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**Original Research Article**

# Antibiotic Susceptibility Patterns in Gram-Positive and Gram-Negative Isolates from Post-Operative Wound Infections

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## Abstract

***Background:*** Post-operative wound infections (POWIs) are a leading cause of morbidity and increase in healthcare costs, especially in low resource settings. The rising prevalence of antibiotic resistance among pathogens also increases the complexity of treatment strategies, highlighting the importance of local surveillance of microbiological and resistance patterns. This study aims to find out the antibiotic susceptibility patterns of gram positive and gram negative isolates from the post-operative wound infections from women undergoing obstetric and gynecological surgeries. ***Methods:*** A cross-sectional study was conducted at Department of Obstetrics and Gynecology, Dhaka Medical College Hospital, Dhaka from October 2019 to September 2021. A total of 200 women with post-operative wound infections were purposively selected. Among them, 134 had culture-positive findings. Bacteriological analysis and antibiotic susceptibility testing were performed on isolates following standard microbiological methods. ***Results:*** Among the 134 culture-positive cases, 33.6% of isolates were gram-positive, with *Staphylococcus aureus* being predominant. Gram-negative bacteria accounted for 66.4% of isolates, with *E. coli* and *Pseudomonas aeruginosa* equally prevalent (20.9%). Gram-positive isolates showed high sensitivity to piperacillin-tazobactam (91.1%) and sulbactam (53.3%) but were resistant to ceftriaxone (48.9%) and cefixime (51.1%). Gram-negative bacteria exhibited sensitivity to amikacin and meropenem but demonstrated widespread resistance to ceftriaxone and doxycycline. ***Conclusion:*** This study describes the diverse microbiological profile and high prevalence of antibiotic resistance in POWIs. Novel antibiotic therapy and strict infection control measures are essential to curb the burden of these infections.

**Keywords:** Post-operative wound infections, Microbial susceptibility, Antibiotic resistance, *E. coli*, *Staphylococcus aureus*.



## INTRODUCTION

Post-operative wound infections (POWIs) are considered a major problem in surgical practice and they are the source of severe morbidity and prolonged hospital admission to patients as well as increase healthcare costs [1, 2]. The global incidence of POWIs varies widely, from 2 to 30%, depending on geographical settings, hospital hygiene standard and antibiotic stewardship practice [3, 4]. These infections are difficult because they happen in developing countries like Bangladesh, where this resource constraints and heavy patient load increases the risk for nosocomial infections [5].

POWIs etiology is multi-factorial, with both gram positive and gram negative bacteria, and different antibiotic resistance patterns often used against common antibiotics. Primarily, gram positive organisms, especially *Staphylococcus aureus* are highly responsible for their resistance to different antibiotics such as methicillin [6]. On the other hand, gram negative pathogens such as *E. coli* or *Pseudomonas aeruginosa*" frequently isolated and resistant to extended spectrum beta lactamase (ESBL) and other resistance mechanisms [7, 8]. Treatment strategies become further complicated by the emergence of multi-drug resistant (MDR) strains, which require continuous surveillance and tailored antibiotic regimens [9].

Prolonged surgical duration, obesity, poor glycemic control, and the inappropriate use of prophylactic antibiotic are several risk factors for POWIs [10]. POWIs are especially common in gynecological and obstetric surgeries and tend to be related to emergency procedures, suboptimal preoperative care, as well as underlying patient comorbidities [11]. Antimicrobial susceptibility patterns and microbiological profile of pathogens must be determined in order for these infections to be managed and prevented effectively [12].

Adopting evidence based practices such as adherence to surgical checklists, optimization of perioperative antibiotic protocols and stringent aseptic techniques are emphasized as critical risk mitigating strategies to prevent POWIs [13]. Routine surveillance of surgical site infections and resistance patterns are recommended by the Centers for Disease Control and Prevention (CDC) guidelines [14]. However, implementation gaps persist in many low resource settings [15] and this seems to call for site specific research aimed at overcoming context specific hurdles.

This study was aimed to evaluate the antibiotic susceptibility pattern of gram positive and gram negative isolates in post-operative wound infections among women who underwent the obstetric and gynecological surgery in Dhaka Medical College Hospital, Dhaka. This research identifies the dominant pathogens and their resistance profiles and the goal is to provide actionable insights to improve infection control strategies and antibiotic use in comparable healthcare settings.

**Objective**

The objective of this study was to determine the antibiotic susceptibility patterns in gram-positive and gram-negative isolates from post-operative wound infections.

## METHODOLOGY & MATERIALS

This cross-sectional study conducted at Department of Gynecology and Obstetrics, Dhaka Medical College Hospital, Dhaka from October 2019 to September 2021. A total 200 woman diagnosed with post-operative wound infection and admitted in the Department of Gynecology & Obstetrics are selected purposively and included in this study. Among the women 134 had positive bacteriological findings and 66 cases had negative bacteriological findings. Antibiotic sensitivity test was carried out in all bacteriological positive women.

**Inclusion Criteria**

A. Women diagnosed with post-operative wound infections following obstetric and gynecological surgeries.
- Patients who provided written informed consent to participate in the study.
- Patients with clinical signs of wound infections.
- Cases with bacteriological findings confirmed by wound culture.

**Exclusion Criteria**

i. Patients with chronic illnesses unrelated to wound infections.
ii. Patients receiving prolonged antibiotic therapy prior to hospital admission.
iii. Patients with infections resulting from non-surgical trauma.
iv. Women with mixed infections involving fungal or viral pathogens.

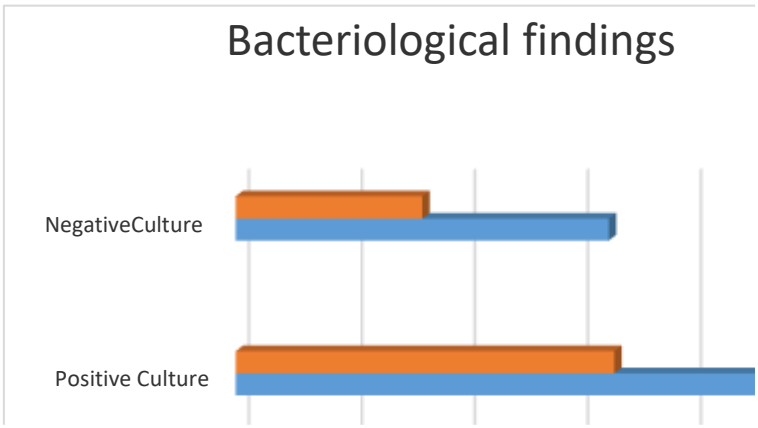
**Data Collection:** Before starting the study, formal ethical approval was taken from the ethical review committee of the Dhaka Medical College Hospital. All women diagnosed with post-operative wound infection in Department of Gynecology and Obstetrics were approached for this study. After describing the aim, purpose and procedure of the study, total of 200 patients were finally enrolled who met the inclusion and exclusion criteria. Informed written consent was taken from parent/guardian. Relevant information was recorded in predesigned proforma. Detailed history was taken including investigations especially C/S reports were collected. Those patients without C/S report, wound swab was collected from the wound site and sent to the pathology department of DMCH for bacteriological study. Data were collected using a semi structured case record form containing all the variables of interest. A standard guideline was followed during post-operative wound infection management. Data collection was carried out by the investigator himself by using separated a case record form.

**Ethical consideration:** Patients who met the inclusion criteria were reviewed in-depth by the researcher after they were admitted to the hospital. A printed handout with study details and relevant information was read out and explained in the local tongue. Written informed consent was acquired when all the information was provided. The patient was informed that his or her privacy would be protected. There would be no financial gain taking part in the study and that declining to take part at any point would not affect the course of treatment. The patient was informed that this study does not involve any invasive procedures.

**Statistical analysis of data:** After collection of all the required data, these were checked, verified for consistency and tabulated using the SPSS version 24. Statistical significance was set as 95% confidence level at 5% acceptable error level. Socio-demographic, clinical and wound swab culture and sensitivity profile were reported. Continuous data were expressed as mean and standard deviation and categorical data were expressed as frequency and percentage. P-value less than <0.05 is considered as statistically significant.

## RESULTS

Bacteriological findings in 200 women with post-operative wound infections are presented in this histogram. Among them, 134 (67%) participants with positive bacteriological cultures and 66 (33%) participants negative bacteriological cultures. Consequently, a high prevalence of bacterial involvement in postoperative wound infections is highlighted for this cohort.




**Histogram-1: Bacteriological findings among the participants (n=200)**

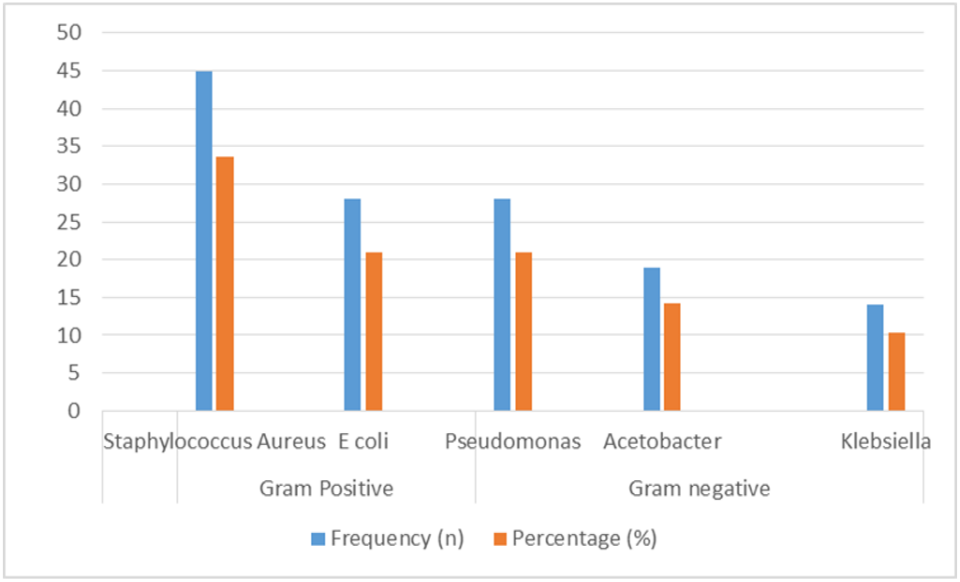
**Table 1: Association of Socio-demographic factors with type of bacteria found (n=134)**

| Characteristics | | Gram Positive | Gram Negative | P value |
|---|---|---|---|---|
| **Age group (years)** | 20 to 29 | 25 (55.6%) | 50 (56.2%) | 0.343 |
| | 30 to 40 | 17 (37.8%) | 26 (29.2%) | |
| | >40 | 3 (6.7%) | 13 (14.6%) | |
| Mean±SD | | 31.7±6.5 | 32.3±7.2 | |
| **Occupational status** | Service | 13 (28.9%) | 37 (41.6%) | 0.317 |
| | Student | 0 (0%) | 2 (2.2%) | |
| | Unemployed | 8 (17.8%) | 16 (18%) | |
| | Housewife | 24 (53.3%) | 34 (38.2%) | |
| **BMI (Kg/m$^2$)** | <18.5 | 0 (0%) | 9 (10.1%) | 0.004 |
| | 18.5 to 24.9 | 11 (24.9%) | 26 (29.2%) | |
| | 25 to 29.9 | 8 (17.8%) | 28 (31.5%) | |
| | >30 | 26 (57.8%) | 26 (29.2%) | |

Table 1 shows the association of socio-demographic factors with the type of bacteria found among 134 culture-positive cases. Gram-positive bacteria were more common in housewives (53.3%), whereas gram-negative bacteria were more frequent among service holders (41.6%). A significant association was observed between BMI and bacterial type, with gram-positive bacteria more prevalent in patients with a BMI >30 (57.8%) compared to gram-negative bacteria (29.2%).

**Table-2: Type of bacteria found among the patients (n=134)**

| Type of bacteria | | Frequency (n) | Percentage (%) |
|---|---|---|---|
| **Gram Positive** | *Staphylococcus Aureus* | 45 | 33.6 |
| **Gram negative** | *E coli* | 28 | 20.9 |
| | *Pseudomonas* | 28 | 20.9 |
| | *Acetobacter* | 19 | 14.2 |
| | *Klebsiella* | 14 | 10.4 |




**Histogram-2: Type of bacteria found among the patients (n=134)**

This histogram-2 gives an overview of the types of bacteria isolated from the 134 culture positive cases. The most common gram positive organism was *Staphylococcus aureus* which accounted for 33.6% of isolates. *E. coli* and *Pseudomonas aeruginosa* (20.9%) were equally common among gram negative bacteria, with *Acetobacter* (14.2%) and *Klebsiella* (10.4%) near behind.

**Table-2: Antibiotic susceptibility pattern of the gram-positive isolates (n=45)**

| **Antibiotics** | **Isolates (Gram Positive)** | | |
|---|---|---|---|
| | ***Staphylococcus Aureus*** | | |
| | **Sensitive** | **Resistant** | **Not done** |
| Amikacin | 21 | 9 | 15 |
| Sulbactam | 24 | 2 | 19 |
| Piperacillin+Tazobactum | 41 | 0 | 4 |
| Vancomycin | 16 | 9 | 20 |
| Gentamycin | 10 | 12 | 23 |
| Colistin | 6 | 9 | 30 |
| Meropenem | 6 | 3 | 36 |
| Ceftriaxone | 14 | 22 | 9 |
| Doxycycline | 16 | 0 | 29 |
| Amoxiclav | 0 | 14 | 31 |
| Ceftazidime | 9 | 16 | 20 |
| Cefixime | 0 | 23 | 22 |
| Penicillin | 0 | 14 | 31 |
| Ciprofloxacin | 0 | 7 | 38 |
| Azithromycin | 9 | 16 | 20 |
| Ampicillin | 14 | 12 | 19 |

The gram positive antibiotic susceptibility patterns for *Staphylococcus aureus* are detailed in Table 2. High sensitivity was shown to piperacillin-tazobactam 41 (91.1%), sulbactam 24 (53.3%), and amikacin 21 (46.7%). Resistance was most pronounced to cefixime 23 (51.1%) and ceftriaxone 22 (48.9%). The findings suggest the importance of using targeted antibiotic therapy according to susceptibility patterns.

**Table-3: Antibiotic susceptibility pattern of the gram-negative isolates (n=89)**

| **Antibiotics** | **Isolates (Gram Negative)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***E. coli* (n=28)** | | | ***Pseudomonas*(n=28)** | | | ***Acetobacter* (n=19)** | | | ***Klebsiella* (n=14)** | | |
| | **S** | **R** | **ND** | **S** | **R** | **ND** | **S** | **R** | **ND** | **S** | **R** | **ND** |
| **Amikacin** | 21 | 7 | 0 | 21 | 7 | 0 | 19 | 0 | 0 | 14 | 0 | 0 |
| **Sulbactam** | 21 | 2 | 5 | 16 | 1 | 12 | 14 | 0 | 5 | 12 | 0 | 2 |
| **Piperacillin+ Tazobactum** | 24 | 0 | 4 | 23 | 0 | 5 | 14 | 0 | 5 | 14 | 0 | 0 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Colistin** | 21 | 0 | 7 | 7 | 7 | 14 | 12 | 0 | 7 | 7 | 0 | 7 |
| **Gentamycin** | 17 | 11 | 0 | 20 | 0 | 8 | 6 | 0 | 13 | 7 | 0 | 7 |
| **Meropenem** | 10 | 7 | 11 | 21 | 0 | 7 | 19 | 0 | 0 | 7 | 0 | 7 |
| **Ampicillin** | 11 | 4 | 13 | 11 | 4 | 13 | 9 | 3 | 7 | 4 | 6 | 4 |
| **Ceftriaxone** | 0 | 21 | 7 | 0 | 21 | 7 | 0 | 13 | 6 | 7 | 7 | 0 |
| **Doxycycline** | 14 | 0 | 14 | 0 | 0 | 28 | 0 | 0 | 28 | 0 | 7 | 7 |
| **Amoxiclav** | 7 | 7 | 14 | 7 | 0 | 21 | 7 | 6 | 6 | 0 | 7 | 7 |
| **Ceftazidime** | 0 | 14 | 14 | 0 | 14 | 14 | 0 | 7 | 12 | 0 | 7 | 7 |
| **Cefixime** | 0 | 0 | 28 | 0 | 0 | 28 | 0 | 6 | 13 | 0 | 0 | 14 |
| **Penicillin** | 0 | 14 | 14 | 0 | 7 | 21 | 0 | 0 | 19 | 0 | 7 | 7 |
| **Ciprofloxacin** | 0 | 7 | 21 | 0 | 7 | 21 | 0 | 6 | 13 | 0 | 0 | 14 |
| **Azithromycin** | 9 | 5 | 14 | 5 | 9 | 14 | 6 | 5 | 8 | 9 | 5 | 0 |

**S= sensitive, R=Resistance, ND= Not Done**

The different antibiotic susceptibility patterns of gram negative isolates, i.e., *E. coli*, *Pseudomonas aeruginosa*, *Acetobacter*, and *Klebsiella* are illustrated in this table. Amikacin and piperacillin-tazobactam were high sensitive against all gram negative organisms. There was widespread resistance to ceftriaxone and doxycycline, as well as multidrug resistance of *Pseudomonas aeruginosa* and *Acetobacter*.

## DISCUSSION

Post-operative wound infection (POWI) is a common complication in surgical patients that account for increased morbidity, prolonged hospitalization, medical resource utilization and society reject. This study was aimed at determining the bacteriological profile and antibiotic susceptibility patterns of women with POWIs after obstetric and gynecological surgeries. This study investigated the bacteriological profile and antibiotic susceptibility patterns in women with POWIs following obstetric and gynecological surgeries. Gram positive isolates predominated with *Staphylococcus aureus*, and gram negative with *E. coli* and *Pseudomonas aeruginosa*. This is consistent with the results of Budhani *et al.*, who recovered *Staphylococcus aureus* as the most common gram positive pathogen isolated from post-operative wounds [6]. It is also consistent with the findings of Kurhade *et al.*, and Deshpande *et al.*, on prevalence of gram negative such as *E. coli* and *Pseudomonas aeruginosa* play a role in nosocomial infections [7, 8].

Our study found gram positives were highly sensitive to piperacillin/tazobactam and sulbactam, with moderate sensitivity to amikacin and doxycycline. Notable resistance to commonly used antibiotics such as ceftriaxone and azithromycin was found. These findings are consistent with studies by Young and Khadaroo and Rajput *et al.*, that demonstrated an increase in resistance patterns among gram positive organisms found in surgical site infections [4, 9]. Gram negative isolates also showed sensitivity to amikacin and meropenem, but resistance to beta lactam antibiotics like ceftriaxone was prominent. Njoku and Njoku and Narula *et al.*, have also reported similar results where *E. coli* and *Pseudomonas* have been isolated as multi-drug resistant pathogens in surgical infections [3, 15].

The high prevalence of *Staphylococcus aureus* in POWIs in this study reflects its continued dominance as a major pathogen in surgical settings. This is similar to the findings of Deshpande *et al.*, and Berríos-Torres *et al.*, which explained the persistence due to poor infection control practice and high prevalence of methicillin resistant *Staphylococcus aureus* (MRSA) [8, 13]. Further detection of gram negative organisms including *E. coli* and *Pseudomonas aeruginosa* demonstrates the roles of these opportunistic pathogens in hospital acquired infections. Kurhade *et al.*, and Owens and Stoessel also note their ability to develop resistance mechanisms such as extended-spectrum beta-lactamases (ESBL), making treatment protocols complicated [7, 14].

This study's results highlight the necessity for routine surveillance and appropriate antibiotic use. This high sensitivity of gram positive bacteria to piperacillin-tazobactam match reports by Berríos-Torres *et al.*, who emphasize the efficacy of piperacillin-tazobactam or sulbactam in treating gram positive infections [13]. This also reflects the findings of Njoku and Njuko in which the resistance to ceftriaxone and other commonly used antibiotics were related to abuse and misuse of antibiotics [3].

Overall, this study showed a variety of microbiological profile of postoperative wound infections with high resistance patterns among both gram positive and gram negative pathogens. The findings underscore the continued need to closely monitor, rigorously follow infection control procedures, and wisely utilize antibiotics in the face of increasing problems caused by resistance to antimicrobial.

### Limitations and Recommendations

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community. It is necessary to do additional extensive investigation in various surgical departments enable clinicians to make a better infection management protocol.

## CONCLUSION

The study findings showed that Maximum study women had positive bacteriological findings, wherein *Staphylococcus aureus* was most commonly found bacteria followed by *E. coli*, *Pseudomonas*, *Acetobacte*r and *Klebsiella*. Besides, majority of both gram-positive and gram-negative bacteria was sensitive to Amikacin, Sulbactam and Piperacillin+Tazobactum.

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**Conflicts of interest:** There are no conflicts of interest.

**Ethical approval:** The Institutional Ethics Committee approved the study.

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