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Original Research Article

A study on clinico-demographic and microbiological profile of surgical site infection (SSI) in a tertiary care hospital, Kolkata: An alarming trend

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ABSTRACT

Background: The Centres for Disease Control and Prevention (CDC) estimates surgical site infections SSI is major contributor of healthcare associated infections (HAI). Multidrug resistant (MDR) Gram-negative bacilli are emerging pathogens. This study aimed to determine the magnitude of SSI and identify predominant pathogens with their antimicrobial susceptibility patterns.

Materials and Methods: It is a hospital-based descriptive cross-sectional study including 2070 suspected SSI specimens from 25809 surgeries between 1^{st} July 2021 to 30^{th} June 2023. Organisms' identification and AST was done by both conventional and automated methods. Data was collected and analysed on MS-Excel sheet with various charts and tables.

Results and Discussion: In our study SSI rate was 6.3%, much higher than previous study (2.83%) from this institution. SSI rate was highest in plastic surgery (8.2%). Major pathogens of SSI were Gram-negative bacilli e.g., *Klebsiella pneumoniae* (26.34%), *Escherichia coli* (25.59%) and *Staphylococcus aureus* (74.69%) was predominant among Gram-positive cocci. Gram-negative bacilli including enterobacterales and non-fermenter *Pseudomonas aeruginosa* and *Acinetobacter baumannii complex* showed resistance to major classes of broad- spectrum antibiotics. Methicillin resistance *Staphylococcus aureus* (MRSA) was 43.9%, which indicates need to improve infection control practices.

Conclusion: Our study showed significant higher proportion of SSI as compared to previous studies from the same institute with alarming number of isolated MDR Gram-negative bacilli. So, this study focusses the need of robust infection control practices and strict implementation of antimicrobial stewardship to overcome challenges of antimicrobial resistance.

1. Introduction

World Health Organization (WHO) estimates surgical site infection (SSI) as one of the frequent types of healthcare associated infections (HCAI) in low-and middle-income countries. SSI involves infection of the skin, soft tissue, organs and implanted materials following surgery and manifested by pain and redness around the area of surgery, discharge from surgery wound, and fever.[1,2]

SSI is classified into superficial incisional (within 30 days), deep incisional SSI and organ/space SSI (within 30 or 90 days). Both superficial and deep incisional SSI are further divided into primary and secondary groups.[3]

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In India recent studies on SSI and Health Management Information System (HMIS) database (2019-20) showed SSI rate varying from 0.12% to 18%.[4–6]

The outcomes of SSI are prolonged hospital stay, development of multidrug resistant organism, high treatment costs and increased mortality.[7]

The risk factors of SSI are patient-related (e.g., pre-existing infection, elderly age), procedure-related and operative environment-related (e.g., emergency surgery, inadequate antiseptic surgical site preparation, air quality of OT).[8,9] Surgery in patients with poly-trauma, hemodynamic instability and patients who develop post-operative hypothermia, hypoxia, hyperglycaemia are prone to develop SSI.[10]

Surgical site infection (SSI) surveillance is an important part of hospital infection control practice.[11] Though considerable improvements in infection control practices, surgical techniques and sterilization procedures have occurred, SSI still remains the major HCAI, mostly due to multidrug resistant organisms either from exogenous sources or from patients' endogenous flora.[12]

Previously *Staphylococcus aureus* (MRSA) was the commonest pathogen isolated from SSI wounds.[13,14] Recent reports have shown that multidrug-resistant (MDR) Gram-negative bacilli and non-fermenters like *Pseudomonas aeruginosa and Acinetobacter baumannii complex* are increasingly isolated from SSI.[15,16]

Hence, aim of this study was to determine magnitude of SSI in various surgical specialities, predominant pathogens causing SSI and their antibiotic susceptibility patterns.

2. Materials and Methods

This was a descriptive cross-sectional study, conducted in the Department of Microbiology at a 2000 bedded tertiary care hospital in Kolkata. The primary objective of this study was to determine magnitude of SSI across various surgical specialities, clinico-demographical and microbiological profile of SSI cases along with their antimicrobial susceptibility profile. These data will help in formulation of local antibiogram of SSI cases which is required for both surgical antimicrobial prophylaxis and hospital infection control practices.

SSI data from 1^{st} July 2021 to 30^{th} June 2023 (24 months) was collected from the SSI surveillance database from the medical record department of the hospital after approval of the Institutional Ethics Committee (IEC No - NRSMC/IEC/133/2023 Dt. 31/05/2023). Detailed epidemiological data and clinical history were collected in a pre-tested structured questionnaire format. Data collection was done from 1^{st} June 2023 to 31^{st} July 2023 and data analysis done between 1^{st} August 2023 and 31^{st} August 2023.

All SSI cases according to guidelines by CDC NHSN SSI classification criteria[3] were included in this study while episiotomy wound infection was excluded.

A total of 25809 surgeries were performed during the study period of 1^{st} July 2021 to 30^{th} June 2023. Two thousand seventy samples from suspected SSI cases, which satisfied CDC NHSN SSI classification criteria,[3] were sent to the Microbiology laboratory for processing.

SSI samples e.g., pus, wound swab, implants were received at the laboratory for processing. After Gram staining, specimens were cultured on 5% Sheep Blood Agar and MacConkey agar plates and plates were incubated at 37°C for 48 hours. After the end of incubation culture plates were examined for colony morphology and preliminary bacteriological identification was done by Gram stain, motility test by hanging drop method and standard battery of biochemical tests. Further identification was done by automated system Vitek 2 Compact ® (BIOMERIEUX).

Antimicrobial susceptibility test (AST) was done by both Vitek 2 Compact® and Kirby Bauer disk diffusion method as required following CLSI guideline 2022. Identification of Gram-positive bacteria in Vitek 2 Compact ® was done using GP cards and AST was done using P628, ST03 cards. Identification of Gram-negative bacteria was done using GN cards and for AST N235, N405 and N406 cards were used. Kirby Bauer disk diffusion method was done on Mueller Hinton agar with commercially available discs of penicillin (10 U), ampicillin (10mcg), cefoxitin (30mcg), oxacillin (1 mcg), amoxycillin-clavulanic acid (20/10mcg), linezolid (30mcg), erythromycin (15mcg), clindamycin (2mcg), levofloxacin (5mcg), amikacin (10mcg), gentamicin (10mcg), ceftriaxone (30mcg), piperacillin-tazobactam (100/10 mcg), cotrimoxazole (1.25/23.75mcg), cefoperazone-sulbactam (75/30 mcg), imipenem (10mcg), meropenem (10mcg). *Staphylococcus aureus* (ATCC 25923), *Escherichia coli* (ATCC 25922) and *Pseudomonas aeruginosa* (ATCC 27853) were used as controls in disc diffusion method. Carbapenemase production in Enterobacterales and *Pseudomonas aeruginosa* was detected phenotypically by Modified Carbapenem Inactivation Method (mCIM) followed by EDTA Carbapenem Inactivation Method (eCIM) following CLSI guideline 2022. All dehydrated media, reagents, antibiotic discs were acquired from Himedia Laboratories Pvt. Ltd, Mumbai.

SSI rate was calculated following NHSN criteria[17]

$$SSI\ rate\ calculation: \frac{Total\ number\ of\ culture-positive\ SSI\ x\ 100}{Total\ number\ of\ surgeries\ performed}$$

Data was collected and analysed in a Microsoft Excel sheet with various charts and tables. For categorical variable e.g., gender of patient, types of SSI, types of wounds, place of occurrence, organisms involved, susceptibility patterns and resistance mechanisms expressed in frequency counts with percentage distribution. Quantitative variable e.g., age of patient was categorized using 10-year categories and expressed using percentage. The statistical test of

hypothesis was not applied to our study.

3. Result

In the present study, 25809 surgeries were performed during the study period of 24 months (from 1^{st} July 2021 to 30^{th} June 2023). Among all these surgeries, 2070 (8.02%) patients developed post operative wound infection suspected of SSI and duplicate samples, e.g., pus, wound swab and implant were sent to our laboratory for microbiological processing. Significant growth was detected in 1628 (6.3%) cases, out of these 1628 positive samples pus, wound swab and implant samples were 1099 (67.5%), 518 (31.81%) and 11 (0.69%) in numbers respectively.

Out of 1628 cases 1062 (65.23%) cases were male and 566 (34.77%) cases were female, with male: female ratio being 1.9:1. The peak incidence of SSI was observed in the age group of 31-40 years n=347 (21.31%) followed by in the 21-30 years age group n=271 (17%) and 51-60 years age group n=269 (16.52%) (Figure 1).

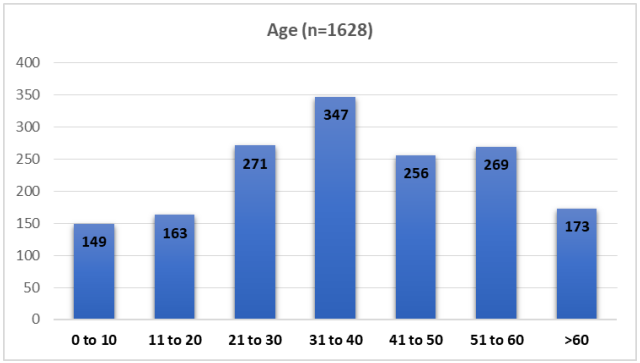

Figure 1: Bar diagram showing distribution of SSI cases across the age groups

The distribution of superficial SSI, deep SSI and organ/space SSI were n=444 (27.27%), n=1002 (61.55%) and n=182 (11.18%) (Table 1).

Degree of wound contamination in SSI cases were as follows, majority wounds were contaminated n=675 (41.46%) followed by clean contaminated n=608 (37.35%) wounds and clean n=345 (21.19%) wounds (Table 2).

Maximum SSI cases were observed in the plastic surgery department n=73 (8.22%), followed by the general surgery department n=759 (7.6%) and orthopaedic department n=555 (6.2%) against total number of surgeries done in each department (Table 3).

Enterobacterales were predominant pathogens in orthopaedics (*Escherichia coli* n=139, 25.03%), general surgery (*Klebsiella pneumoniae* n=190, 25.03%), plastic surgery (*Escherichia coli* n=23, 31.05%), ENT (*Escherichia coli* and *Klebsiella pneumoniae* n=3, 37.5% each), urosurgery (*Klebsiella pneumoniae* n=9, 39.1%), gynaecology & obstetrics (*Escherichia coli n*=20, 16.2%)

Table 1: Showing category of SSI in different surgical departments

	General surgery (n=759)	Orthopaedics (n=555)	Gynaecology and obstetrics (n=124)	Plastic surgery (n=73)	Paediatric surgery (n=40)	Neurosurgery (n=38)	Urosurgery (n=23)	ENT (n=8)	CTVS (n=8)	Total (n=1628)
Superficial SSI n (%)	143 (18.84%)	206 (37.11%)	18 (14.51%)	46 (63.01%)	17 (42.5%)	9 (23.68%)	1 (4.3%)	1 (12.5%)	3 (37.5%)	444 (27.27%)
Deep SSI n (%)	509 (67.06%)	338 (60.90%)	89 (71.77%)	23 (31.50%)	21 (52.5%)	12 (31.57%)	4 (17.3%)	1 (12.5%)	5 (62.5%)	1002 (61.55%)
Organ/space SSI n (%)	107 (14.09%)	11 (1.98%)	17 (13.70%)	4 (5.47%)	2 (5%)	17 (45.94%)	18 (78.4%)	6 (75%)	Nil	182 (11.18%)

Table 2: Showing types of SSI wound in different surgical departments

	General surgery (n=759)	Orthopaedics (n=555)	Gynaecology and obstetrics (n=124)	Plastic surgery (n=73)	Paediatric surgery (n=40)	Neurosurgery (n=38)	Urosurgery (n=23)	ENT (n=8)	CTVS (n=8)	Total (n=1628)
Contaminated n (%)	267 (35.17%)	258 (46.48%)	46 (37.09%)	34 (46.57%)	26 (65%)	28 (73.68%)	5 (21.7%)	4 (50%)	7 (87.5%)	675 (41.46%)
Clean-contaminated n (%)	262 (34.51%)	221 (39.81%)	67 (54.03%)	20 (27.39%)	8 (20%)	10 (26.31%)	16 (69.5%)	3 (37.5%)	1 (12.5%)	608 (37.35%)
Clean n (%)	230 (30.30%)	76 (13.69%)	11 (8.87%)	19 (26.02%)	6 (15%)	Nil	2 (8.8%)	1 (12.5%)	Nil	345 (21.9%)

Table 3: Table showing SSI rate in different surgical departments

	General surgery	Orthopaedics	Gynaecology and obstetrics	Plastic surgery	Paediatric surgery	Neurosurgery	Urosurgery	ENT	CTVS	Total
Number of surgeries done	9989	8953	2387	888	754	1183	415	946	294	25809
Confirmed SSI cases	759	555	124	73	40	38	23	8	8	1628
SSI Rate	7.6%	6.2%	5.19%	8.22%	5.3%	3.21%	5.54%	0.85%	2.72%	6.3%

and in paediatric surgery significant proportion of isolates was *Staphylococcus aureus* n=11 (27.5%) (Table 4).

The average day of presentation of superficial SSI, deep SSI and organ/space SSI were 7 days, 13 days and 12 days respectively. Among positively isolated samples, 1300 (79.85%) growths were mono-microbial and 328 (20.15%) were poly-microbial. A total of 1928 microbial pathogens were isolated among which 478 (24.79%) were Gram-positive cocci and 1450 (75.21%) were Gram-negative bacilli.

Out of 478 Gram-positive cocci 357 (74.69%) *Staphylococcus aureus*, 88 (18.41%) coagulase-negative *Staphylococcus spp*. (CONS), 25 (5.23%) *Enterococcus spp*. and 8 (1.67%) *Streptococcus pyogenes.* were identified (Figure 2). According to our laboratory practice duplicate samples were collected and processed before CONS were reported as a pathogen.

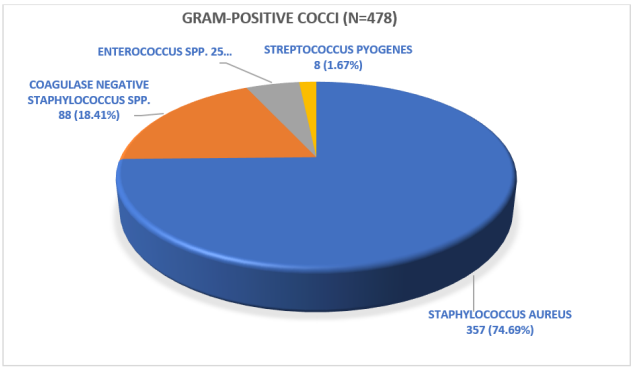

Figure 2: Pie diagram showing distribution of different Gram positive cocci

Among 1450 Gram-negative bacilli n=382 (26.34%) *Klebsiella pneumoniae*, n=371 (25.59%) *Escherichia coli*, n=214 (14.76%) *Pseudomonas aeruginosa*, n=173 (11.93%) *Acinetobacter baumannii complex*, n=119 (8.2%) *Enterobacter spp*, n=94 (6.48%) *Proteus spp* and n=30 (2.06%) *Citrobacter spp*. and n=60 (4.64%) other Gram-negative bacilli were identified (Figure 3).

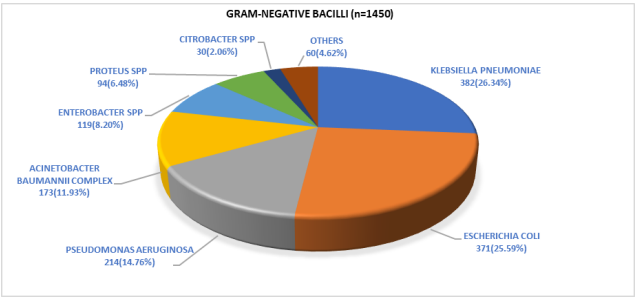

Figure 3: Pie diagram and table 5 showing distribution of different GNB

Table 4: Showing different pathogens isolated in different surgical departments

	General surgery (n=759)	Orthopaedics (n=555)	Gynaecology and obstetrics (n=124)	Plastic surgery (n=73)	Paediatric surgery (n=40)	Neurosurgery (n=38)	Urosurgery (n=23)	ENT (n=8)	CTVS(n=8)
S. aureus n (%)	91 (11.98%)	83 (14.95%)	14 (11.29%)	6 (8.21%)	11 (27.5%)	5 (13.15%)	2 (8.69%)	Nil	2 (25%)
E. coli n (%)	144 (18.97%)	139 (25.04%)	20 (16.12%)	23 (31.05%)	10 (25%)	5 (13.5%)	5 (21.74%)	3 (37.5%)	2 (25%)
K. pneumoniae n (%)	190 (25.03%)	128 (23.06%)	12 (9.67%)	8 (10.95%)	4 (10%)	5 (13.15%)	9 (39.13%)	3 (37.5%)	Nil
P.aeruginosa n (%)	68 (8.95%)	111 (20%)	4 (3.22%)	18 (24.65%)	2 (5%)	5 (13.15%)	3 (13.04%)	2 (25%)	Nil
A. baumannii n (%)	53 (6.98%)	67 (12.07%)	22 (17.74%)	6 (8.21%)	2 (5%)	5 (13.15%)	Nil	Nil	1 (12.5%)
Others n (%)	213 (28.06%)	27 (4.86%)	52 (41.93%)	12 (16.43%)	11 (27.5%)	13 (34.21%)	4 (17.39%)	Nil	3 (37.5%)

In this study, Gram-positive cocci showed higher susceptibility to daptomycin n=414 (99.22%), linezolid n=471 (98.64%), teicoplanin n=463 (96.96%) and vancomycin n=462 (97.67%) and least susceptibility to penicillin n=15 (3.2%) (Figure 4). Among all Gram-positive cocci, 157 (43.9%) Methicillin-resistant *Staphylococcus aureus* (MRSA) among *Staphylococcus aureus* (n=357) and 1 (4%) Vancomycin-resistant *Enterococcus* (VRE) among *Enterococcus spp* (n=25) were detected (Table 6).

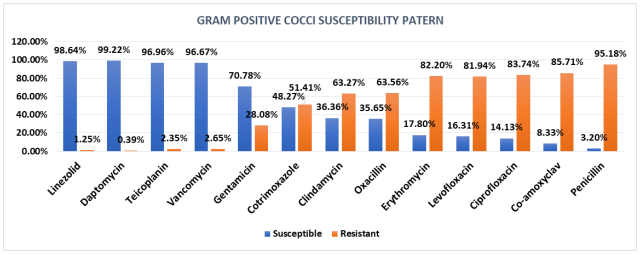

Figure 4: Bar diagram showing susceptibility pattern (blue bar) and resistant pattern (orange bar) among Gram-positive cocci

Gram-negative bacilli showed greater resistance pattern, 30% (n=435) was multidrug-resistant organisms (MDRO). Higher resistance was detected against ciprofloxacin (n=279, 73.03%) in *Klebsiella pneumoniae*, ceftriaxone (n=72, 76.59%) in *Proteus spp*., imipenem (n=82, 87.23%) in *Proteus spp*., levofloxacin (n=341, 91.91%) in *Escherichia coli)*, ciprofloxacin (n=140, 80.92%) and co-trimoxazole (n=130, 75.14%) in *Acinetobacter baumannii complex* (Table 5).

Greater susceptibility was observed in *Pseudomonas aeruginosa* against piperacillin-tazobactam (n=34, 15.88%), gentamicin (n=60, 28.03%), meropenem (n=83, 38.78%), *Acinetobacter baumannii complex* against cefoperazone-sulbactam (n=83, 47.97%), *Klebsiella pneumoniae* against amikacin (n=130, 34.03%), *Escherichia coli* against amikacin (n=82, 22.10%), imipenem (n=137, 36.92%) and cefoperazone-sulbactam (n=160, 43.12%) (Table 5).

In our study 34.78% were carbapenem-resistant Enterobacterales (CRE) among enterobacterales and 16.35% *Pseudomonas aeruginosa* were Difficult-to-Treat Resistance *Pseudomonas spp*. (DTR-P) and 70.52% *Acinetobacter baumannii complex* were carbapenem-resistant *Acinetobacter spp*. (CRAB) among non-fermenters (Table 6).

Proportion of isolated organisms from previous three studies from same institute[14,16,18] and current study is compared in Figure 5.

4. Discussion

Surgical site infection is the second most common reported healthcare-associated infection around the world.[1] It is responsible for an extended hospital stay, life-threatening

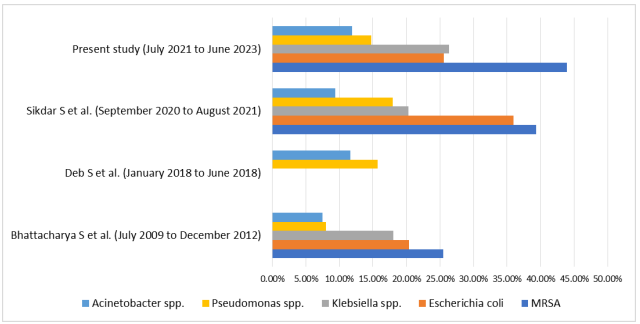

Figure 5: Bar diagram showing isolated organisms causing SSI in different studies from same institute

multidrug-resistant infection and higher healthcare costs, ultimately increasing the burden on the already stressed healthcare system in lower- and middle-income countries as well as mental agony to the patient and his/her family.[7,19]

Rates of SSI in different studies in India vary between 5% to 18%, SSI rate in this study was 6.3%. Similar studies done by Hirani S et al. and Singh S et al. showed SSI rates to be 5.6% and 4.2% respectively.[7,20]

Duplicate samples collected from suspected SSI sites were pus, wound swab in duplicate and removed implant (along with pus sample), a similar procedure was also followed in a study by Negi V et al.[21]

In our study male preponderance was observed among those affected with a male-to-female ratio of 1.88:1 which was lower than 2.9:1 as shown by Negi V et al[21] but higher than 1.56:1 found in a study by Reddy Chada CK et al.[22]

A higher proportion of SSI was observed in the age group of 31-40 years (21.31%) followed by 21-30 years (17%) and 51-60 years (16.52%) age group. Delayed wound healing due to advanced age and comorbidities are risk factors as evident in other studies.[18,21–23]

Majority of SSI in our study was deep SSI (61.55%) followed by superficial SSI (27.27%) and organ/space SSI (11.18%) whereas a previous study by Lawson EH et al[24] documented 6.2% superficial SSI and 4.7% deep/organ-space SSI.

We observed SSI occurrence were much higher in contaminated (41.46%) and clean contaminated (37.35%) surgical wounds than clean (21.19%) surgical wounds which was similar to findings by Lilani SP et al.[25]

Maximum SSI was recorded in the plastic surgery department (8.22%), followed by the general surgery department (7.6%) and orthopaedic department (6.2%). In a previous study by Pham JC et al[26] highest SSI was recorded in the general surgery department followed by orthopaedics and Gravante G. et al[27] showed SSI rate in plastic surgery varied from 0.001% to 36% in different procedures.

The average days of presentation of superficial SSI were 7 days and 12-13 days in deep or organ/space SSI. In a study by Alfouzan W et al[28] majority of SSI cases in the caesarean

Table 5: Showing resistance pattern among GNB against different antimicrobials,*IR = Intrinsic Resistance

	E. coli (n=371)	*K. pneumoniae* (n=382)	*Citrobacter spp.* (n=30)	*P. aeruginosa* (n=214)	*A. baumannii* (n=173)	*Proteus spp.* (n=94)
Ampicillin	204 (54.98%)	IR	IR	IR	IR	56 (59.57%)
Ceftriaxone	260 (70.08%)	264 (69.10%)	23 (76.66%)	IR	116 (67.05%)	72 (76.59%)
Cefoperazone-sulbactam	160 (43.12%)	199 (52.09%)	16 (53.33%)	71 (33.17%)	83 (47.97%)	33 (35.10%)
Piperacillin-tazobactam	190 (51.21%)	206 (53.92%)	18 (60%)	34 (15.88%)	137 (79.19%)	14 (14.89%)
Amikacin	82 (22.10%)	130 (34.03%)	15 (50%)	62 (28.97%)	99 (57.22%)	30 (31.91%)
Gentamicin	145 (39.08%)	153 (40.05%)	11 (36.66%)	60 (28.03%)	121 (69.94%)	57 (60.63%)
Levofloxacin	341 (91.91%)	271 (70.94%)	23 (76.66%)	96 (44.85%)	118 (68.20%)	76 (80.85%)
Ciprofloxacin	297 (80.05%)	279 (73.03%)	23 (76.66%)	88 (41.12%)	140 (80.92%)	75 (79.78%)
Imipenem	137 (36.92%)	222 (58.11%)	18 (60%)	81 (37.85%)	135 (78.03%)	82 (87.23%)
Meropenem	152 (40.97%)	214 (56.02%)	17 (56.66%)	83 (38.78%)	130 (75.14%)	24 (25.53%)
Co-trimoxazole	234 (63.07%)	176 (46.07%)	22 (73.33%)	IR	130 (75.14%)	65 (69.14%)

Table 6: Showing distribution of different resistance mechanisms among isolated microorganisms

Organism	Resistance	Percentage
Staphylococcus aureus (n=357)	MRSA	157 (43.9%)
Enterococcus spp. (n=25)	VRE	1 (4%)
Enterobacterales (n= 1055)	CRE	367 (34.78%)
Pseudomonas aeruginosa (n=214)	DTR-P	35 (16.35%)
Acinetobacter baumannii complex (n=173)	CRAB	122 (70.52%)

sections presented within 15 days.

Monomicrobial growth was observed in 79.85% of samples and polymicrobial growth in 20.15% as also reported by Rao AV et al.[29] Polymicrobial infection in SSI poses significant challenges in treatment because broad-spectrum antibiotics are needed for a longer duration which increases treatment cost and resistance among organisms.

In our study majority causative microorganisms were Gram-negative bacilli (75.21%) and rest were Gram-positive cocci (24.79%). Previously Bhattacharya S et al.[14] showed MRSA as the major pathogen of SSI but recent studies by Deka S et al[15] and Pradeep MS et al[30] established Gram-negative bacilli as predominant pathogens of SSI.

Staphylococcus aureus, *Klebsiella pneumoniae* and *Escherichia coli* were frequently isolated followed by *Pseudomonas aeruginosa* and *Acinetobacter baumannii complex*. Sikdar S et al demonstrated that *Klebsiella pneumoniae* and *Escherichia coli* were predominant pathogens of SSI[18] and Deb S et al. showed non-fermenters like *Pseudomonas aeruginosa* and *Acinetobacter baumannii complex* as emerging pathogens of SSI.[16] Isolation of enteric pathogens, e.g., *Escherichia coli* which are part of patient's endogenous flora, and non-fermenter *Pseudomonas aeruginosa* which thrives in warmer healthcare environment, indicate poor hospital hygiene practices.[31]

The susceptibility pattern of Gram-positive cocci showed resistance to penicillin (95.18%) but higher susceptibility has been recorded against daptomycin (99.22%), linezolid (98.64%), teicoplanin (96.96%) and vancomycin (96.67%). A significant proportion of Gram-positive cocci were MRSA (43.9%) as observed in study done by Negi V et al.[21] In his study MRSA rate was 15.7% which was much lower than our finding but Eagye et al[32] and Kaye et al[33] documented MRSA rates as 45% and 58.2% respectively. As MRSA has predominant role in healthcare associated infections, higher isolation of MRSA from SSI samples indicates need of better infection control practices.

Resistance was even higher among Gram-negative bacilli with a significant proportion to be MDR. Among enterobacterales, *Klebsiella pneumoniae* was least susceptible to quinolones and *Escherichia coli* was least susceptible against ceftriaxone and quinolones but their susceptibility against aminoglycosides, carbapenems,

piperacillin-tazobactam, cefoperazone-sulbactam were much better. Non-fermenter GNB *Acinetobacter baumannii complex* was least susceptible against carbapenems, quinolones, aminoglycosides, piperacillin-tazobactam and ceftriaxone. *Pseudomonas aeruginosa* was susceptible against most of the antibiotics except quinolones. Susceptibility pattern was similar in study by Negi V et al,[21] showing better susceptibility in Gram-negative bacilli against meropenem, piperacillin-tazobactam, and amikacin.

In contrast to the three preceding studies,[14,16,18] the present study reveals a notably higher proportion of MRSA, multi-drug resistant *Klebsiella pneumoniae* and *Acinetobacter baumannii complex* isolations from SSI samples indicating a matter of concern.

SSI remains major HCAI mostly due to MDR organisms and poor adherence to infection prevention control practices (IPC). SSI surveillance is an important tool to counter both these obstacles. Significant reduction of SSI rate can be achieved by the formation of local antibiogram according to isolates' susceptibility pattern, strict adherence to IPC protocols and routine SSI surveillance.

5. Limitations

1. Mycobacterial culture, fungal culture and anaerobic culture of received SSI samples were not done.
2. Phenotypic resistance patterns were only detected.

6. Conclusion

The higher SSI rate in our study as compared to previous studies can be attributed to involvement of contaminated wound, infection by MDR pathogens among other risk factors. Greater isolation of Gram-negative bacilli in SSI cases and their better susceptibility against β-lactam/β-lactamase inhibitor combination indicates need to rationalize antibiotic uses and appropriate surgical prophylaxis. Higher proportion of SSI in plastic surgery, orthopaedic departments was an alarming scenario where outcomes were graft failure or implant rejection. Hence this study highlighted the need for improved and strict infection control measures as well as implementation of a robust antimicrobial stewardship program in our hospital.

7. Source of Funding

None.

8. Conflicts of Interest

The authors declare that there are no conflicts of interest associated with this manuscript.

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References

1. Allegranzi B, Bagherinejad S, Chraiti M, Combescure C, Attar H, Pittet D. Report on the burden of endemic health care-associated infection worldwide. Geneva, Switzerland: World Health Organization; 2011.
2. Centers for Disease Control and Prevention. Surgical Site Infection (SSI) Events. Available from: https://www.cdc.gov/nhsn/psc/ssi/index.html.
3. Centers for Disease Control and Prevention. Frequently Asked Questions About Surgical Site Infections; 2019. Available from: https://www.cdc.gov/hai/ssi/faq_ssi.html.
4. Pathak A, Saliba EA, Sharma S, Mahadik VK, Shah H, Lundborg CS. Incidence and factors associated with surgical site infections in a teaching hospital in Ujjain, India. *Am J Infect Control*. 2014;42(1):11–5.
5. Kumar A, Rai A. Prevalence of surgical site infection in general surgery in a tertiary care centre in India. *Int Surg J*. 2017;4(9):3101.
6. Vatavati SR, Kampli MS. Surgeries and surgical site infection in India: A analysis of Health Management Information System 2019-2020. *J Surg Surg Res*. 2020;6:146–8.
7. Hirani S, Trivedi NA, Chauhan J, Chauhan Y. A study of clinical and economic burden of surgical site infection in patients undergoing caesarian section at a tertiary care teaching hospital in India. *PLoS One*. 2022;17(6):e0269530.
8. Suranigi SM, Ramya S, Devi CS, Kanungo R, Najimudeen S. Risk factors, bacteriological profile and outcome of surgical site infections following orthopaedic surgery. *Iran J Microbiol*. 2021;13(2):171–7.
9. Xu Z, Qu H, Gong Z, Kanani G, Zhang F, Ren Y, et al. Risk factors for surgical site infection in patients undergoing colorectal surgery: A meta-analysis of observational studies. *PLoS One*. 2021;16(10):e0259107.
10. Cheadle WG. Risk factors for surgical site infection. *Surg Infect (Larchmt)*. 2006;7(1):7–11.
11. Zamel HA. Surgical Site Infection Surveillance. *Infection Control Today*. 2023;27(5).
12. Roy MC, Stevens M, Fidsa FS. Guide to infection control in the healthcare setting; 2018. Available from: https://isid.org/wp-content/uploads/2019/06/ISID_GUIDE_THE_OPERATING_ROOM.pdf.
13. Gupta BB, Soman K, Bhoir L, Gadahire M, Patel B, Ahdal J. The Burden of Methicillin Resistant Staphylococcus aureus in Surgical Site Infections: A Review. *J ClinDiagn Res*. 2021;15(5):1–6.
14. Bhattacharya S, Pal K, Jain S, Chatterjee SS, Konar J. Surgical Site Infection by Methicillin Resistant Staphylococcus aureus- on Decline? *J Clin Diagn Res*. 2016;10(9):32–36.
15. Deka S, Kalita D, Mahanta P, Baruah D. High Prevalence of Antibiotic-Resistant Gram-Negative Bacteria Causing Surgical Site Infection in a Tertiary Care Hospital of Northeast India. *Cureus*. 2020;12(12):e12208.
16. Deb S, Sarkar S, Chatterjee C, Pal NK, Ganguly S. Study of gram negative non fermenting bacilli from surgical site infections in a tertiary care hospital in Kolkata. *Int J Res Rev*. 2019;6(7):169–74.
17. Edwards JR, Peterson KD, Mu Y, Banerjee S, Allen-Bridson K, Morrell G. National Healthcare Safety Network (NHSN) report: Data summary for. *Am J Infect Control*. 2006;37(10):783–805.
18. Sikdar S, Choudhury K, Basu S, Bhattacharjee SG, Deb S, Tabassum N. Surgical site infection: Clinico- bacteriological Profile and antibiogram in a tertiary care hospital in Kolkata. *Panacea J Med Sci*. 2023;13(2):299–304.
19. Andersson AE, Bergh I, Karlsson J, Nilsson K. Patients' experiences of acquiring a deep surgical site infection: An interview study. *Am J Infect Control*. 2010;38(9):711–7.
20. Singh S, Chakravarthy M, Rosenthal VD, Myatra SN, Dwivedy A, Bagasrawala I, et al. Surgical site infection rates in six cities of India: findings of the International Nosocomial Infection Control Consortium (INICC). *Int Health*. 2015;7(5):354–9.
21. Negi V, Pal S, Juyal D, Sharma MK, Sharma N. Bacteriological Profile of Surgical Site Infections and Their Antibiogram: A Study

From Resource Constrained Rural Setting of Uttarakhand State. *India J ClinDiagn Res*. 2015;9(10):17–20.
22. Chada CKR, Kandati J, Ponugoti M. A prospective study of surgical site infections in a tertiary care hospital. *Int Surg J*. 2017;4(6):1945.
23. Korol E, Johnston K, Waser N, Sifakis F, Jafri HS, Lo M. A Systematic Review of Risk Factors Associated with Surgical Site Infections among Surgical Patients. *PLoS One*. 2013;8(12):e83743.
24. Lawson EH, Hall BL, Ko CY. Risk factors for superficial vs deep/organ-space surgical site infections: implications for quality improvement initiatives. *JAMA Surg*. 2013;148(9):849–58.
25. Lilani SP, Jangale N, Chowdhary A, Daver GB. Surgical site infection in clean and clean-contaminated cases. *Indian J Med Microbiol*. 2005;23(4):249–52.
26. Pham JC, Ashton MJ, Kimata C, Lin DM, Nakamoto BK. Surgical site infection: Comparing surgeon versus patient self-report. *J Surg Res*. 2016;202(1):95–102.
27. Gravante G, Caruso R, Araco A, Cervelli V. Infections after plastic procedures: incidences, etiologies, risk factors, and antibiotic prophylaxis. *Aesthet Plast Surg*. 2008;32(2):243–51.
28. Alfouzan W, Fadhli M, Abdo N, Alali W, Dhar R. Surgical site infection following cesarean section in a general hospital in Kuwait: trends and risk factors. *Epidemiol Infect*. 2019;147:e287.
29. Rao AVR, Rajan R, Priyadharsini RI, I R. Aerobic Bacteriological Profile of Surgical Site Infection and their Antimicrobial Resistance Pattern at a Tertiary Care Hospital. *Int J Curr Microbiol Appl Sci*. 2019;8(7):113–21.
30. Rao KVV, Pradeep M. A Study on surgical Site Infections, their bacteriological profile and antimicrobial susceptibility pattern. *IP International Journal of Medical Microbiology and Tropical Diseases*. 2019;5(1):9–13.
31. Aghdassi SJS, Gastmeier P, Hoffmann P, Schwab F. Increase in surgical site infections caused by gram-negative bacteria in warmer temperatures: Results from a retrospective observational study. *Infect Control Hosp Epidemiol*. 2021;42(4):417–24.
32. Eagye KJ, Kim A, Laohavaleeson S, Kuti JL, Nicolau DP. Surgical site infections: does inadequate antibiotic therapy affect patient outcomes? *Surg Infect (Larchmt)*. 2009;10(4):323–31.
33. Kaye KS, Anderson DJ, Sloane R, Chen LF, Choi Y, Link K, et al. The effect of surgical site infection on older operative patients. *J Am Geriatr Soc*. 2009;57(1):46–54.

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