobin level (<7gm/dL), prolonged duration of surgery and longer hospital stay (more than 7 days) were significantly associated with the development of surgical site infection with p value less than 0.05. The emergency surgical procedures have a higher SSI rate as compared to elective surgery. ASA class 3 or higher has a greater risk of SSI as compared to class 1 and 2. The parity status of the patient was not a significant risk factor (p value=0.98). (**Table 4**)

In our study, there were 28 (17.2%) isolates of *Staphylococcus aureus,* out of which 17 were methicillin-resistant strains (MRSA). There were 2 vancomycin-resistant *Staphylococcus aureus* strains. All isolates of *Staphylococcus aureus* showed 100% sensitivity to Rifampicin, Daptomycin, Linezolid, and Teicoplanin.

Among gram-negative bacilli Enterobacter cloacae (32.7%) showed the highest prevalence, followed by Klebsiella pneumoniae (19.7%), E. coli (16%), Pseudomonas aeruginosa (6.7%), Proteus spp. (4.3%), Citrobacter spp (1.8%) and Acinetobacter baumannii (1.2%) as shown in Figure 2. All the gram-negative isolates showed the highest sensitivity to the carbapenem group of drugs. (**Table 6**, **Table 7**)

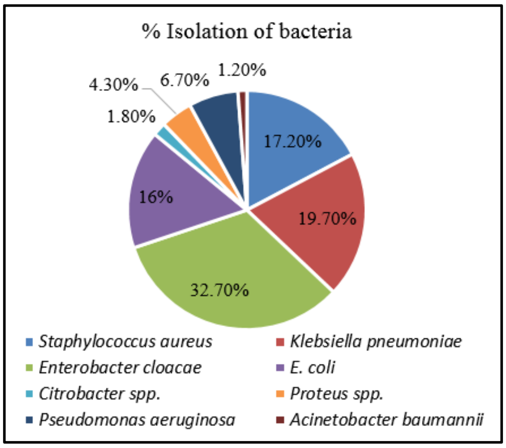

Figure 2: % Isolation of bacteria

Antibiotic sensitivity of various organism as shown below.

5. Discussion

According to the World Health Organization 2011 data, the incidence of SSI was 11.8 episodes per 100 surgical procedures among low and middle-income countries.[5] According to 2023 CDC HAI data, there was about a 2% increase in SSI standardized infection ratio (SIR) related to all NHSN operative procedures compared to the previous year.[6,7]

In African countries, 20% of women develop SSI following caesarean section, compromising the health of the mother and child. The surgical site infections are not just a concern for poor countries; USA also reported that SSI leads to more than 400,000 extra patient days and additional costs of US$ 900 million per year.[4,5,12]

The present study was carried out for a period of 4 years in the obstetric and gynecology department for the surveillance of surgical site infections. Out of a total of 1460 patients

162 developed a surgical site infection. Thus incidence of surgical site infection in our study was 11.09%. Our SSI rate was comparatively higher as compared to other studies (**Table 8**). This variation might be due to different hospital environments, different immune status of the patient, and improper implementation of infection control practices.

Out of a total of 162 patients with surgical site infection, 112 patients (69.1%) developed superficial surgical site infection, 41 patients (25.3%) developed deep SSI, and 9 patients (5.5%) developed organ-spaced infection. Out of all the surgeries, highest SSI rate was among LSCS procedures (24%), followed by vaginal hysterectomy (20.9%), abdominal hysterectomy (12.9%), vaginal delivery (9.8%), Episiotomy (9.2%) and exploratory laparotomy (7.4%). In a study conducted by Divya et al[(17)] superficial SSI accounted for 91.5% of total cases and highest SSI rate was among LSCS (43.39%) followed by total abdominal hysterectomy (21.69%), Episiotomy (8.49%) and vaginal hysterectomy (5.66%).

In our study statistical analysis showed that body-mass index (>30kg/m^2), random blood sugar (>140 mg/dL), low hemoglobin level (<7gm/dL), prolonged duration of surgery and longer hospital stay (more than 7 days) were significantly associated with the development of surgical site infection with p value less than 0.05. The emergency surgical procedures have a higher SSI rate as compared to elective surgery. ASA class 3 or higher has a greater risk of SSI as compared to class 1 and 2. The parity status of the patient was not a significant risk factor (p value=0.98).

In a study conducted by Sayali Kulkarni et al.[18] higher proportion of SSI 82.7%, was among patients with BMI 25-30 kg/m^2 and a lower proportion 17.3% with BMI 18-24.9 kg/m^2.Based on the type of procedure higher SSI rate of 55.3% was for emergency procedures and 44.7% for elective surgeries. In the study, hemoglobin level and SSI rate were significantly associated (chi-square of 152, and p-value is less than 0.0001). Statistical analysis also showed a correlation between Random blood sugar level and SSI rate (chi-square of 64.627 and a p-value of <0.002)

In our study, there were 28 (17.2%) isolates of *Staphylococcus aureus* out of which 17 were methicillin-resistant strains (MRSA). There were 2 vancomycin-resistant *Staphylococcus aureus* strains. Among gram-negative bacilli *Enterobacter cloacae* (32.7%) showed the highest prevalence, followed by *Klebsiella pneumoniae (19.7%), E. coli (16%), Pseudomonas aeruginosa (6.7%), Proteus spp. (4.3%), Citrobacter spp (1.8%) and Acinetobacter baumannii (1.2%).*Our observation was in contrast with various studies by Divya et al,[17] Shikha et al[8] and Surekha Tayade et al[9] who reported *Staphylococcus aureus* as the most common bacterial isolate. On the other hand, Sayali et al,[18] Sahu et al,[15] and Giri et al[16] reported *E.coli* as the most frequent bacterial isolate with a prevalence of 30.5%, 30%, and 23%, respectively.

Our present study has certain limitations. We do not have standardized method for collection and analysis of data which need to be established. Proper training must be provided to health care staff to ensure adequate data. In certain cases we were unable to track surgical site infections due to lack of hospital resources, inadequate infrastructure facilities and improper postoperative follow-up. Only certain pre, intra and post-operative interventions were analysed.

6. Conclusion

The present study was carried out at a rural-based tertiary-care hospital to evaluate the incidence of surgical-site infection following obstetric and gynecological surgeries. The present study also identified various risk factors associated with SSI, which will further guide in risk stratification and prioritizing intervention. Regular surveillance has to be carried out in our hospital setting to monitor the SSI rate and ensure proper implementation of infection prevention and control measures.

7. Source of Funding

None.

8. Conflict of Interest

None.

9. Acknowledgements:

The authors thank all the patients for providing their consent for the study.

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Cite this article: Bhalodia NM, Bhalodia MJ, Pandya H, Javadekar T, Lakhani S. Microbiological Profile and Risk Assessment of surgical- site infections following Obstetric and Gynecological Surgeries: A study at a rural-based tertiary care hospital. *IP Int J Med Microbiol Trop Dis.* 2025;11(2):225-231.