# Antimicrobial Sensitivity and Resistance Pattern in Surgical Site Infections following Gynaecological and Obstetrical Operations

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## Abstract

**Background:** Surgical Site Infections (SSIs) are one of the common problem in obstetrical and gynaecological operations. It is related to the increasing cost, morbidity and mortality. Objectives of this study were, find out the rate of surgical site infection, frequencies of various pathogens causing SSIs and their antibiotic sensitivity and resistance pattern in gynaecological and obstetrical operations in the Department of Obs & Gynae Chittagong Medical College, Chattogram.

**Materials and methods:** This hospital based prospective longitudinal study was carried from January 2021 to July 2021 in the Department of Gynaecology and Obstetrics, Chittagong Medical College, Chattogram, Bangladesh. After operation, patients' surgical wounds were inspected first on 5-7 th day and there after weekly up to 30 postoperative- day. If there had any features of wound infection, pus or discharge would have been collected from the wound. A total 100 pus or discharge were collected from the wound after obtaining written informed consent and according to the inclusion and exclusion criteria. Samples were processed following the standard laboratory technique.The isolates were identified by colony morphology, Gram's staining and biochemical test according to standard laboratory test methods.

**Results:** In this study most of the surgical site infections were caused by gram negative organisms (90%). *Pseudomonas aeruginosa* (36%) was the commonest organism responsible for SSIs. *Staphylococcus species* were responsible for SSIs in 6% of cases. In case of gram negative bacteria Amikacin and Imipenem were sensitive to about 89% and 91% microorganisms. While in case of gram positive organisms it were about 78% and 89%. Commonly used antibiotics in our set up included Ceftriaxone, Cefixime, Ciprofloxacin and Cefuroxime were sensitive in gram positiveorganisms 45%, 33%, 33% and 33% respectively. Butin case of gram negative organisms it were 76%, 63%, 79%, and 66%.

**Conclusion:** Surgical site infections are the reflection of quality of hospital services. Once it was thought that the organisms responsible for the SSIs were derived from normal bacterial flora of the skin. But in last few years, it has been shown that the gram negative organisms are the main pathogens responsible for SSIs. Most of them are derived from the hospital environment.So the strict surgical ritual has come to mainstay in the management of the patients instead of being used antibiotics irrationally, which not only increases the chance of resistance to the micro-organisms but also glooming our future.

**Key words:** Amikacin; SSI; Imipenem.

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## Introduction

Surgical Site Infections (SSIs) remain an important cause of postoperative morbidity and mortality and generate considerable additional healthcare and social costs. In USA, they have been needed about 1.6 billion dollar per year to treat SSIs.[1] The SSIs are not uncommon in our set up rather would it is much higher.It creates an enormous pressure on health system. The symptoms of a surgical site infection typically appear on 5$^{th}$to 7$^{th}$ post-operative day.[2] According to Center for Disease Control and Prevention (CDC) surgical Site Infections (SSIs) are defined as infection that occurs at incision site within 30 days after surgery (One year if surgery involves any implant).[3] Post-operative surgical site infection is the leading nosocomial cause of morbidity and ranked third in the low income countries.[4] The common clinical features of surgical site infections include, spreading erythema, localized pain,pus or discharge from the wound, wound dehiscence and persistent pyrexia.[2] The National Healthcare Safety Network (NHSN) categorizes SSIs are, superficial incisional SSIs, deep incisional SSIs or organ/space SSIs.[5] Superficial or minor wound infection may discharges pus or infected serous fluid but are not associated with systemic manifestations. On the other hand deep or major SSIs are usually having systemic signs such as tachycardia, pyrexia and a raised white cell count etc.[6] SSIs are commonly caused by skin-derived bacteria such as Staphylococcus aureus and coagulase-negative staphylococci. But in

recent, trend has been changed to gram negative organisms[7]. Antimicrobial resistance among these and other clinically important pathogens is an increasing problem. Although overall risk of SSIs are influenced by numerous patient and procedure-specific factors but antibiotic prophylaxis, skin preparation, less attendant in the ward and follow strict operation theatre ritual arethe important components of the polymodal approach to prevent SSIs.[8]

Aim of this study was to find out the rate of surgical site infections, frequencies of various pathogens causing SSIs and their antibiotic sensitivity and resistance pattern in our set up. This study wasalso generate data that would help in selection of appropriate empirical antimicrobial therapy for pathogens causing SSIs in gynaecological and obstetrical operations.

## Materials and methods

This hospital based prospective longitudinal study was carried from January 2021 to July 2021 in the Department of Gynaecology and Obstetrics, Chittagong Medical College, Chattogram, Bangladesh. Surgical wounds were inspected first time usually at the 5$^{th}$ to 7$^{th}$ postoperative day and weekly thereafter for thirty days. If any of the following were fulfilled, wound infection would have been diagnosed. Serous or pus discharge from the wound with or without signs of inflammation and wound deliberately opened by the surgeons due to localized collection (Serous or purulent). A total 100 samples were collected from the wound either by sterile cotton swab or aspirated in a sterile disposable syringe. The samples were collected randomly after obtaining written informed consent from the patient and processed following the standard laboratory techniques. Later twelve patients had been excluded from the study due to negative culture report. Approval of this study was obtained from the ethical review committee of Chittagong Medical College.

*Inclusion criteria:*

Patients had underwent operative surgery in the Department of Obs & Gynae Chittagong Medical College Hospital and developed wound infection within 30 days of operation.

*Exclusion criteria:*

If wound infection developed after 30 days of operation. Wound cellulitis without wound discharge and stich abscess were excluded from the study. No growth in the culture also being excluded from the study.

All statistical analyses are performed using the Statistical Package for the Social Sciences (SPSS) version 20.0 for Windows (SPSS, Inc. Chicago, IL). First, descriptive statistics, including count and percentage are used to describe the demographic characteristics of the subjects. The mean and standard deviation are computed for quantitative data variables while Qualitative data are compared using proportion. Bivariate analysis for association between potential risk factors and their potential association with SSIs were performed using Chi square ($\chi^2$) and Fisher's exact tests. p-value < 0.05 was considered statistically significant.

## Results

**Table I** Demographic and comorbid illness related variables

| Age Years (Mean ±SD)<br>Incidence of SSI | 32.23±14.6 (IQR- 18-75<br>Total No. of operations- 4759<br>No. of patients | Total No. of SSI-229(4.81%))<br>Percentage | p-value |
|---|---|---|---|
| Socio-economic condition (n=88) | | | |
| Upper | 03 | 4 | .0875 |
| Middle | 32 | 36 | .0439 |
| Lower | 53 | 60 | .0235 |
| Occupation(n=88) | | | |
| House wife | 74 | 84 | .01432 |
| Service holder | 11 | 12 | .0678 |
| Self employed | 03 | 04 | .0864 |
| Comorbid illness(n=88) | | | |
| Anaemia (<10g/dl) | 16 | 18 | .0382 |
| Diabetes Mellitus | 08 | 9 | .0523 |
| Jaundice | 01 | 1 | .0986 |
| Malignancy | 03 | 4 | .0647 |
| CKD | 01 | 1 | .0986 |

Data are expressed as frequency (Percentage), mean ± SD. p-value is obtained from Chi-square test. p< .05 is statistically significant. CKD-Chronic Kidney Disease

**Table II** Operation related variables

| Name of operation (n=88) | Frequency | Percentage | p-value |
|---|---|---|---|
| Cesarean section | 68 | 77 | .0235 |
| Abdominal hysterectomy | 06 | 07 | .0597 |
| Ectopic pregnancy | 08 | 09 | .0723 |
| Vaginal hysterectomy | 01 | 01 | .0976† |
| Others | 05 | 06 | .0643† |
| Types of operations (n=88) | | | |

| | | | |
|---|---|---|---|
| Emergency | 69 | 78 | .0312 |
| Elective | 19 | 22 | .0767 |
| Types of wound (n=88) | | | |
| Clean | 11 | 13 | .0523 |
| Clean contaminated / contaminated | 77 | 87 | .0275 |
| Classification of wounds(n=88) | | | |
| Superficial / Minor | 76 | 86 | .0128 |
| Deep/ Major | 12 | 14 | .0569 |
| Methods of collection of pus(n=100) | | | |
| Sterile swab | 68 | 68 | NA |
| Aspiration by disposable syringe | 32 | 32 | NA |

p-value is obtained from Chi-square test p< .05 is statistically significant. †p-values is obtained from Fishers exact test.Cesarean section (64%) operation is commonly performed operation. Clean contaminated and contaminated wounds (85%) are the common type of wound. Superficial / Minor wound infections (89%) are the commonest variety of wound disruption.

**Table lll** Total number of gram positive and gram negative organisms responsible for wound infection (n=88)

| Organisms | Total number | Percentage | p-value |
|---|---|---|---|
| Gram positive | 9 | 10 | .0294 |
| Gram negative | 79 | 90 | |

p-value is obtained from Chi-square test p < .05 is statistically significant. Gram negative organisms are significantly higher in number than the gram positive organisms responsible for wound infection (p<.05).

**Table lV** Frequency of various pathogens responsible for wound infection (n=88)

| Aerobic organisms | No. of isolates | Percentage (%) |
|---|---|---|
| Gram positive cocci | | |
| Staphylococcus Aureus | 05 | 6 |
| MRSA | 02 | 2 |
| Total | 07 | 8 |
| Mixed gram positive and gram negative | | |
| Staph+ E. coli | 01 | 1 |
| Staph+ Acinetobacter | 01 | 1 |
| Total | 02 | 2 |
| Gram negative Bacilli | | |
| Pseudomonas sapprophyticus | 32 | 36 |
| Escherichia Coli | 09 | 10 |
| Aeromonas | 03 | 4 |
| Klebsiella sapprophyticus | 22 | 25 |
| Acinetobacter | 08 | 9 |
| Total | 74 | 84 |
| Gram negative poly microbial | | |
| Acinetobacter+ Aeromonas | 01 | 1 |
| Acinetobacter+ Pseudomonas | 03 | 4 |
| Klebsiella+ E. coli | 01 | 1 |
| Total | 05 | 6 |

Table lV shows most common cause of SSIs are gram negative bacteria (90%) and gram positive organism is responsible for 10% of cases.

**Table V** Antimicrobial susceptibility pattern of gram+ve (n=9) and gram-ve (n=79) organisms

| Antibiotics | Susceptible (%) | | Intermediate (%) | | Resistance (%) | |
|---|---|---|---|---|---|---|
| | gm+ve | gm-ve | gm+ve | gm-ve | gm+ve | gm-ve |
| Amikacin | 7(78) | 70(89) | 1(11) | 5(6) | 1(11) | 4(5) |
| Imipenem | 8(89) | 72(91) | 0(0) | 4(5) | 1(11) | 3(4) |
| Ceftraixone | 4(45) | 60(76) | 2(22) | 8(10) | 3(33) | 11(14) |
| Ciprofloxacin | 3(33) | 62(79) | 1(11) | 5(6) | 5(56) | 12(15) |
| Cefotaxime | 4(45) | 58(74) | 2(22) | 10(12) | 3(33) | 11(14) |
| Amoxicillin/clavulinic acid | 5(56) | 65(82) | 2(22) | 6(18) | 2(22) | 8(10) |
| Cloxacillin | 4(45) | 44(56) | 2(22) | 15(19) | 3(33) | 20(25) |
| Linezolid | 6(67) | 55(70) | 1(11) | 5(6) | 2(22) | 19(24) |
| Cefixime | 3(33) | 50(63) | 2(22) | 3(4) | 4(45) | 26(33) |
| Erythormicin | 2(22) | 36(46) | 2(22) | 7(8) | 5(56) | 36(46) |
| Ofloxacin | 1(11) | 42(54) | 1(11) | 10(12) | 7(78) | 27(34) |
| Cefaparazone | 2(22) | 48(61) | 3(33) | 9(11) | 4(45) | 22(28) |
| Piperacillin/ Tazobactum | 5(56) | 69(87) | 1(11) | 1(1.5) | 3(33) | 9(11.5) |
| Azithromycin | 2(22) | 34(43) | 2(22) | 5(6) | 5(56) | 40(51) |
| Gentamicin | 4(45) | 68(86) | 2(22) | 5(6) | 3(33) | 6(8) |
| Trimethoprim/ Sulphamethaxozole | 6(67) | 62(79) | 1(11) | 2(3) | 2(22) | 15(18) |
| Cefuroxime | 3(33) | 52(66) | 1(11) | 12(15) | 5(56) | 15(19) |

Table V shows Amikacin and Imipenem are two antibiotics sensitive to both gram positive and gram negative organisms.Ceftraixzone, Ciprofloxacin, Cefixime, Cefuroxime are less sensitive to both gram positive and negative organisms.

## Discussion

Surgical site infections are the major cause of sufferings of the patients after operations.[9] Ignaz-Semmelweisa Hungarian obstetrician, worked in Vienna in 1847, first took a step for reduction of infection by introducing 'hand wash'. By the implementation of 'hand wash' infection rate and puerperal sepsis related death dropped from more than 20% to less than 2%.[10, 11] Joseph Lister of England adopted antiseptic spray in the operation theatre and in the ward to reduce the infection.[12] Later part of 1930s, antibiotics were discovered. Antiseptic technique and antibiotics together had reduced the surgical site infection in a considerable numbers. But heavily relied on the antibiotics, emergence a new problem, that was antibiotic resistance microorganisms.This study showed that the incidence of SSIs were about 4.81%. World Health Organization (WHO) showed that SSIs were most frequently reported type of nosocomial infection in low and middle

income countries with a pooled incidence of 11.8%.[9] In high-income countries, approximately 2% of surgeries were affected by SSIs.[9, 13].

This study showed the mean age (Years±SD) of the patients were 32.23± 14.6 years. The incidence of SSI were common among younger age group. A study in England demonstrated an increased risk SSIs for younger women.[14] The factors associated with SSIs in younger group were- poorer nutrition, premature rupture of membrane, neonatal death, intra-operative blood loss and post-operative haematoma.[15, 16, 17] Poor antenatal care, frequent vaginal examination and obesity were also responsible for surgical site infections in younger age group.[18,19] Infection ratein the age group 15-30 years (30.9%) was higher than other age groups[20].In this study, patients with low socio-economic condition, house wives, anaemic and diabetic patients were more likely todevelop SSIs.

Current series showed, most of the SSIs were related to the Cesarean Section (CS) delivery (77%). Mpogora FJ et al had shown that the incidence of SSIs rate were much higher among all obstetrical operations and emergency operations.[19] The occurrence of a SSIs following a CS reported inliterature ranges from 0.3% in Turkey to 24% in Tanzania [19]. But Pathak A et al showed that surgical site infection rates were much higher in gynecological operations and in elective cases, about 10.3%.[20]

Surgical site infections varied from a low of 2.5% to a high of 41.9% according to the classification of the wound.[6, 7] The rate of SSIs were 5.9% for clean wounds and 29.4% for clean-contaminated wounds.[18] Current series showed most of the infected wounds belonged to clean contaminated and contaminated wounds (87%). Pathak A et al had shown that, most of their surgeries were clean (78%) or clean contaminated (18%).[20] In another study it had shown that the infection rate in clean wounds were 3.03% and clean contaminated wounds were 22.41%.[6]

In this series most of the surgical site infections were superficial/ minor wound infection (86%) and remaining were the deep/ major surgical site infection (14%). Chu K et al in their study had shown the incidence of superficial wound infection accounts about 93%.[21] In another study, they noticedthe incidence of deep tissue infections were 14.7%.[19] It is similar to present study. The differentiation between major and minor and the definition of SSIs are important in audits and clinical trials of antibiotic prophylaxis.[22]

In the pre-antibiotic era streptococcus pyogenes and other gram positive organisms were the main causes of SSIs.[12] Now gram negative organisms i.e Pseudomonas aeruginosa, Klebsiella, Proteus, E.coli, Acinetobacter, Aeromonas, Salmonella etc. are in the forefront. [23,24]

Present study showed, surgical site infections caused by gram negative and gram positive organisms were 90% & 10% respectively. Statistically it was significant ($p < 0.05$). Banjara et al. reported in their study that 27% were Gram positive and 73% were Gram negative bacteria.[25] Pseudomonas aeruginosa gram negative bacilli were in first place responsible for 36% of cases. It is primarily an opportunistic pathogens. It can be grown in water containing only trace nutrients and this favors their persistence in the hospital environment. Pathogenesis of Pseudomonas aeruginosa is based on endotoxin, exotoxin and enzymes.[26] In this study organisms isolated were *Escherichiacoli* (10%) *staphylococci* (6%), MRSA (2%) Acinetobacter spp. (9%) *Klebsiella* spp. (25 %) *Aeromonas hydrophillia* (4%) Acinetobacter + Aeromonas (1%) Acinetobacter+ pseudomonas (4%), Klebsiella + E.coli (1%). Many studies have reported *Staphylococcus aureus* as the commonest isolate from the wound infections.[27] Chaudhary R et al showed the main organism responsible for SSIs in their study was Staphylococcus aureus (47.2%), and second most common organism was E. coli (20.6%).[28] Lilani SP et al had shown that the most common organisms responsible for SSIs were staphylococcus aureus and Pseudomonas aeruginosa.[6] SSIs were caused by gram negative bacilli mostly exogenous or from hospital environment,including in surgical instruments and operating room air for long period of times, even months not from endogenous sources.[29]

The wide spread and indiscriminate use of antibiotics, gradually replaces antibiotic sensitive strains to those resistant to multiple antibiotics commonly used in the hospital.[30] There is negligence of established methods of prevention of SSIs due to unjustified faith in the efficacy of antimicrobials. The emergent antimicrobial resistant strains are commonly involved in the causation of SSIs.[31]

Present series showed most of the gram positive and gram negative organisms were sensitive to the Amikacin and Imipenem. In case of gram positive organisms Amikacin and Imipenem was sensitive to 78% and 89% respectively. It is about 89% and 91% in gram negative bacteria. Commonly used antibiotics in our set up are ceftriaxone, cefixime, ciprofloxacin and cefuroxime were sensitive in gram positive and gram negative organisms 45%, 33%, 33% 33% and 76%, 63%, 79%, 66% respectively.They are less sensitive to all form of microorganisms. In one study it had shown that the effective antibiotic for the Gram positive isolates were Amikacin (93.1%) followed by Chloramphenicol (92.6%) Piperacillin/Tazobactam (86.2%) Clindamycin (81.7%) and Gentamicin (79.6%).[28] Amikacin (81.8%) and Imipenem (81.8%) were found to be the drug of choice for gram negative bacterial wound isolates followed by Gentamicin (73.0%), Piperacillin/ Tazobactam (72.2%) and Meropenem (60.7%). This study almost similar to present series.

70% of bacteria that cause wound infections are resistant to minimum one of the most commonly used antibiotics.[32] S. aureus and P. aeruginosa - strains were both significantly resistance to different types of antibiotics.[33] The microorganisms resistant to at least one antibiotic of three or more than three different classes of antibiotics were considered Multidrug Resistant (MDR).[28] In current study, we found 35.12% of the isolates were MDR organisms. Banjara et al. found 47.2% isolates were multidrug resistance category.[26] The multi-drug resistant bacteria are important cause of nosocomial infection and infection associated with such microorganism poses serious threat to entire health system.[34]

**Limitations**

- Single centered study.
- Small sample size.
- In Covid situation emergency surgery is more than the routine surgery.

**Conclusion**

Surgical site infections are the reflection of quality of hospital service as well the quality of operation in Gynae wards. Present series shows gram negative organisms are responsible for the SSIs in our set up instead of gram positive organisms and they are less sensitive to commonly used antibiotics. Post- operative follow up and surveillance are essential for detection of surgical site infections. Once SISs are diagnosed appropriate measures should be taken. Without signs of spreading infection systemic antibiotics are not required, rather drainage of pus or discharge, excision of devitalized tissues, regular dressing, topical antibiotics ointment etc. are the prime modes of treatment. If systemic antibiotics are required it should be according to the culture and sensitivity report.

**Recommendation**

Antibiotics should be used strictly according to the culture and sensitivity report and when they are required.

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**Contribution of authors**

TS- Conception, design, drafting & final approval.
KB- Data analysis, drafting & final approval.
KN- Interpretation of data, critical revision & final approval.

**Disclosure**

All the authors declared no competing interest.

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