e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(2); 1446-1452

Original Research Article

Study of Antimicrobial Susceptibility Pattern of Organisms Causing Surgical Site Infection: A Cross-Sectional Analysis

Amit Kumar Patel[1], Vineeta Baxla[2], Jiwesh Kumar Thakur[3], Pinki Kumari[4]

[1]Senior Resident, Department of Microbiology, Phulo Jhano Medical College and Hospital, Dumka, Jharkhand, India

[2]Senior Resident, Department of Microbiology, Sheikh Bhikhari Medical College and Hospital, Hazaribag, Jharkhand, India

[3]Professor, Department of Surgery, Gauri Devi Institute of Medical Sciences, Durgapur, West Bengal.

[4]Professor, Department of Microbiology, Phulo Jhano Medical College and Hospital, Dumka, Jharkhand, India

Received: 05-12-2025 / Revised: 15-12-2025 / Accepted: 21-01-2026

Corresponding author: Dr. Pinki Kumari

Conflict of interest: Nil

Abstract

Background: Surgical site infections (SSIs) factor in morbidity, mortality, and higher healthcare expenses. They are the third most prevalent nosocomial infection. Finding the isolates that cause surgical site infections, and their pattern of antimicrobial susceptibility is the primary goal of this investigation.

Methods: For the study, a total of fifty surgical site infection cases were collected. Standard microbiological techniques were used to process the suspected samples. The antibiotic susceptibility pattern was determined using the modified Kirby-Bauer's disc diffusion method. In accordance with Clinical and Laboratory Standards Institute (CLSI) recommendations, the isolates of the Enterobacteriaceae family were first screened for ESBL production before being further verified by the Double Disk Synergy Test. As controls, reference strains of Klebsiella 700603, P. aeruginosa (ATCC-27853), S. aureus (ATCC 25923), and E. coli (ATCC 25922) were employed.

Result: Out of 50 samples, 19(38%) were culture positive and total 23 organisms were isolated. Pseudomonas aeruginosa 9 (39.13%) was the most common organism isolated, followed by Klebsiella spp. 5 (21.73%), Staphylococcus aureus 3 (13.04%). Most of the Gram-negative isolates were sensitive to imipenem and meropenem followed by piperacillin-tazobactam. Gram-positive organisms were found to be more sensitive to levofloxacin, linezolid and vancomycin. ESBL production was seen among 44.44% isolates of Enterobacteriaceae family.

Conclusion: Infection rates have an impact on hospital treatment standards and patient care. Accurate antibiotic policies are therefore necessary for better SSI stewardship. It is advised that etiology and antibiotic susceptibility be routinely monitored in both hospital and community settings.

Keywords: Surgical site infection, Bacteriological profile, Antibiotic susceptibility test, ESBL (Extended Spectrum Beta-Lactamase).

DOI: 10.25258/ijcpr.18.2.239

Introduction

A surgical site infection (SSI) is a surgical procedure-related infection that exclusively affects the skin or subcutaneous tissue of the incision and develops at or near the surgical incision within 30 days of the procedure.[1-3] SSI rates have been reported to range from 2.5% to 41.9% worldwide.[1,2]A recent ICMR report indicates that India experiences approximately 15 lakh (1.5 million) Surgical Site Infections (SSIs) annually, with a 5.2% incidence rate, which is higher than many high-income countries. The highest infection rates occur in orthopaedic surgeries (54.2%).[4]Surgical Site Infection (SSI) is the 3rd most frequently reported nosocomial infections4 and account for 14% to 16% of all nosocomial infections among hospitalized patients.[2,5] The incidence of surgical site infection (SSI) varies from hospital to hospital and also varies in different studies that have been reported from time to time.[6]Despite recent advances in aseptic techniques including operation theatre and surgical techniques, sterilization methods and standard protocols of preoperative preparation and antibiotic prophylaxis, SSI continues to be a major cause of

hospital-acquired infections and a major source of morbidity and mortality amongst hospitalized patients in developing countries.[2]The risk of developing SSIs is multifactorial. It includes emergency procedures, pre-morbid illness, extremes of age, gender, altered immune response, malnutrition, metabolic diseases and wound classification.[2]

SSIs increase the rate of rehospitalization, the use of health care, diagnostic, and therapeutic resources, and hospital costs.2,5 Patients who develop SSIs are 5 times more likely to be readmitted to the hospital, 60% more tending to require to stay in an intensive care unit (ICU), and twice as likely to die compared with patients without SSIs.[5]

Nosocomial infection due to multi-drug resistant organisms like Methicillin-Resistant Staphylococcus aureus (MRSA), Metallo-beta-lactamase producing Pseudomonas aeruginosa, vancomycin-resistant Enterococcus (VRE), Extended-spectrum beta-lactamase (ESBL) producing Klebsiella which has added a new dimension to the problem in the management of SSI8. It has made the choice of empirical therapy more difficult and costlier. The condition is serious in developing countries owing to irrational prescriptions of antimicrobial agents.[8] The treatment depends on determining its susceptibility to antibiotics.[7]

World health organization (WHO) and other studies indicated that periodic surveillance and giving feedback to surgeons on SSIs rate and associated factors can decrease up to 50% of SSIs.5 The literature suggests that 60% of SSIs are preventable.[5]

The frequent studies of anti-microbial susceptibility pattern of organisms causing SSI enables hospital departments to keep an eye on illegitimate use of anti-microbial and set rules on use of the antibiotics.

It is therefore essential to identify microbes in post-operative surgical wounds and study anti-microbial susceptibility pattern of the microbes causing SSIs.

Material and Methods

A cross sectional study was conducted in the Microbiology department of Phulo Jhano Medical College and Hospital, Dumka, Jharkhand from August 2025 to November 2025. The sample size obtained was 50.

The information of patient was taken according to the proforma prepared which included name, age, sex, case history.

Patients specimens (pus swabs, wound swabs) of post-operative patients of all clinical departments, developing infections within 30 days after operation, age above 18 years, able to provide consent and able to participate in an interview (He/she has no speech or hearing impairment).

The pus swabs and wound swabs from all cases of SSI were routinely collected aseptically and sent to the Microbiology department without delay for analysis. The samples in the laboratory were processed for direct microscopy, aerobic/anaerobic culture and sensitivity as per the standard protocols. The swabs were used to make smear and Gram's staining was done to ascertain the morphological form of bacteria present. The samples were inoculated on the required agar plates like Nutrient agar (NA), MacConkey Agar (MA), Blood Agar (BA) and Sabouraud's dextrose agar (SDA) in two sets. One set was incubated aerobically at 37°C for 18-24 hours and another anaerobically. After incubation, different microbes were identified from positive cultures by their morphological and biochemical characteristics.[9] The modified Kirby-Bauer’s disc diffusion method was used for antibiotic sensitivity pattern. It was done on Mueller Hinton agar using various antibiotics as per Clinical and Laboratory Standards Institute (CLSI) guidelines.[10] The isolates of Escherichia coli, Klebsiella and Proteus showing resistance to ceftazidime and cefotaxime were further tested for ESBL production by Double Disk Synergy Test.[10] More than 5 mm increased in zone diameter for ceftazidime-clavulanic acid vs. zone diameter of ceftazidime disk incubated for 18 hours on Mueller-Hinton agar was interpreted as positive for ESBL production.[10] Reference strains of E. coli (ATCC 25922), P. aeruginosa (ATCC-27853), S. aureus (ATCC 25923) and Klebsiella 700603 were tested as controls.

The observations were recorded and analyzed in MS Excel 2024.

Result

Nineteen (38%) of the fifty samples that were sent to the microbiology lab for culture and sensitivity showed growth, while thirty-one (62%) did not. [Table 1]

Table 1: Infection detected in study group (N=50)

Infection detected	No. of cases	Percentage
No. Growth	31	62%
Growth	19	38%

The majority of the 19 culture-positive cases, i.e. 78.94% (15/19), were male, whereas 21.05% (4/19) were female. According to Table 2, there were more cases in the 48–58 age group 6(31.57%) than in the 38–48 age group 4(21.05%).

Table 2: Culture positive age-group in years (N=19)

Age Group (in years)	No. of cases	Percentage
18-28	3	15.80%
28-38	1	5.26%
38-48	4	21.05%
48-58	6	31.57%
58-68	3	15.80%
68-78	2	10.52%

The rate of surgical site infections varies depending on the type of surgery. Amputation procedures had a higher infection rate than fracture procedures. [Figure 1] Diabetic foot was the most prevalent surgical diagnosis.

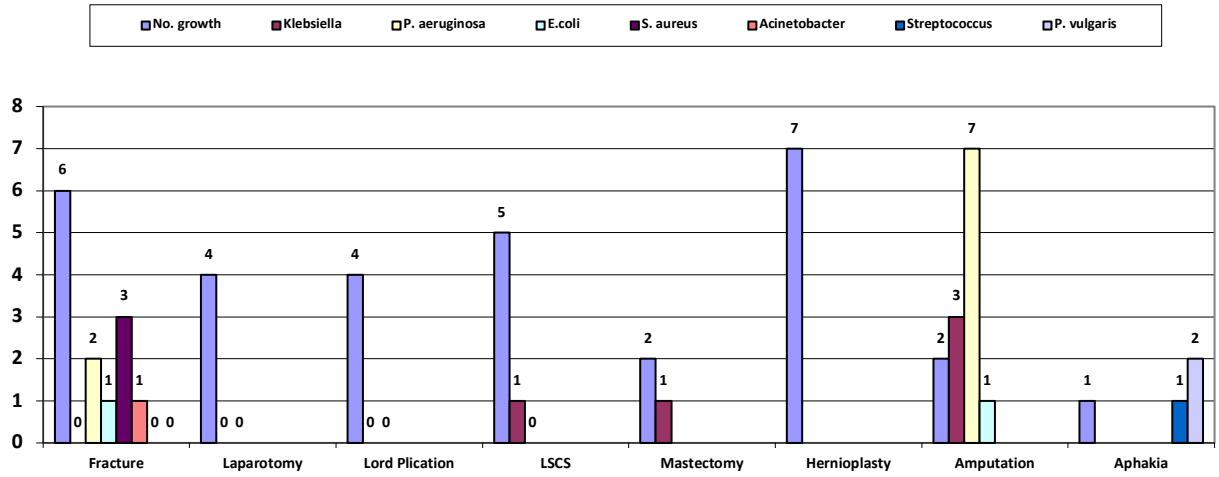

Figure 1: Distribution of organism in different surgery

Among 19 culture positive samples, 15(78.95%) yielded pure bacterial isolates and 4(21.05%) yielded mixed infections. So overall 23 organisms were isolated from 19 culture positive samples. Among the 23 organisms isolated from culture positive pus samples, 4 (17.39%) were Gram-positive bacteria and 19 (82.61%) were Gram-negative bacteria. [Table 3]

Table 3: Isolated Microbes

Isolated Microbes	No. of cases	Percentage
Gram-negative bacteria	19	82.61%
Gram-positive bacteria	4	17.39%

The bacteriological profile of the contaminated samples is displayed in Table 4. Staphylococcus aureus 3 (13.04%) and Streptococcus 1 (4.35%) were the most prevalent Gram-positive cocci isolates. Pseudomonas aeruginosa 9 (39.13%) was the most prevalent organism among Gram-negative bacteria, followed by Klebsiella 5 (21.73%), Escherichia coli 2 (8.7%), Proteus vulgaris 2 (8.7%), and Acinetobacter species 1 (4.35%).

Table 4: Bacteriological profile of infected samples

Bacteriological profile	No. of cases	Percentage
Klebsiella	5	21.73%
P. aeruginosa	9	29.13%
E. coli	2	8.7%
S. aureus	3	13.04%
Streptococcus	1	4.35%
P. vulgaris	2	8.7%
Acinetobacter	1	4.35%

Klebsiella was found to be 80% sensitive to Imipenem and Meropenem followed by 60% sensitive to Amikacin, Gentamycin, and Kanamycin. It was 40% sensitive to piperacillin/Tazobactam, cefoperazone, cefotaxime, ceftriaxone, ceftazidime; cefepime, Levofloxacin, ciprofloxacin, Ofloxacin, Cotrimoxazole and 20%

sensitive to Cefazolin and Cefaclor and 0% sensitive to Ampicillin. [Table 5]

Proteus was found to be 100% sensitive to Piperacillin/Tazobactam, Imipenem, Meropenem and Cotrimoxazole and 50% sensitive to Cefoperazone; Cefotaxime; Ceftriaxone; Ceftazidime, Cefepime, amikacin, Gentamycin, Cefaclor, Levofloxacin, Ciprofloxacin, and Ofloxacin. Ampicillin, Amoxicillin/clavulanate, cefazolin, and cefaclor were 0% sensitive to Proteus and E. coli. [Table 5]

E. coli was found to be 100% sensitive to Imipenem, Meropenem, Levofloxacin; Ciprofloxacin; Ofloxacin and 50% to piperacillin/Tazobactam, Amikacin; Gentamycin; Kanamycin and fully resistant to ampicillin, cefazolin and cefaclor. [Table 5]

Table 5: Antibiotic sensitivity pattern of Enterobacteriacae (n=9)

	Enterobacteriacae		
Microbes	**Klebsiella (5)**	**Proteus (2)**	**Escherichiacoli (2)**
Drugs	**Sensitivity %**	**Sensitivity %**	**Sensitivity %**
Ampicillin	0	0	0
Amoxicillin/clavulanicacid	0	0	0
Piperacillin/Tazobactam	40	100	50
Cefazolin	20	0	0
Cefaclor	20	0	0
Cefoperazone	40	50	50
Cefotaxime	40	50	50
Ceftriaxone	40	50	50
Ceftazidime	40	50	50
Cefepime	40	50	50
Imipenem	80	100	100
Meropenem	80	100	100
Amikacin	60	50	50
Gentamycin	60	50	50
Cefaclor	60	50	50
Levofloxacin	40	50	100
Ciprofloxacin	40	50	100
Ofloxacin	40	50	100
Cotrimoxazole	40	100	50

Two strains of Klebsiella, one strain of Escherichia coli and one strain of Proteus were found to be Extended Spectrum Beta-Lactamase (ESBL) producer (44.44%) i.e. resistant to first, second, and third generation cephalosporins and monobactams but sensitive to imipenem and meropenem. Most of these ESBL producing isolates were isolated from the patients of amputation.

Among non-fermenters, Pseudomonas showed 100% sensitivity towards Polymyxin-B, followed by 78% to piperacillin/Tazobactam, Imipenem, Meropenem. It showed 33% sensitivity towards Cefepime, Aztreonam, Ciprofloxacin, Ofloxacin, Levofloxacin, Gatifloxacin followed by 22% shown by Ceftazidime and 11% sensitivity towards Piperacillin, Amikacin and Gentamycin.

Acinetobacter was 100% sensitive to piperacillin/Tazobactam, Ceftazidime, Cefepime, Imipenem, Meropenem, Amikacin; Gentamycin; Ciprofloxacin, Ofloxacin, Levofloxacin and Cefotaxime except for piperacillin which was resistant. [Table 6]

Table 6: Antibiotic sensitivity pattern of Non-fermenters (n=10)

Microbes	**Pseudomonas (9)**	**Acinetobacter (1)**
Drugs	**Sensitivity %**	**Sensitivity %**
Piperacillin	11	0
Piperacillin/Tazobactam	78	100
Ceftazidime	22	100
Cefepime	33	100
Aztreonam	33	-
Imipenem	78	100
Meropenem	78	100
Amikacin	11	100

Gentamycin	11	100
Ciprofloxacin	33	100
Ofloxacin	33	100
Levofloxacin	33	100
Gatifloxacin	33	-
Polymyxin-B	100	-
Cefotaxime	-	100

Gram-Positive isolates, S. aureus were 100% sensitive to Rifampin, Tetracycline, Levofloxacin, Ciprofloxacin, Moxifloxacin, Clindamycin, Trimethoprim, Linezolid and Vancomycin followed by 67% sensitive to Amikacin; Gentamycin; Kanamycin; Azithromycin; Clarithromycin, and erythromycin.

All strains of Staphylococcus were resistant to penicillin and ampicillin but sensitive to cefoxitin and oxacillin. Thus isolated strains were Methicillin Sensitive Staphylococcus aureus (MSSA). [Table 7]

Streptococci was sensitive to Rifampin, Penicillin G, Tetracycline, Levofloxacin, Ciprofloxacin, Moxifloxacin, Trimethoprim, Linezolid and Vancomycin and resistant to Azithromycin; Clarithromycin, Erythromycin, and Clindamycin. [Table 7]

Table 7: Antibiotic sensitivity pattern of Gram positive cocci (n=4)

Microbes	**Staphylococcus (3)**	**Streptococci (1)**
Drugs	**Sensitivity %**	**Sensitivity %**
Rifampin	100	100
PenicillinG	0	100
Ampicillin	0	-
Amoxicillin/clavulanicacid	0	-
Amikacin	67	-
Gentamycin	67	-
Kanamycin	67	-
Azithromycin	67	0
Clarithromycin	67	0
Erythromycin	67	0
Tetracycline	100	100
Levofloxacin	100	100
Ciprofloxacin	100	100
Moxifloxacin	100	100
Clindamycin	100	0
Trimethoprim	100	100
Linezolid	100	100
Vancomycin	100	100

Discussion

Fifty patients who had different operations participated in the current investigation. Of the 50 instances, 19 (38%) had positive cultures, while 31 (62%) had no growth. This is comparable to a another study by Anirudh S. et al. that found a 32% infection rate.[6] In contrast to our findings, a small number of other researchers have discovered a very high percentage of culture-positive cases.[11]Hospitals in India have a far higher infection rate than those in other nations; in the USA, it is 2.8%, while in Europe, it is 2–5%.[1,8] The significant disparities in working circumstances that exist in industrialized nations may be the cause of the low infection rate in these nations.[6] Some authors may have included contaminated and dirty wound types as well as emergency procedures in their studies, which could explain the increased rates they reported.[6]

In our study, males had a higher incidence of SSI (78.94%, 15/19) than females (21.05%, 4/19). This could be because men are more likely to experience trauma as a result of their outdoor hobbies. Dr. Ashok Kumar's study revealed a similar pattern: 17.6% for women and 25.6% for men. Males were more likely to experience SSI, according to the study.[12]Comparable to the other research, the age group of 48–58 years old had the highest number of cases (31.57%), followed by 38–48 years old (21.05%).[1, 4, 12] Growing older is associated with an increased risk of malnutrition, certain chronic illnesses, and a decline in the body's immune system, all of which increase the risk of SSI.[4, 6, 12]

Shah et al[1] and Brian Mawalla[8] reported a higher rate of infection in patients with diabetes mellitus which is similar to the present study.

When the association of type of surgery with infection rate was assessed, it was revealed that maximum post-operative infection rate was found in amputation surgery (22%) followed by in fractures operations (12%) which is contrary to other studies in which laparotomy was most common.[8]

Microbiological profile of wound infection shows that Pseudomonas were the most common isolated organisms which is comparable with other studies[13] while it's contrary with other studies[6,11] which found that E. coli was most common isolated organism. S. aureus was the predominant causative agent among gram positive cocci which corroborated with other studies.[8,13]

In our study the members of Enterobacteriaceae family showed high sensitivity to Meropenem and Imipenem followed by Amikacin, gentamycin, and kanamycin. This correlates with other studies.[13]

Two strains of Klebsiella, one strain of E. coli and one strain of Proteus were found to be Extended Spectrum Beta-Lactamase (ESBL) producer (44.44%) which is comparable with other studies.[6,8]

Our study revealed that among non-fermenters piperacillin-tazobactam and Polymyxin-B were the most effective antibiotic which is comparable with other study.[13]

In Gram-Positive Bacteria, S. aureus was not sensitive to penicillin, ampicillin at all which is comparable with a study done by Aniruddha S. et al.[6] But it was 100% sensitive to cefoxitin and oxacillin. Thus isolated strains were Methicillin-Sensitive Staphylococcus aureus (MSSA) which was similar to the study by Aniruddha S7 but contrary to other studies where Methicillin-Resistant Staphylococcus aureus (MRSA) were isolated.[8,13] Also they were sensitive to linezolid and vancomycin which was comparable with other studies.[11,13] While some other study revealed gentamycin as the most effective antibiotic.[6]

The usage of ineffective drugs in severe bacterial infections could be havoc as it can complicate management and increase morbidity and mortality. The majority of Gram-negative isolates were sensitive to meropenem while gram-positive being sensitive to vancomycin and clindamycin; this could be explained by the fact that these antibiotics are relatively rare in the hospital and are more expensive so they are rarely misused.[8]

The high isolation rate of bacteria and increased drug resistance to the commonly used antibiotics warrants the need for immediate measures ensuring effective infection prevention and rational use of antimicrobial agents leading to minimize infection rate and emergence of drug resistance.

When empirical therapy of surgical site infection is necessary, imipenem and meropenem become the best option because they are effective against the majority of isolates of Enterobacteriacae and non-fermenters. Gram-positive cocci were susceptible to Levofloxacin, Linezolid, and Vancomycin. Nearly every isolate in our institute was successfully treated with piperacillin-tazobactam.

Conclusion

One major complication of surgeries in the modern era is surgical site infection. It is a significant contributor to postoperative mortality and morbidity. Any hospital's patient care and treatment standards are reflected in the infection rate. Therefore, improved SSI management is necessary. Accurate antibiotic policies will assist lower the significant issue of antimicrobial resistance in hospital-acquired infections and, eventually, the rate of SSI in developing nations. It is advised to regularly assess antibiotic susceptibility and etiology in both community and hospital settings.

References

1. Surgical site infections: incidence, bacteriological profiles, and risk factors in a tertiary care teaching hospital in western India, Kalpesh H Shah, Suman P Singh, and Jignesh Rathod. ijmsph (2017).
2. Manisha Narayan Saswade and Shalini MahanaValecha. An original study on the prevalence and risk factors of surgical site infections after major abdominal procedures in gynecology and obstetrics. Ijrcog (2017).
3. Sujatha, O. Sasikumari, T.L. The frequency and microbiological causes of surgical site infections after major gynecologic procedures on the abdomen at a tertiary care facility. JMSCR 2019.
4. According to the ICMR data, India has about 15 lakh (1.5 million) The yearly incidence rate of surgical site infections (SSIs) is 5.2%, greater than that of many high-income nations. (2024).
5. CDR Valerie Diaz, CRNA, DNP, USN Johanna Newman, CRNA, DNAP. Surgical Site Infection and Prevention Guidelines: A Primer for Certified Registered Nurse Anesthetists. (AANA Journal Course) (February 2015;83(1).
6. Aniruddha S. Mundhada, Sunita Tenpe. A study of organisms causing surgical site infections and their antimicrobial susceptibility in a tertiary care Government Hospital. Ijpmonline 2019.

7. Mohammad Shahid Raza, Anil Chander, Abirodh Ranabhat. Antimicrobial Susceptibility Patterns of the Bacterial Isolates in Post-Operative Wound Infections in a Tertiary Care Hospital, Kathmandu, Nepal. (ojmm.2013.33024).
8. Mawalla B, Mshana SE, Chalya PL, Imirzalioglu C, Mahalu W. Predictors of surgical site infections among patients undergoing major surgery at Bugando Medical Centre in Northwestern Tanzania. BMC Surg. 2011;11(1):21.
9. Collee JG, Fraser AG, Marmion BP, Simmons A, editors. Mackie and McCartney - Practical Medical Microbiology. 14th ed., Ch. 4. New Delhi: Elsevier 2007;53-94.
10. The Institute for Clinical and Laboratory Standards. Antimicrobial susceptibility test performance standards; 27 informational supplements. CLSI M100–S27.
11. Solomon Gebre-selassie, Endale Tadesse, Techalew Shimelis, and Lopiso Dessalegn. A cross-sectional study conducted in a hospital examined the antibiotic susceptibility pattern of aerobic bacterial isolates from surgical wounds. E3 J Med Res 3(2):018-023, 2014.
12. Upendra Nath and Ashok Kumar Singh. Surgical Site Infection in Abdominal Surgeries in a Tertiary Centre. 2016; 6(3). IF: 3.919. IC Value: 74.50Resea. ISSN: 2249-555X.
13. Amruthkishan Upadhya, Vijaykumar Mane, Mita D. Wadekar, and Trupti B. Naik. Aerobic bacteria and their pattern of antibiotic susceptibility in orthopedic wound infections at a Karnataka tertiary care hospital were examined cross-sectionally. [DOI: 10.5958/2394-5478.2016.00015.7]