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Bacterial Profile and Antimicrobial Susceptibility Patterns of Isolates Among Patients with Surgical Site Infections at a Tertiary Care Hospital

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Abstract: ***Background**: Surgical site infections (SSIs) are among the most common healthcare-associated infections, particularly in low- and middle-income countries. The emergence of antimicrobial resistance has significantly affected the management and outcomes of SSIs. **Objectives**: To determine the bacterial profile of surgical site infections and to assess the antimicrobial susceptibility patterns of the isolated pathogens. **Materials and Methods**: A prospective cross-sectional study was conducted in the Department of Microbiology at Hi-Tech Medical College and Hospital, Bhubaneswar, from January 2024 to June 2024. A total of 200 pus samples collected from clinically suspected SSIs in both inpatient and outpatient departments were processed. Samples were cultured on Blood agar and MacConkey agar, and organisms were identified by standard conventional methods. Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar, and results were interpreted according to CLSI guidelines. **Results**: Of the 200 samples, 68 (34.0%) yielded positive bacterial growth. Staphylococcus aureus was the most common isolate (30.9%), followed by Klebsiella pneumoniae (29.4%), Pseudomonas aeruginosa (20.6%), and Escherichia coli (19.1%). High resistance was observed among Gram-negative isolates to amoxicillin-clavulanic acid (94.0%), amoxicillin (94.0%), cefixime (90.7%), and cefepime (89.8%). All Staphylococcus aureus isolates were resistant to ampicillin and amoxicillin but showed 100% susceptibility to linezolid and vancomycin. **Conclusion**: The study highlights a predominance of multidrug-resistant organisms causing SSIs, emphasizing the need for continuous surveillance, rational antibiotic use, and adherence to antibiotic stewardship programs.*

Keywords: Surgical site infection, antimicrobial resistance, bacterial profile, antibiotic susceptibility, tertiary care hospital

1. Introduction

Surgical site infections (SSIs) are infections that occur at or near the surgical incision within 30 days of an operative procedure or within one year in cases involving implant placement. SSIs may involve superficial incisional tissues, deep incisional tissues, or organs and spaces manipulated during surgery. According to the World Health Organization, SSIs are the most frequently reported healthcare-associated infections in low- and middle-income countries, affecting up to one-third of surgical patients.

The increasing prevalence of antimicrobial resistance among SSI pathogens has emerged as a major global health concern, leading to prolonged hospital stays, increased healthcare costs, and higher morbidity and mortality. Knowledge of local bacterial profiles and antimicrobial susceptibility patterns is essential for guiding empirical therapy and improving patient outcomes.

2. Materials and Methods

a) Study Design and Setting

A prospective cross-sectional study was carried out in the Department of Microbiology, Hi-Tech Medical College and Hospital, Bhubaneswar, Odisha, over a period of six months (January 2024–June 2024).

b) Sample Collection

A total of 200 pus samples were collected from patients clinically diagnosed with surgical site infections attending inpatient and outpatient departments. Samples included pus swabs, pus aspirates, and wound swabs collected under strict aseptic precautions and transported promptly to the microbiology laboratory.

c) Microbiological Processing

Samples were inoculated on Blood agar and MacConkey agar and incubated aerobically at 37°C for 24 hours. Bacterial isolates were identified using standard conventional microbiological techniques, including colony morphology, Gram staining, and relevant biochemical tests.

d) Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar. Results were interpreted in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines.

e) Data Analysis

Data were entered and analyzed using Microsoft Excel. Categorical variables such as type of organism and antibiotic susceptibility were expressed as frequencies and percentages.

3. Results

Out of 200 pus samples analyzed, 68 (34.0%) showed bacterial growth, while 132 (66.0%) samples were sterile.

a) Distribution of Bacterial Isolates

The most common organism isolated was *Staphylococcus aureus* (21 isolates, 30.9%), followed by *Klebsiella pneumoniae* (20 isolates, 29.4%), *Pseudomonas aeruginosa* (14 isolates, 20.6%), and *Escherichia coli* (13 isolates, 19.1%).

b) Antimicrobial Susceptibility Pattern

All Gram-negative isolates showed high resistance to commonly used antibiotics such as amoxicillin-clavulanic acid (94.0%), amoxicillin (94.0%), cefixime (90.7%), and cefepime (89.8%).

All *Staphylococcus aureus* isolates were resistant to ampicillin, amoxicillin, and ampicillin–sulbactam. However, 100% susceptibility was observed to linezolid and vancomycin. Among Gram-negative isolates, amikacin and piperacillin–tazobactam showed comparatively better sensitivity profiles.

4. Discussion

In the present study, *Staphylococcus aureus* emerged as the most common cause of surgical site infections, consistent with findings reported by Sajjanar V et al., who observed *S. aureus* as the predominant isolate. The high prevalence of Gram-negative organisms such as *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* underscores the growing burden of hospital-acquired infections.

The high level of resistance to beta-lactam antibiotics among Gram-negative isolates observed in this study is alarming and may be attributed to indiscriminate antibiotic use and inadequate infection control practices. The complete susceptibility of *Staphylococcus aureus* to linezolid and vancomycin is encouraging and aligns with findings reported by Dahal K et al.

5. Conclusion

Surgical site infections in the present study were caused predominantly by multidrug-resistant bacteria, with *Staphylococcus aureus* being the most common pathogen. Regular monitoring of antimicrobial susceptibility patterns and implementation of strict antibiotic stewardship programs are essential to combat rising antimicrobial resistance and to improve surgical outcomes.

Acknowledgements

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Conflict of Interest

None declared.

Funding

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S. No	Patient ID	Clinical Sample	Organism	Amoxicillin-clavulanic acid	amoxicillin	cefixime	cefepime	ampicillin	ampicillin/ sulbactam
1		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
2		PUS	NO GROWTH						
3		PUS	*Escherichia coli*	Resistant	Resistant	Resistant	Resistant		
4		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
5		PUS	NO GROWTH						
6		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
7		PUS	NO GROWTH						
8		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
9		PUS	NO GROWTH						
10		PUS	NO GROWTH						
11		PUS	NO GROWTH						
12		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		
13		PUS	NO GROWTH						
14		PUS	NO GROWTH						
15		PUS	*Escherichia coli*	Resistant	Resistant	Resistant	Resistant		
16		PUS	NO GROWTH						
17		PUS	NO GROWTH						
18		PUS	NO GROWTH						
19		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
20		PUS	NO GROWTH						
21		PUS	NO GROWTH						
22		PUS	NO GROWTH						
23		PUS	NO GROWTH						
24		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		
25		PUS	NO GROWTH						
26		PUS	NO GROWTH						
27		PUS	NO GROWTH						
28		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
29		PUS	NO GROWTH						
30		PUS	NO GROWTH						
31		PUS	NO GROWTH						
32		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
33		PUS	NO GROWTH						
34		PUS	NO GROWTH						
35		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant

36		PUS	NO GROWTH						
37		PUS	NO GROWTH						
38		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		
39		PUS	NO GROWTH						
40		PUS	NO GROWTH						
41		PUS	NO GROWTH						
42		PUS	*Escherichia coli*	Resistant	Resistant	Resistant	Resistant		
43		PUS	NO GROWTH						
44		PUS	NO GROWTH						
45		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
46		PUS	NO GROWTH						
47		PUS	NO GROWTH						
48		PUS	NO GROWTH						
49		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
50		PUS	NO GROWTH						
51		PUS	NO GROWTH						
52		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Sensitive	Sensitive		
53		PUS	NO GROWTH						
54		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
55		PUS	NO GROWTH						
56		PUS	NO GROWTH						
57		PUS	*Escherichia coli*	Resistant	Resistant	Resistant	Resistant		
58		PUS	NO GROWTH						
59		PUS	NO GROWTH						
60		PUS	NO GROWTH						
61		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
62		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
63		PUS	NO GROWTH						
64		PUS	NO GROWTH						
65		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
66		PUS	NO GROWTH						
67		PUS	NO GROWTH						
68		PUS	NO GROWTH						
69		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		
70		PUS	NO GROWTH						
71		PUS	NO GROWTH						
72		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
73		PUS	NO GROWTH						
74		PUS	*Escherichia coli*	Resistant	Resistant	Resistant	Resistant		
75		PUS	NO GROWTH						
76		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
77		PUS	NO GROWTH						
78		PUS	NO GROWTH						
79		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Sensitive	Sensitive		
80		PUS	NO GROWTH						
81		PUS	NO GROWTH						
82		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
83		PUS	NO GROWTH						
84		PUS	NO GROWTH						
85		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		
86		PUS	NO GROWTH						
87		PUS	NO GROWTH						
88		PUS	NO GROWTH						
89		PUS	NO GROWTH						
90		PUS	*Escherichia coli*	Resistant	Sensitive	Resistant	Resistant		
91		PUS	NO GROWTH						
92		PUS	NO GROWTH						
93		PUS	NO GROWTH						
94		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
95		PUS	NO GROWTH						
96		PUS	NO GROWTH						
97		PUS	NO GROWTH						
98		PUS	NO GROWTH						
99		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		
100		PUS	NO GROWTH						
101		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
102		PUS	NO GROWTH						

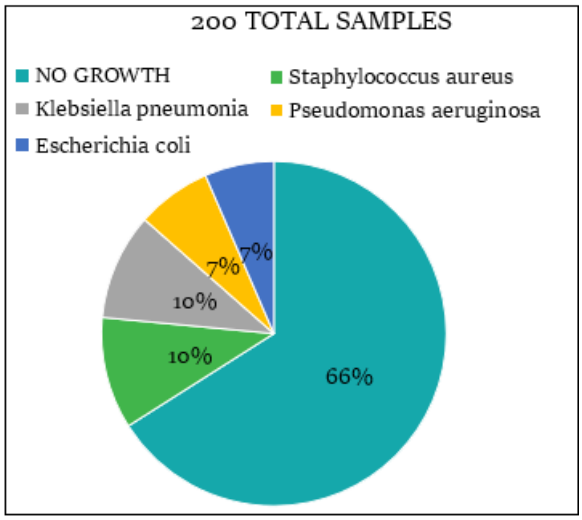
103		PUS	NO GROWTH						
104		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
105		PUS	NO GROWTH						
106		PUS	NO GROWTH						
107		PUS	NO GROWTH						
108		PUS	*Escherichia coli*	Resistant	Resistant	Sensitive	Sensitive		
109		PUS	NO GROWTH						
110		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
111		PUS	NO GROWTH						
112		PUS	NO GROWTH						
113		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		
114		PUS	NO GROWTH						
115		PUS	NO GROWTH						
116		PUS	NO GROWTH						
117		PUS	*Escherichia coli*	Resistant	Resistant	Resistant	Resistant		
118		PUS	NO GROWTH						
119		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
120		PUS	NO GROWTH						
121		PUS	NO GROWTH						
122		PUS	NO GROWTH						
123		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		
124		PUS	NO GROWTH						
125		PUS	NO GROWTH						
126		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
127		PUS	NO GROWTH						
128		PUS	NO GROWTH						
129		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
130		PUS	NO GROWTH						
131		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
132		PUS	NO GROWTH						
133		PUS	NO GROWTH						
134		PUS	NO GROWTH						
135		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
136		PUS	NO GROWTH						
137		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		
138		PUS	NO GROWTH						
139		PUS	NO GROWTH						
140		PUS	NO GROWTH						
141		PUS	*Escherichia coli*	Resistant	Sensitive	Resistant	Resistant		
142		PUS	NO GROWTH						
143		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
144		PUS	NO GROWTH						
145		PUS	NO GROWTH						
146		PUS	NO GROWTH						
147		PUS	NO GROWTH						
148		PUS	*Escherichia coli*	Resistant	Resistant	Resistant	Resistant		
149		PUS	NO GROWTH						
150		PUS	NO GROWTH						
151		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
152		PUS	NO GROWTH						
153		PUS	NO GROWTH						
154		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		
155		PUS	NO GROWTH						
156		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
157		PUS	*Escherichia coli*	Resistant	Resistant	Resistant	Resistant		
158		PUS	NO GROWTH						
159		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Sensitive	Sensitive		
160		PUS	NO GROWTH						
161		PUS	NO GROWTH						
162		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
163		PUS	NO GROWTH						
164		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
165		PUS	NO GROWTH						
166		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
167		PUS	NO GROWTH						
168		PUS	NO GROWTH						
169		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Sensitive	Sensitive		

170		PUS	NO GROWTH						
171		PUS	*Escherichia coli*	Sensitive	Resistant	Resistant	Resistant		
172		PUS	NO GROWTH						
173		PUS	NO GROWTH						
174		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
175		PUS	NO GROWTH						
176		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
177		PUS	NO GROWTH						
178		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
179		PUS	NO GROWTH						
180		PUS	NO GROWTH						
181		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		
182		PUS	NO GROWTH						
183		PUS	*Staphylococcus aureus*		Resistant			Resistant	Resistant
184		PUS	NO GROWTH						
185		PUS	*Klebsiella pneumonia*	Resistant	Sensitive	Resistant	Resistant		
186		PUS	NO GROWTH						
187		PUS	NO GROWTH						
188		PUS	*Escherichia coli*	Sensitive	Resistant	Resistant	Resistant		
189		PUS	NO GROWTH						
190		PUS	NO GROWTH						
191		PUS	*Klebsiella pneumonia*	Resistant	Resistant	Resistant	Resistant		
192		PUS	NO GROWTH						
193		PUS	NO GROWTH						
194		PUS	NO GROWTH						
195		PUS	*Klebsiella pneumonia*	Sensitive	Resistant	Resistant	Resistant		
196		PUS	NO GROWTH						
197		PUS	NO GROWTH						
198		PUS	NO GROWTH						
199		PUS	NO GROWTH						
200		PUS	*Pseudomonas aeruginosa*	Resistant	Resistant	Resistant	Resistant		

Pus Samples Collected	200	%
No Growth	132	66.0 %
Growth	68	34.0 %
Staphylococcus aureus	21	30.9 %
Klebsiella pneumonia	20	29.4 %
Pseudomonas aeruginosa	14	20.6 %
Escherichia coli	13	19.1 %

Organism	Amoxicillin-clavulanic acid	Amoxicillin	Cefixime	Cefepime	Ampicillin	Ampicillin/ Sulbactam
Staphylococcus aureus	Resistant- Sensitive-	Resistant-21 Sensitive-0	Resistant- Sensitive-	Resistant- Sensitive-	Resistant-21 Sensitive-0	Resistant-21 Sensitive-0
Klebsiella pneumonia	Resistant-19 Sensitive-1	Resistant-19 Sensitive-1	Resistant-18 Sensitive-2	Resistant-18 Sensitive-2	Resistant- Sensitive-	Resistant- Sensitive-
Pseudomonas aeruginosa	Resistant-14 Sensitive-0	Resistant-14 Sensitive-0	Resistant-12 Sensitive-2	Resistant-12 Sensitive-2	Resistant-11 Sensitive-2	Resistant-11 Sensitive-2
Escherichia coli	Resistant-11 Sensitive-2	Resistant-11 Sensitive-2	Resistant-12 Sensitive-1	Resistant-12 Sensitive-2	Resistant- Sensitive-	Resistant- Sensitive-

Organism	Amoxicillin-clavulanic acid	Amoxicillin	Cefixime	Cefepime	Ampicillin	Ampicillin/ Sulbactam
Staphylococcus aureus	Resistant-	Resistant-21	Resistant-	Resistant-	Resistant-21	Resistant-21
	Sensitive-	Sensitive-0	Sensitive-	Sensitive-	Sensitive-0	Sensitive-0
Klebsiella pneumonia	Resistant-19	Resistant-19	Resistant-18	Resistant-18	Resistant-	Resistant-
	Sensitive-1	Sensitive-1	Sensitive-2	Sensitive-2	Sensitive-	Sensitive-
Pseudomonas aeruginosa	Resistant-14	Resistant-14	Resistant-12	Resistant-12	Resistant-11	Resistant-11
	Sensitive-0	Sensitive-0	Sensitive-2	Sensitive-2	Sensitive-2	Sensitive-2
Escherichia coli	Resistant-11	Resistant-11	Resistant-12	Resistant-12	Resistant-	Resistant-
	Sensitive-2	Sensitive-2	Sensitive-1	Sensitive-2	Sensitive-	Sensitive-
	Resistant-44	Resistant-65	Resistant-42	Resistant-42	Resistant-32	Resistant-32



- All gram-negative isolates were resistant to amoxicillin-clavulanic acid (94.0%), amoxicillin (94.0%), cefixime (90.7%), and cefepime (89.8%).

Antibiotic Sensitivity Pattern of *Staphylococcus aureus*	
Linezolid	100.0 %
Vancomycin	100.0 %
Clindamycin	88.9 %
Gentamycin	63 %

Antibiotic Sensitivity Pattern of Gram Negative Species			
Antibiotics	*Klebsiella pneumoniae (%)*	*Pseudomonas aeruginosa (%)*	*Escherichia coli (%)*
Imipenem	NP	70.1	92.4
Piperacillin-tazobactam	11.8	88.7	29.8
Gentamicin	NP	8.2	80.8
Aztreonam	92.6	45.2	47.1
Amikacin	76.2	79.8	65.1

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