ISSN(online): 2589-8698
ISSN(print): 2589-868X

International Journal of Medical and Biomedical Studies

Available Online at www.ijmbs.info

Volume 1, Issue 5; September-October: 2017; Page No. 22-26

Bacteriological Profile and Antibiotic Susceptibility Pattern of Pus Isolates in Surgical Site Infections: A Cross-Sectional Study

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Abstract:

Background: Surgical site infections (SSIs) are among the most common hospital-acquired infections, contributing to increased morbidity, prolonged hospital stays, and antimicrobial resistance. Understanding the local bacteriological spectrum and susceptibility pattern is essential for empirical therapy.

Objective: To isolate and identify bacterial pathogens from pus samples of surgical site infections and to determine their antibiotic susceptibility patterns as per CLSI 2012 guidelines.

Methods: This cross-sectional study was conducted on 210 pus samples collected from post-operative patients with clinically suspected SSIs. Culture and identification were performed using standard bacteriological techniques. Antibiotic susceptibility testing was carried out by the Kirby-Bauer disk diffusion method, and results interpreted using CLSI guidelines. Data were analyzed using descriptive statistics and chi-square test.

Results: Out of 210 samples, 172 (81.9%) were culture-positive. Staphylococcus aureus was the predominant isolate (41.3%), followed by Escherichia coli (22.1%) and Pseudomonas aeruginosa (14.5%). Methicillin resistance was found in 36% of S. aureus isolates. Gram-negative bacilli showed high resistance to ampicillin (84%) and ceftriaxone (66%). Amikacin and imipenem were the most effective agents. A statistically significant association was found between prior antibiotic use and multidrug resistance ($p < 0.05$).

Conclusion: S. aureus remains the leading cause of SSIs, with considerable methicillin resistance. Empirical therapy should be guided by local antibiogram data, and strict adherence to antimicrobial stewardship is recommended.

Keywords: Surgical site infection, Staphylococcus aureus, antibiotic resistance, pus culture

Introduction:

Surgical site infections (SSIs) remain one of the most common and challenging hospital-acquired infections (HAIs), accounting for approximately 20–30% of all nosocomial infections in surgical wards [1,2]. These infections are associated with prolonged hospital stays, delayed postoperative recovery, increased morbidity, and elevated healthcare costs, placing a significant burden on healthcare systems, particularly in resource-constrained settings [3,4]. SSIs can also result in increased rates of reoperation, poor wound healing, and in severe cases, sepsis and mortality [5].

The etiology of SSIs is complex and varies across institutions and geographical locations, being influenced by a combination of host-related factors (such as age, comorbidities, nutritional status), environmental factors (operating room sterility, hygiene practices), and procedural variables (duration of surgery, type of incision, prophylactic antibiotic use) [6,7]. Despite advances in aseptic techniques and infection control protocols, SSIs remain prevalent, highlighting the importance of continual surveillance and local microbiological profiling.

A major challenge in managing SSIs is the inappropriate or empirical use of broad-spectrum antibiotics, particularly in the perioperative period. Such practices have contributed to the emergence and spread of antimicrobial resistance (AMR) among both Gram-positive organisms (e.g., Staphylococcus aureus, including MRSA) and Gram-negative organisms (e.g., Escherichia coli, Klebsiella spp., Pseudomonas aeruginosa) [8,9]. Over time, the efficacy of commonly used antimicrobials has diminished, necessitating more judicious and evidence-based prescribing.

The accurate identification of the causative pathogens in SSIs and their antimicrobial susceptibility patterns is thus essential to guide targeted therapy and optimize outcomes. Standardized protocols such as those outlined by the Clinical and Laboratory Standards Institute (CLSI) guidelines provide the foundation for uniform susceptibility testing and ensure comparability of results across laboratories [10]. Knowledge of local antibiogram trends aids clinicians in selecting effective empiric therapies and contributes to antimicrobial stewardship initiatives.

In light of the growing burden of SSIs and rising antimicrobial resistance, this study was undertaken to determine the bacteriological profile and antimicrobial susceptibility pattern of organisms isolated from pus samples of post-surgical patients in a tertiary care teaching hospital. The findings are expected to enhance local surveillance data, support antibiotic policy formulation, and contribute to improved infection control practices.

Materials and Methods

This cross-sectional study was carried out over a period of six months in the Department of Microbiology after obtaining ethical approval. A total of 210 patients who developed signs of surgical site infections (pain, redness, swelling, or purulent discharge) within 30 days of surgery were included. Exclusion criteria were patients with pre-existing infections or antibiotic exposure exceeding 72 hours prior to culture.

Pus samples were collected aseptically using sterile swabs or syringes from wound sites and transported immediately to the laboratory. Each sample was subjected to direct Gram staining, followed by inoculation onto blood agar, MacConkey agar, and nutrient agar plates. Cultures were incubated aerobically at 37°C for 18–24 hours.

Isolated colonies were identified based on colony morphology, Gram reaction, and standard biochemical tests (catalase, coagulase, oxidase, indole, urease, citrate, and TSI). Antibiotic susceptibility testing was performed using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar and interpreted as per CLSI guidelines. Antibiotics tested for gram-positive organisms included penicillin, erythromycin, clindamycin, ciprofloxacin, cefoxitin (for MRSA detection), vancomycin, and linezolid. For gram-negative bacilli, ampicillin, amoxicillin-clavulanate, ceftriaxone, ceftazidime, gentamicin, amikacin, ciprofloxacin, imipenem, and piperacillin-tazobactam were tested.

Data were entered into Microsoft Excel and analyzed using SPSS version 22.0. Proportions were calculated, and the chi-square test was applied to assess associations. A p-value <0.05 was considered statistically significant.

Results

Out of 210 samples, 172 (81.9%) showed significant bacterial growth. Among the isolates, 96 (55.8%) were gram-positive and 76 (44.2%) were gram-negative. The predominant organism was Staphylococcus aureus, isolated from 71 cases (41.3%), followed by Escherichia coli (22.1%), Pseudomonas aeruginosa (14.5%), and Klebsiella pneumoniae (7.5%).

Table 1: Bacterial Isolates from Pus Samples (n = 172)

Bacterial Species	Number (%)
Staphylococcus aureus	71 (41.3%)
Escherichia coli	38 (22.1%)
Pseudomonas aeruginosa	25 (14.5%)
Klebsiella pneumoniae	13 (7.5%)
Enterococcus spp.	10 (5.8%)
Proteus spp.	6 (3.5%)
Others	9 (5.2%)

Among the 71 S. aureus isolates, 26 (36.6%) were methicillin-resistant (MRSA), confirmed by cefoxitin disc testing. All MRSA isolates were sensitive to vancomycin and linezolid. Resistance to erythromycin and ciprofloxacin was 58% and 51%, respectively.

Gram-negative bacilli showed high resistance to ampicillin (84%), ceftriaxone (66%), and ciprofloxacin (61%). Amikacin (92%) and imipenem (96%) retained the highest sensitivity among gram-negatives. The detailed resistance pattern is presented in Table 2.

Table 2: Antibiotic Resistance Pattern of Major Isolates (CLSI)

Antibiotic	S. aureus (n=71)	E. coli (n=38)	P. aeruginosa (n=25)
Penicillin	84%	NA	NA
Cefoxitin (MRSA screen)	36.6%	NA	NA
Erythromycin	58%	NA	NA
Ciprofloxacin	51%	61%	68%
Amikacin	NA	8%	12%
Imipenem	NA	4%	8%
Ceftriaxone	NA	66%	NA
Piperacillin-Tazobactam	NA	14%	22%

(NA: not applicable)

Multidrug resistance (resistance to ≥3 classes of antibiotics) was observed in 59 isolates (34.3%), with a higher prevalence in gram-negative bacilli (45%) than gram-positives (25%). Prior antibiotic exposure was significantly associated with MDR strains ($p = 0.02$, χ^2 test).

Discussion

Our findings confirm that Staphylococcus aureus, particularly methicillin-resistant Staphylococcus aureus (MRSA), continues to be the predominant pathogen in surgical site infections (SSIs). The observed MRSA rate of 36.6% is consistent with findings from other Indian tertiary care hospitals, where MRSA prevalence in SSIs has been reported in the range of 30%–50% [11,12]. This persistent trend highlights the need for routine screening, MRSA surveillance, and implementation of stringent infection control protocols to curb the transmission and outbreak of resistant strains [13,14].

The study revealed a high level of resistance to penicillin, ciprofloxacin, and cephalosporins among both Gram-positive and Gram-negative organisms, which aligns with the widespread empirical and sometimes irrational antibiotic use documented in Indian hospitals [15,16]. This empirical approach contributes significantly to antibiotic selection pressure, driving the evolution of multidrug-resistant (MDR) organisms. These results echo the findings of large-scale surveillance networks in India [17].

Despite the resistance observed in commonly used agents, S. aureus retained sensitivity to linezolid and vancomycin, while Gram-negative bacilli such as E. coli, Klebsiella spp., and Pseudomonas spp. remained susceptible to amikacin and carbapenems, consistent with previous regional antibiogram studies [18,19].

The use of CLSI guidelines for antimicrobial susceptibility interpretation in this study allowed standardized and reproducible reporting, minimizing inter-observer variability and ensuring consistency with global standards [10].

A statistically significant association was observed between prior antibiotic exposure and MDR infections, showing the importance of detailed antibiotic history-taking and strengthening hospital-based antibiotic stewardship programs. These programs are essential for reducing irrational antibiotic prescriptions and curbing resistance trends [20].

Nevertheless, the study had certain limitations. The lack of anaerobic culture techniques and molecular confirmation of MRSA (such as mecA gene detection) may have resulted in under-detection of relevant pathogens and resistance mechanisms. Additionally, being a single-center study, the generalizability of results to broader populations may be limited. However, the data contribute meaningfully to the local resistance surveillance landscape, which is a cornerstone for rational antibiotic policy development and infection prevention strategies.

Conclusion

S. aureus, especially MRSA, remains the principal pathogen in surgical site infections, followed by gram-negative bacilli like E. coli and Pseudomonas. The increasing multidrug resistance, particularly in previously exposed patients, demands strict antibiotic stewardship, regular antibiogram reporting, and hospital infection control practices.

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