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Original Article

A Cross Sectional Study on Bacteriological Profile of Post-Operative Wound Infections in A Tertiary Care Hosputal

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ABSTRACT

Background: Post-operative wound infections are a common complication in surgical patients, leading to increased morbidity, prolonged hospital stay, and higher healthcare costs. The emergence of multidrug-resistant (MDR) organisms further complicates management, necessitating local epidemiological and antimicrobial susceptibility data.

Objectives: To determine the bacteriological profile, antimicrobial susceptibility patterns, and prevalence of drug-resistant strains, including MRSA, ESBL, and MDR bacteria, in post-operative wound infections.

Materials and Methods: A cross-sectional study was conducted at the Diagnostic Microbiology Division, Karpagam Faculty of Medical Sciences and Research, Coimbatore, from January 2019 to June 2020. A total of 250 patients with post-operative wound infections were included. Specimens were collected from wound sites, processed for Gram staining and culture, and pathogens were identified using standard biochemical tests. Antimicrobial susceptibility was assessed by Kirby-Bauer disk diffusion. ESBL and MRSA detection followed CLSI guidelines. Data were analyzed using SPSS and Epi-Info.

Results: Out of 250 wound samples, 184 (73.6%) showed bacterial growth. Gram-negative bacilli (64.6%) predominated over Gram-positive cocci (35.4%). Common isolates included *Staphylococcus aureus* (MSSA 22.3%, MRSA 12%), *Escherichia coli* (20.1%), and *Pseudomonas aeruginosa* (16.8%). MRSA showed 100% sensitivity to vancomycin and 90.9% to linezolid. Among Gram-negative bacilli, carbapenems and aminoglycosides demonstrated the highest efficacy. ESBL producers constituted 28.3% of isolates, predominantly *E. coli* (53.8%), while MDR strains were observed in 5.4% of isolates.

Conclusion: Post-operative wound infections are primarily caused by Gram-negative bacilli and *S. aureus*, with a significant proportion of drug-resistant strains. Vigilant antimicrobial stewardship, timely identification of pathogens, and tailored therapy based on susceptibility patterns are crucial to optimize patient outcomes and limit the spread of resistance.

Keywords*: Post-operative wound infection, MRSA, ESBL, Multidrug-resistant bacteria, Antimicrobial susceptibility, Gram-negative bacilli, Gram-positive cocci.*

INTRODUCTION

Post-operative wound infections (POWIs) are among the most common complications following surgical procedures, contributing significantly to patient morbidity, prolonged hospital stay, increased healthcare costs, and in severe cases, mortality [1,2]. Surgical site infections (SSIs), a subset of POWIs, account for a substantial proportion of nosocomial infections, with incidence varying between 2% and 20% depending on the type of surgery, patient population, and healthcare setting [3,4]

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The pathogenesis of post-operative wound infections is multifactorial, involving host factors such as diabetes mellitus, immunosuppression, and age, as well as procedural factors including duration of surgery, use of implants, and adherence to aseptic techniques [5,6]. The microbial flora responsible for POWIs is diverse, with Gram-positive cocci, especially *Staphylococcus aureus*, and Gram-negative bacilli, including *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiellapneumoniae*, being the most frequently isolated pathogens [7,8]. Methicillin-resistant *Staphylococcus aureus* (MRSA) and extended-spectrum beta-lactamase (ESBL) producing Gram-negative bacteria have emerged as significant contributors to antimicrobial resistance in these infections, posing a challenge for effective management [9,10].

Early identification of the causative organisms and their antimicrobial susceptibility patterns is crucial for initiating appropriate empirical therapy and guiding rational antibiotic use [11]. Antimicrobial stewardship programs have emphasized the need for local surveillance studies to monitor pathogen prevalence and resistance trends, which can aid in updating hospital antibiotic policies and reducing the burden of multidrug-resistant infections [12,13].

Despite the global burden of POWIs, there is limited data from tertiary care centers in India documenting the bacterial profile, prevalence of resistant strains, and their antibiotic susceptibility patterns. Understanding these parameters is essential for improving post-operative care and reducing infection-related complications [14,15]. This study was therefore designed to evaluate the bacteriological profile of post-operative wound infections, analyze the prevalence of drug-resistant strains, including MRSA and ESBL producers, and determine their antimicrobial susceptibility patterns in patients attending a tertiary care hospital.

MATERIALS AND METHODS

Study Locale

The study was conducted in the Diagnostic Microbiology Division, Central Service Laboratory, Karpagam Faculty of Medical Sciences and Research, Othakkalmandapam, Coimbatore.

Study Population

A total of 250 patients with post-operative wound infections attending as outpatients and inpatients in various surgical departments of our hospital during the study period were included in the study.

Study Design

This was a hospital-based cross-sectional study.

Study Period

The study was conducted over one year and six months, from 1st January 2019 to 30th June 2020.

Sampling Method

Continuous sampling was employed.

Sample Size

The sample size was calculated using the formula:

$$N = \frac{Z^2 \cdot P(1-P)}{e^2}$$

Where:

- Prevalence (P) = 20%
- Confidence Interval (CI) = 95%
- Margin of error (e) = 5%
- Z value = 1.654

$$N = \frac{(1.654)^2 \cdot 0.2(1-0.2)}{(0.05)^2} \approx 175$$

Sample size taken for the study: 250 patients.

Inclusion Criteria

- All inpatients and outpatients of both genders in the post-operative period attending various surgical departments.

Exclusion Criteria

1. Patients on definitive antimicrobial therapy in the last 1 week.
2. Patients unwilling to provide informed consent.

3. Patients with stitch abscesses or focal sepsis.
4. Patients on immunosuppressive drugs.
5. Immunocompromised patients.

Methodology

Ethical Approval and Consent

- The study was conducted after obtaining approval from the Institutional Human Ethics Committee (IHEC).
- Informed consent was obtained from all participants in the vernacular language.

Patient Data Collection

- Relevant past medical history including diabetes mellitus, hypertension, bronchial asthma, ischemic heart disease, etc., was recorded.

Sample Collection

- Specimens (pus, tissue material, wound discharge) were collected from surgical wounds showing signs of infection 48 hours post-operation or during follow-up for 30 days.
- Wounds were wiped with sterile saline; two swabs were collected from the depth of the wound.
- Color, consistency, and odor were noted, followed by smear examination and culture.

Specimen Processing

1. Macroscopic examination (color, consistency, odor)
2. Direct Gram staining
3. Culture on Nutrient agar, Blood agar, and MacConkey agar
4. Preliminary identification by colony morphology
5. Biochemical characterization for species identification
6. Antimicrobial susceptibility testing

Microscopy

- **Direct Gram smear**: first swab smeared, heat-fixed, and Gram-stained. Presence of pus cells, Gram reaction, size, shape, and arrangement of organisms were noted.

Culture of Organisms

- The second swab was inoculated onto **Nutrient agar, 5% Sheep Blood agar, and MacConkeyagar**and incubated at 37 °C for 24 – 48 hours.
- Blood agar was incubated in **5-10% CO_2**.
- Plates were observed after **24-48 hours** for colony growth and hemolysis.

Identification of Pathogens

- **Gram-positive cocci (GPC)**: Catalase, coagulase (slide and tube), mannitol motility, bile esculin, heat tolerance, and OF tests.
- **Gram-negative bacilli (GNB)**: Motility, oxidase, indole, citrate, urease, MR, VP, TSI, nitrate reduction, sugar fermentation.

Controls were included in all tests (e.g., *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, *Enterococcus faecalis* ATCC 29212, *Pseudomonasaeruginosa* ATCC 27853).

Antimicrobial Susceptibility Testing

- Performed using **modified Kirby-Bauer disk diffusion method** on Mueller-Hinton agar.
- Inoculum turbidity adjusted to **0.5 McFarland standard**.
- Antibiotic discs placed ≥25 mm apart and incubated at **35-37°C for 16-18 hours**.
- GNB and GPC were tested with antibiotics relevant to their species, including cephalosporins, aminoglycosides, fluoroquinolones, and glycopeptides.

Detection of ESBL Producers

1. **Double Disk Synergy Test**: synergy between third-generation cephalosporin and amoxicillin/clavulanate indicated ESBL production.
2. **ESBL Screening**: isolates with reduced zone diameters were subjected to confirmatory tests using cephalosporin/clavulanate disks or broth microdilution.

Detection of MRSA

- *Staphylococcus aureus* isolates were screened using **cefoxitin (30 µg) disk diffusion** according to CLSI guidelines.

D-Test for Inducible Clindamycin Resistance

- Performed on **erythromycin-resistant, clindamycin-susceptible isolates** by placing erythromycin and clindamycin disks 15–20 mm apart.

Statistical Analysis

- Data were analysed using SPSS and Epi-Info.
- Proportional data were evaluated using the Chi-square test and Binomial proportion test.

RESULTS AND OBSERVATIONS

Table 1: Age and Gender Distribution of Study Population (N = 250)

Age Group (Years)	Male (n, %)	Female (n, %)	Total (n, %)
11–20	3 (1.2)	6 (2.4)	9 (3.6)
21–30	13 (5.2)	21 (8.4)	34 (13.6)
31–40	20 (8)	16 (6.4)	36 (14.4)
41–50	33 (13.2)	27 (10.8)	60 (24)
51–60	27 (10.8)	20 (8)	47 (18.8)
61–70	28 (11.2)	12 (4.8)	40 (16)
71–80	15 (6)	5 (2)	20 (8)
81–90	4 (1.6)	0 (0)	4 (1.6)
Total	143 (57.2)	107 (42.8)	250 (100)
Mean ± SD	49.14 ± 16.58 years	

Table 2: Occupation and Socioeconomic Status of Study Population (N = 250)

Category	Subgroup	N	%
Occupation	Business	64	25.6
	Coolie	41	16.4
	Employed	68	27.2
	Housewife	72	28.8
	Student	5	2.0
	Total	250	100
Socioeconomic Status	Upper	78	31.2
	Upper middle	76	30.4
	Middle	41	16.4
	Lower middle	22	8.8
	Lower	33	13.2
	Total	250	100

Table 3: Patient Status and Wound Site Distribution in Study Population (N = 250)

Category	Subcategory / Diagnosis	N	%
Patient Status	Inpatient (IP)	187	74.8
	Outpatient (OP)	63	25.2
	Total	250	100
Wound Site / Diagnosis	PVD / Gangrene Toe	1	0.4
	Ulcer Foot	2	0.8
	Abscess	2	0.8
	Adenomyosis Uterus	1	0.4
	Adventitious Bursa Ankle	5	2.0
	Appendicitis	16	6.4
	Both Bone Fracture Forearm	1	0.4
	Carcinoma Prostate	1	0.4
	Cellulitis Foot	9	3.6
	Corn Foot	11	4.4
	Ductal Carcinoma	1	0.4
	Fibroid Uterus	1	0.4
	Fistulo in Ano	1	0.4
	Foot Abscess	2	0.8

	Ulcer	35	14
	Fracture	9	3.6
	Ganglion Wrist	8	3.2
	Gangrene	4	1.6
	Gluteal Abscess	2	0.8
	Incisional Hernia	1	0.4
	Infected 3rd Toe	1	0.4
	Inguinal Abscess and Hernia	13	5.2
	Intertrochanteric Fracture Femur	12	4.8
	Knee Injury	4	1.6
	Leiomyoma Uterus	4	1.6
	Lipoma	10	4.0
	Liver Abscess	2	0.8
	Mucinous Cyst Adenoma Ovary	1	0.4
	Osteomyelitis Toe	1	0.4
	Ovarian Cyst	7	2.8
	Sebaceous Cyst Scrotum	9	3.6
	Secondary Wound Infection	1	0.4
	Umbilical Hernia	11	4.4
	Venous Ulcer Foot	1	0.4
	Patellar Fracture	10	4.0
	Perianal Abscess	1	0.4
	Peripheral Arterial Disease	1	0.4
	Phimosis	10	4.0
	Postnatal Mother	24	9.6
	Post-op Both Bone Fracture Leg	1	0.4
	Posterior Auricular Abscess	5	2.0
	Sebaceous Cyst Arm	1	0.4
	Sebaceous Cyst Forearm	7	2.8
	Total	250	100

Table 4: Types of Surgery and Post-Operative Day (POD) Distribution in Study Population (N = 250)

Category	**Subcategory / Description**	**N**	**%**
Types of Surgery	Amputation	1	0.4
	Appendicectomy	16	6.4
	Arthrodosis	2	0.8
	Arthroscopic Meniscectomy	4	1.6
	Bone Grafting	1	0.4
	Circumcision	9	3.6
	CT Guided Digital Drainage	1	0.4
	Debridement	1	0.4
	DHS	12	4.8
	Disarticulation Toe	4	1.6
	Excision	52	20.8
	Fasciotomy	1	0.4
	Fistulectomy	1	0.4
	Hernioplasty	24	9.6
	I & D	21	8.4
	Intramedullary Nail Fixation	6	2.4
	LSCS	12	4.8
	Myomectomy	1	0.4
	Orchidectomy	1	0.4
	ORIF	12	4.8
	PS	7	2.8
	SSG	31	12.4
	TAH + BSO	14	5.6
	TAT	5	2.0
	Toe Amputation	8	3.2
	True Cut Biopsy	1	0.4

	USG Guided Drainage	1	0.4
	Wound Debridement	1	0.4
	Total	250	100
Post-Operative Days (POD)	2 days	31	12.4
	3 days	68	27.2
	4 days	56	22.4
	5 days	39	15.6
	6 days	21	8.4
	7 days	23	9.2
	8 days	5	2.0
	9 days	2	0.8
	16 days	1	0.4
	19 days	1	0.4
	20 days	1	0.4
	24 days	1	0.4
	40 days	1	0.4
	Total	250	100

Table 5: Complications and Wound Type Distribution in Study Population (N = 250)

Category	Subcategory / Description	N	%
Complications	Diabetes Mellitus	45	18
	Hypertension	9	3.6
	Diabetes Mellitus + Hypertension	14	5.6
	Thyroid Disease	5	2.0
	Bronchial Asthma	4	1.6
	No Complication	173	69.2
	Total	250	100
Wound Type / Nature	Clean	100	40
	Clean + Contamination	113	45.2
	Contaminated	15	6.0
	Dirty	22	8.8
	Total	250	100

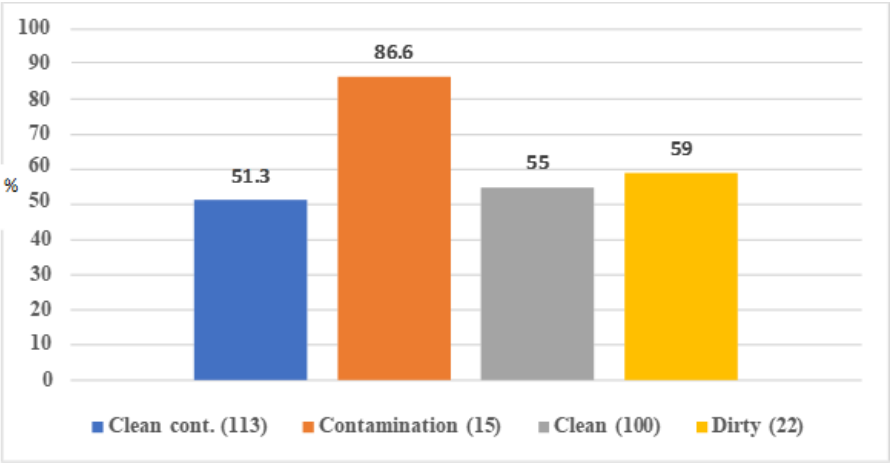

Figure 1: Descriptive analysis of growth rate from different types of wounds

Table 6: Types of Organisms and Distribution of Gram-Negative and Gram-Positive Bacteria in Study Population

Category	Subcategory / Description	N	%
Culture Result / Type of Organism	Mono-microbes	94	37.6
	Poly-microbes	45	18.0
	No Growth	74	29.6
	Skin Commensals	37	14.8
	Total	250	100
Distribution of Isolates (n = 184)	Gram Negative Bacilli (GNB)	119	64.6
	Gram Positive Cocci (GPC)	65	35.4
	Total	184	100

Table 7: Distribution of Bacterial Species in Wound Infections (N = 184)

Organism	Frequency	%	Type
Staphylococcus aureus (MSSA)	41	22.3	Gram Positive Cocci
Staphylococcus aureus (MRSA)	22	12.0	Gram Positive Cocci
Escherichia coli	37	20.1	Gram Negative Bacilli
Pseudomonas aeruginosa	31	16.8	Gram Negative Bacilli
Klebsiellapneumoniae	15	8.2	Gram Negative Bacilli
Enterobacter species	9	4.9	Gram Negative Bacilli
Proteus mirabilis	9	4.9	Gram Negative Bacilli
Proteus vulgaris	7	3.8	Gram Negative Bacilli
Morganellamorganii	5	2.7	Gram Negative Bacilli
Enterococcus species	2	1.1	Gram Positive Cocci
Acinetobacter species	2	1.1	Gram Negative Bacilli
Citrobacterkoseri	2	1.1	Gram Negative Bacilli
Klebsiellaoxytoca	1	0.5	Gram Negative Bacilli
Providencia species	1	0.5	Gram Negative Bacilli
Total	184	100	–

Table 8: Distribution of MSSA and MRSA among *Staphylococcus aureus*

Staphylococcus aureus	Frequency
MSSA	41
MRSA	22
Total	63

Table 9: Antibiotic Sensitivity and Resistance Patterns of Major Isolates

Organism	Antibiotic	Sensitive (N, %)	Resistant (N, %)
MRSA (N=22)	GEN	15 (68.2)	7 (31.8)
	CIP	0 (0.0)	22 (100)
	CX	0 (0.0)	22 (100)
	COT	9 (40.9)	13 (59.1)
	P	0 (0.0)	22 (100)
	E	4 (18.2)	18 (81.8)
	CD	19 (86.4)	3 (13.6)
	DO	13 (59.1)	9 (40.9)
	VA	22 (100)	0 (0.0)
	LZ	20 (90.9)	2 (9.1)
MSSA (N=41)	GEN	35 (85.4)	6 (14.6)
	CIP	11 (26.8)	30 (73.2)
	CX	41 (100)	0 (0.0)
	COT	16 (39.0)	25 (61.0)
	P	5 (12.2)	36 (87.8)
	E	19 (46.3)	22 (53.7)
	CD	41 (100)	0 (0.0)
	DO	36 (87.8)	5 (12.2)
	VA	41 (100)	0 (0.0)
	LZ	41 (100)	0 (0.0)
Escherichia coli (N=37)	PIT	24 (64.9)	13 (35.1)
	CFS	25 (67.6)	12 (32.4)
	CPM	10 (27.0)	27 (73.0)
	GEN	17 (45.9)	20 (54.1)
	CIP	4 (10.8)	33 (89.2)
	AK	28 (75.7)	9 (24.3)
	LE	21 (56.8)	16 (43.2)
	IPM	33 (89.2)	4 (10.8)
	AMP	0 (0.0)	37 (100)
	CTR	8 (21.6)	29 (78.4)
	CX	8 (21.6)	29 (78.4)
	AMC	15 (40.5)	22 (59.5)

	COT	12 (32.4)	25 (67.6)
	CTX	8 (21.6)	29 (78.4)
	ETP	26 (70.3)	11 (29.7)
Klebsiellapneumoniae (N=15)	PIT	9 (60.0)	6 (40.0)
	CFS	9 (60.0)	6 (40.0)
	CPM	9 (60.0)	6 (40.0)
	GEN	10 (66.7)	5 (33.3)
	CIP	3 (20.0)	12 (80.0)
	AK	11 (73.3)	4 (26.7)
	LE	10 (66.7)	5 (33.3)
	IPM	12 (80.0)	3 (20.0)
	AMP	0 (0.0)	15 (100)
	CTR	7 (46.7)	8 (53.3)
	CX	2 (13.3)	13 (86.7)
	AMC	4 (26.7)	11 (73.3)
	COT	8 (53.3)	7 (46.7)
	CTX	6 (40.0)	9 (60.0)
	ETP	12 (80.0)	3 (20.0)
Enterobacter species (N=9)	PIT	4 (44.4)	5 (55.6)
	CFS	4 (44.4)	5 (55.6)
	CPM	3 (33.3)	6 (66.7)
	GEN	5 (55.6)	4 (44.4)
	CIP	2 (22.2)	7 (77.8)
	AK	7 (77.8)	2 (22.2)
	LE	6 (66.7)	3 (33.3)
	IPM	5 (55.6)	4 (44.4)
	AMP	1 (11.1)	8 (88.9)
	CTR	3 (33.3)	6 (66.7)
	CX	1 (11.1)	8 (88.9)
	AMC	1 (11.1)	8 (88.9)
	COT	3 (33.3)	6 (66.7)
	CTX	3 (33.3)	6 (66.7)
	ETP	6 (66.7)	3 (33.3)

Table 10: Sensitivity and Resistance Pattern of Pseudomonas aeruginosa and Acinetobacter Species

Organism	Antibiotic	Sensitive (N, %)	Resistant (N, %)
Pseudomonas aeruginosa (N=31)	CAZ	21 (63.6)	10 (30.3)
	PIT	23 (69.7)	10 (30.3)
	CFS	26 (78.8)	7 (21.2)
	CPM	20 (60.6)	13 (39.4)
	GEN	28 (84.8)	5 (15.2)
	CIP	16 (48.5)	17 (51.5)
	AK	30 (90.9)	3 (9.1)
	LE	30 (90.9)	3 (9.1)
	MRP	30 (90.9)	2 (6.1)
	IPM	30 (90.9)	3 (9.1)
Acinetobacter species (N=2)	PIT	2 (100)	0 (0)
	CFS	2 (100)	0 (0)
	CPM	2 (100)	0 (0)
	GEN	2 (100)	0 (0)
	CIP	2 (100)	0 (0)
	AK	2 (100)	0 (0)
	LE	2 (100)	0 (0)
	IPM	2 (100)	0 (0)
	AMP	0 (0)	2 (100)
	CTR	2 (100)	0 (0)
	CX	0 (0)	2 (100)
	AMC	0 (0)	2 (100)
	COT	0 (0)	2 (100)

	CTX	2 (100)	0 (0)
	ETP	2 (100)	0 (0)

Table 11: Sensitivity and Resistance Pattern of Proteus vulgaris, Proteus mirabilis, and Morganellamorganii

Organism	Antibiotic	Sensitive (N, %)	Resistant (N, %)
Proteus vulgaris (N=7)	PIT	6 (85.7)	1 (14.3)
	CFS	5 (71.4)	2 (28.6)
	CPM	3 (42.9)	4 (57.1)
	GEN	5 (71.4)	2 (28.6)
	CIP	1 (14.3)	6 (85.7)
	AK	5 (71.4)	2 (28.6)
	LE	4 (57.1)	3 (42.9)
	IPM	5 (71.4)	2 (28.6)
	AMP	7 (100)	0 (0)
	CTR	3 (42.9)	4 (57.1)
	CX	1 (14.3)	6 (85.7)
	AMC	4 (57.1)	3 (42.9)
	COT	1 (14.3)	6 (85.7)
	CTX	2 (28.6)	5 (71.4)
	ETP	5 (71.4)	2 (28.6)
Proteus mirabilis (N=9)	PIT	9 (100)	0 (0)
	CFS	8 (88.9)	1 (11.1)
	CPM	6 (66.7)	3 (33.3)
	GEN	6 (66.7)	3 (33.3)
	CIP	0 (0)	9 (100)
	AK	5 (55.6)	4 (44.4)
	LE	7 (77.8)	2 (22.2)
	IPM	9 (100)	0 (0)
	AMP	2 (22.2)	7 (77.8)
	CTR	4 (44.4)	5 (55.6)
	CX	4 (44.4)	5 (55.6)
	AMC	3 (33.3)	6 (66.7)
	COT	3 (33.3)	6 (66.7)
	CTX	6 (66.7)	3 (33.3)
	ETP	8 (88.9)	1 (11.1)
Morganellamorganii (N=5)	PIT	5 (100)	0 (0)
	CFS	3 (60)	2 (40)
	CPM	2 (40)	3 (60)
	GEN	2 (40)	3 (60)
	CIP	1 (20)	4 (80)
	AK	4 (80)	1 (20)
	LE	5 (100)	0 (0)
	IPM	3 (60)	2 (40)
	AMP	0 (0)	5 (100)
	CTR	1 (20)	4 (80)
	CX	2 (40)	3 (60)
	AMC	1 (20)	4 (80)
	COT	1 (20)	4 (80)
	CTX	1 (20)	4 (80)
	ETP	5 (100)	0 (0)

Table 12: Drug-Resistant Strains and Distribution of ESBL and MDR among Isolates (N=184)

Parameter / Organism	Frequency (N)	%	MDR (N)	MDR (%)
Total isolates	184	100	-	-
Drug resistant strains				
MRSA	22	12	-	-
ESBL	52	28.3	-	-
MDR	10	5.4	-	-
Distribution of ESBL				

Escherichia coli	28	53.8	3	30
Klebsiellapneumoniae	8	15.4	3	30
Morganellamorganii	4	7.7	0	0
Enterobacter species	5	9.6	3	30
Pseudomonas aeruginosa	3	5.8	1	10
Proteus vulgaris	4	7.7	0	0
Total	52	100	10	100

DISCUSSION

Post-operative wound infections (POWIs) remain a significant challenge in surgical practice, often leading to prolonged hospitalisation, increased morbidity, and higher healthcare costs [16]. In the present study of 250 post-operative patients, the overall culture positivity rate was 73.6% (184/250), with 37.6% mono-microbial and 18% polymicrobial growth. Similar findings were reported by Sharma et al., where the rate of bacterial isolation in surgical wounds was 70–75% [17].

Demographic Profile

The mean age of patients in our study was 49.14 ± 16.58 years, with a male predominance (57.2%). This is consistent with previous studies indicating that middle-aged and elderly patients are more prone to POWIs, possibly due to comorbidities such as diabetes mellitus and hypertension [18,19]. In our cohort, 18% of patients had diabetes mellitus, 3.6% had hypertension, and 5.6% had both, which likely contributed to increased susceptibility to infection. Host-related factors such as diabetes have been associated with impaired wound healing and increased risk of surgical site infection [20].

Distribution of Wound Types and Surgery

Most wounds were classified as “clean + contamination” (45.2%) and “clean” (40%), with the remainder being contaminated (6%) or dirty (8.8%). Excision procedures (20.8%) and split skin grafting (12.4%) were the most common surgeries. The predominance of contaminated or clean-contaminated wounds correlates with the higher prevalence of Gram-negative bacilli, as reported by Allegranzi et al. [21]. POWIs are more frequent in surgeries involving tissue manipulation or foreign body implantation, consistent with our findings in appendicectomy, hernioplasty, and orthopedic procedures.

Microbiological Profile

Among 184 bacterial isolates, Gram-negative bacilli predominated (64.6%) over Gram-positive cocci (35.4%), with *Escherichia coli* (20.1%), *Pseudomonas aeruginosa* (16.8%), and *Klebsiellapneumoniae* (8.2%) being the most frequent. Among Gram-positive isolates, *Staphylococcus aureus* (34.3%) was predominant, of which 22/63 (34.9%) were MRSA. Similar trends have been documented in Indian tertiary care hospitals, where Gram-negative bacteria account for 60–70% of post-operative wound infections [22,23]. The high prevalence of *E. coli* and *Pseudomonas* may reflect endogenous gut and skin flora contamination during surgery [24].

Antimicrobial Susceptibility Patterns

MRSA isolates showed 100% sensitivity to vancomycin and high sensitivity to linezolid (90.9%) and clindamycin (86.4%), consistent with CLSI guidelines and previous studies highlighting vancomycin and linezolid as first-line agents against MRSA [25,26]. MSSA isolates retained full sensitivity to clindamycin, vancomycin, and linezolid, confirming the continued efficacy of these drugs for Gram-positive infections.

Among Gram-negative bacilli, *E. coli* exhibited high resistance to ampicillin (100%), ciprofloxacin (89.2%), and cephalosporins (CTX 78.4%), whereas aminoglycosides (amikacin 75.7%) and carbapenems (imipenem 89.2%) remained highly effective. Similar resistance trends have been reported in other Indian studies, indicating the emergence of ESBL-producing and multidrug-resistant strains in surgical wounds [27,28]. *Klebsiellapneumoniae* and *Enterobacter* species also showed marked resistance to fluoroquinolones and beta-lactams, with carbapenems retaining 80–100% sensitivity.

For non-fermenting Gram-negative bacilli, *Pseudomonas aeruginosa* showed high sensitivity to amikacin, meropenem, imipenem, and levofloxacin (90.9% each), whereas ciprofloxacin sensitivity was lower (48.5%). *Acinetobacter* species demonstrated 100% sensitivity to most tested antibiotics, except for ampicillin, cefuroxime, amoxicillin-clavulanate, and cotrimoxazole, which showed 100% resistance. These results align with previous reports highlighting amikacin and carbapenems as the most reliable agents for *Pseudomonas* infections [29,30].

Among Proteus and Morganella species, high sensitivity to piperacillin and imipenem (100%) was observed, whereas resistance to ciprofloxacin and ampicillin was notable. This reflects the need for guided therapy, as empirical use of fluoroquinolones may be ineffective in these infections [31].

Drug-Resistant Strains

In this study, MRSA constituted 12% of isolates, ESBL-producing Gram-negative bacteria 28.3%, and multidrug-resistant (MDR) strains 5.4%. *Escherichia coli*was the predominant ESBL producer (53.8%), followed by *Klebsiellapneumoniae* (15.4%). Among MDR strains, *E. coli*, *Klebsiellapneumoniae*, and *Enterobacter* species each accounted for 30%, and *Pseudomonas aeruginosa* 10%. These findings are consistent with reports from tertiary care hospitals, highlighting the growing prevalence of multidrug-resistant organisms in surgical site infections [32,33].

Clinical Implications

The high prevalence of Gram-negative bacteria and resistant strains underscores the importance of local antimicrobial surveillance. Empirical therapy for POWIs should consider local resistance patterns, with carbapenems and aminoglycosides reserved for severe infections, and vancomycin or linezolid for MRSA. Rational antibiotic stewardship and adherence to aseptic surgical techniques are essential to limit the emergence of resistant strains [34,35].

CONCLUSION

Post-operative wound infections remain a significant cause of morbidity in surgical patients, with a predominance of Gram-negative bacilli, particularly *Escherichia coli* and *Pseudomonas aeruginosa*, alongside Gram-positive *Staphylococcus aureus*. The study highlights a considerable burden of multidrug-resistant organisms, including MRSA (12%) and ESBL-producing Gram-negative bacteria (28.3%), emphasising the need for targeted antibiotic therapy. Carbapenems and aminoglycosides demonstrated the highest efficacy against Gram-negative isolates, while vancomycin and linezolid were effective against MRSA. Rational antibiotic stewardship, strict adherence to aseptic surgical techniques, and local antimicrobial surveillance are essential to curb the emergence of resistant pathogens and improve post-operative outcomes.

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