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ORIGINAL ARTICLE

Aerobic bacteriological profile and susceptibility antibiogram of isolates from pus in complicated wound infections in a Tertiary Care Hospital in Faisalabad.

Rabia Ali[1], **Shahzad Amjad Khan**[2]

ABSTRACT… Objective: To determine the aerobic bacteriological profile of pus samples from complicated wound infections and to assess the antimicrobial susceptibility patterns of the isolated organisms in a tertiary care hospital in Faisalabad. **Study Design:** Retrospective Descriptive study. **Setting:** Pathology Laboratory, Aziz Fatima Medical and Dental College, Faisalabad. **Period:** January to December 2024. **Methods:** A total of 112 pus samples from patients with complicated wound infections were analyzed. Samples were processed using standard aerobic culture techniques. Bacterial isolates were identified by conventional microbiological methods, and antibiotic susceptibility testing was performed using the Kirby–Bauer disc diffusion method in accordance with standard guidelines. **Results:** Out of 112 pus samples, 35 (31.3%) were culture positive. The isolates included Staphylococcus aureus (MSSA) (3), methicillin-resistant S. aureus (MRSA) (10), coagulase-negative staphylococci (5), Escherichia coli (6), Enterobacter spp. (4), Klebsiella spp. (1), Citrobacter spp. (1), and Yersinia pseudotuberculosis (2). Antibiotic susceptibility testing revealed that clindamycin, vancomycin, and linezolid showed high effectiveness against Gram-positive organisms (>95% sensitivity). Among Gram-negative isolates, carbapenems (meropenem 93%, imipenem 90%) and aminoglycosides (87%) were the most effective. Fluoroquinolones, sulfonamides, and third-generation cephalosporins demonstrated poor efficacy (<30%). **Conclusion:** Complicated wound infections remain a significant clinical problem, with MRSA contributing substantially to the burden of disease. Carbapenems and aminoglycosides remain valuable therapeutic options for Gram-negative infections. Continuous antimicrobial surveillance and strict stewardship programs are essential to guide effective empiric therapy and curb antimicrobial resistance.

Key words: Antibiotic Susceptibility, Antibiogram, Antibiotic Stewardship, MRSA, Wound Infection.

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INTRODUCTION

Complicated wound infections represent a significant clinical challenge due to delayed healing, increased morbidity, prolonged hospital stay, and higher treatment costs. Among the various factors contributing to these infections, the presence of aerobic bacterial pathogens plays a crucial role in determining both the clinical course and therapeutic outcome. Pus obtained from infected wounds provides a valuable specimen for identifying the causative organisms and guiding appropriate antimicrobial therapy.[1]

Over the past few decades, the rise of multidrug-resistant bacteria has further complicated the management of wound infections, particularly in surgical and post-traumatic settings. Common aerobic pathogens such as Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli, Klebsiella spp., and Proteus spp. are frequently implicated, often exhibiting resistance to multiple classes of antibiotics. Therefore, culture and sensitivity testing remain the cornerstone for rational antibiotic selection.[2]

Globally, the aerobic bacteriology of complicated wound infections is dominated by Gram-positive cocci, notably Staphylococcus aureus (including MRSA) and Gram-negative bacilli such as Pseudomonas aeruginosa, Escherichia coli, Klebsiella spp., and Proteus spp.[3] Burn units and post-operative wounds often show higher isolation rates of non-fermenters (Pseudomonas, Acinetobacter), while diabetic foot and traumatic wounds more frequently yield Enterobacteriacae alongside S. aureus.

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Many studies report polymicrobial growth, but aerobes typically drive the empiric therapy choices and stewardship policies. Across regions, pathogen distribution varies with patient mix, prior antibiotic exposure, device use, and infection control practices, underscoring the need for up-to-date, site-specific data.[4]

Antimicrobial resistance trends consistently complicate management. MRSA remains a prominent cause of treatment failure in surgical site infections, while ESBL-producing Enterobacteriacae have reduced the utility of third-generation cephalosporins for empiric coverage.[5] Rising fluoroquinolone and aminoglycoside resistance is commonly reported, and carbapenem resistance among P. aeruginosa (and, in some centers, Acinetobacter) further narrows options. Biofilm formation, well documented in chronic and device-associated wounds, attenuates antibiotic activity and impairs host defenses, contributing to persistent infection and recurrence. These patterns collectively reinforce the importance of local antibiograms to guide empiric therapy and to inform stewardship interventions.[6]

Methodologically, prior studies are largely cross-sectional laboratory surveys using aerobic culture on standard media (e.g., blood and MacConkey agars), organism identification via conventional biochemical tests or automated platforms, and AST interpreted by CLSI/EUCAST standards (disk diffusion, broth microdilution, or automated systems). Heterogeneity in sampling (superficial swab vs. deep tissue/pus aspirate), patient selection, and prior antibiotic exposure frequently limits comparability and may bias pathogen yield and resistance rates. Recent work emphasizes good sampling practice (preferably aspirates/deep tissue over surface swabs) and stratified analyses by care area (ward/ICU), wound type, and comorbidities to enhance clinical relevance. The present study addresses these gaps by providing current, local aerobic profiles and susceptibility patterns from pus isolates in complicated wounds, enabling more precise empiric recommendations and targeted stewardship actions.[7]

Studying the aerobic bacteriological profile and antibiogram patterns of isolates from pus samples not only assists clinicians in choosing effective empirical therapy but also provides insight into local antimicrobial resistance trends. Such data are essential for infection control strategies, formulation of antibiotic stewardship policies, and reduction of complications associated with inappropriate treatment.[8]

This study aims to evaluate the spectrum of aerobic bacterial pathogens isolated from pus samples of complicated wound infections and analyze their antibiotic susceptibility patterns to support evidence-based clinical management.

METHODS

This retrospective observational study assessed all pus samples for culture and sensitivity received between 01-01-2024 to 31-12-2024, in the Pathology Lab of Aziz Fatima Medical and Dental College in Faisalabad. We included all patients from 12 to 80 years of age including both genders. Outdoor and Indoor samples were all added to this study for the purpose of creating a complete antibiogram. During this period, 110 samples were received for culture and antimicrobial sensitivity. Samples were received from Surgical wards, Orthopedics ward, Medical ICU, Neurosurgery and Medical wards.

BSL-2 practices; gloves, lab coat, eye protection; biological safety cabinet (Class II) for processing; appropriate waste disposal, sharps handling were performed. Pus specimens were cultured aerobically on Blood agar and MacConkey agar (Oxoid) and incubated at 37 °C for 24 h. Isolates were identified by Gram staining and standard biochemical tests, including catalase, DNase/coagulase for Gram-positive cocci, oxidase and API 10A (BioMérieux) for Gram-negative rods. Antimicrobial susceptibility was determined using the Kirby–Bauer disk diffusion method on MHA agar, with incubation at 37 °C for 16–18 h, and results interpreted according to CLSI guidelines. Data was retrieved from HIMS.

Data analysis was performed using SPSS version 28. Categorical variables were summarized as frequencies and percentages. The distribution of bacterial isolates and their resistance patterns to different antibiotics were also expressed in

percentages. For continuous variables, including patient age and hospital wards, the mean and standard deviation were calculated.

The study was carried out following approval from the hospital's Ethical Review Committee (Ref. No. IEC/357-25, dated 05/05/2025), and all ethical guidelines and principles were strictly observed.

RESULTS

A total of 112 were received for culture and sensitivity. Amongst these 35 were culture positive and 77 were culture negative. Out of the total pus samples collected, a variety of Gram-positive cocci and Gram-negative bacilli were isolated, reflecting the polymicrobial and diverse etiology of complicated wound infections (Figure-1). Staphylococcus aureus was isolated in 3 cases, indicating its well-recognized role as a leading pathogen in wound infections. Coagulase-negative staphylococci (CoNS) were found in 5 cases, which may represent either true pathogens in compromised wounds or possible skin contaminants; however, their increasing clinical relevance in hospital-acquired infections cannot be overlooked. MRSA was isolated in 10 cases, which is a significant proportion. This highlights the burden of methicillin resistance in wound infections and the associated therapeutic challenges, as MRSA is resistant to most β-lactam antibiotics and requires alternative agents such as vancomycin or linezolid. Escherichia coli was isolated in 6 samples, confirming its frequent involvement in wound and soft-tissue infections, especially in hospitalized or diabetic patients. Enterobacter species were isolated in 4 samples, organisms known for their inducible β-lactamases, which limit cephalosporin use. Klebsiella was found in 1 sample, often linked with multidrug resistance including ESBL production. Citrobacter was identified in 1 sample; though less common, it has clinical significance due to its opportunistic pathogenicity and potential resistance mechanisms. Interestingly, Yersinia pseudotuberculosis was recovered from 2 samples, which is unusual in wound infections. Its presence may reflect environmental exposure or a rare opportunistic infection in immunocompromised patients (Figure-1).

FIGURE-1

Bacteriological profile of pus samples

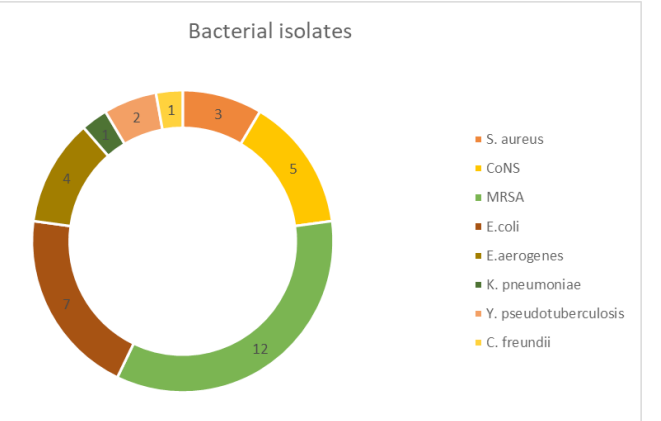


TABLE-I

Antibiotic sensitivity pattern of gram-positive isolates

Antibiotic	Sensitive (n)	Resistant (n)	Sensitivity (%)
Penicillin	0	20	0
Co-amoxiclav	11	9	55
Ampicillin/sulbactam	9	11	45
Piperacillin/tazobactam	9	11	45
Ceftriaxone	8	12	40
Cefoxitin	9	12	45
Cefepime	9	12	45
Clindamycin	20	0	100
Vancomycin	19	1	95
Linezolid	19	1	95
Imipenem	18	2	90
Tetracycline	3	17	15

Gram-positive isolates were 100% responsive to Clindamycin, 95% of the isolates showed sensitivity to Linezolid and Vancomycin. Only 1 VRSA was isolated from these pus samples. Imipenem showed a good efficacy as 90% of the isolates proved susceptible. Tetracycline showed the least efficacy at 15% (Table-I). The best treatment option for gram-negative isolates appeared to be Meropenem with 93.3% isolates showing susceptibility. Gentamicin and Amikacin showed inhibition of 86.6% of the isolates. The worst treatment option appeared to be Sulfamethoxazole/trimethoprim to which 0% were found susceptible. Cephalosporins also showed poor efficacy against the gram-negative bacteria (Table-II).

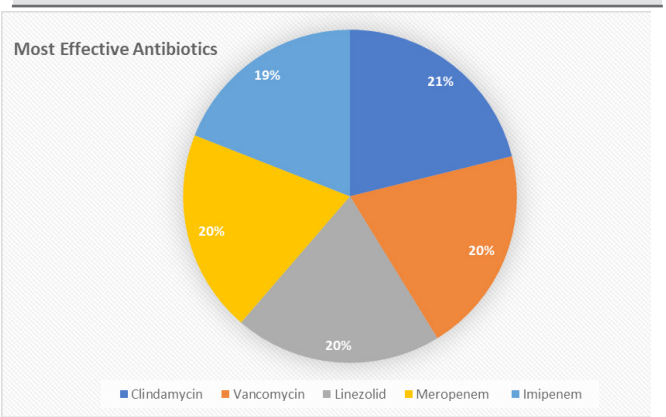
TABLE-II

Antibiotic sensitivity pattern of gram-negative isolates

Antibiotic	Sensitive (n)	Resistant (n)	Sensitivity (%)
Co-amoxiclav	9	6	60
Ampicillin/sulbactam	6	9	40
Piperacillin/ tazobactam	13	2	86.6
Ceftriaxone	16	14	6.7
Cefepime	3	12	20
Ceftazidime	3	12	20
Ciprofloxacin	2	13	13.3
Gentamicin	13	2	86.6
Meropenem	14	1	93.3
Amikacin	13	2	866
Sulfamethoxazole/ Trimethoprim	0	15	0

FIGURE-2

Recommended antibiotic panel highlighting the top five most effective antibiotics



The above data shows that the highly effective (>85% sensitivity) drugs are; Clindamycin (100%), Vancomycin (95%), Linezolid (95%), Meropenem (93%), Imipenem (90%), Amikacin (87%), Gentamicin (87%). While the Moderately effective (40–65%) drugs are; Piperacillin/Tazobactam (62%), Co-amoxiclav (57%), Ampicillin/Sulbactam (43%), Cefoxitin (43%); and drugs showing Poor efficacy (<30%) in vivo are Ceftriaxone (26%), Ceftazidime (20%), Cefepime (33%), Ciprofloxacin (13%), Septran (0%), Tetracycline (23%). (FIGURE-2)

The best antibiotics for gram-positive coverage appear to be Clindamycin, Vancomycin and Linezolid; each showing an efficacy higher than 95%. The drugs for gram-negative coverage appear to be the carbapenems showing an overall efficacy of more 90% and followed by the aminoglycosides, to which 87% of the isolated show sensitivity. Fluoroquinolones, anti-metabolites and cephalosporins appear to be poor options for the treatment of complicated wound infections.

DISCUSSION

The present study underscores the complex and polymicrobial nature of complicated wound infections, which remain a significant clinical challenge worldwide. Out of 112 pus samples analyzed, 35 (31.3%) were culture-positive, a rate consistent with prior studies reporting variable positivity due to prior antibiotic exposure or the presence of non-culturable organisms[9]. The isolation of both Gram-positive cocci and Gram-negative bacilli reflects the diverse etiology of wound infections, necessitating broad-spectrum empirical coverage initially, followed by de-escalation based on culture and sensitivity.

Staphylococcus aureus, isolated in 3 cases, continues to be a dominant pathogen in wound infections due to its virulence factors, biofilm-forming capacity, and high resistance potential.[10] The recovery of methicillin-resistant Staphylococcus aureus (MRSA) in 10 isolates is of particular concern, representing nearly one-third of positive cultures. This proportion highlights the increasing burden of MRSA in skin and soft tissue infections, especially in hospital environments.[11] The clinical management of MRSA remains challenging due to resistance to β-lactams, making vancomycin, linezolid, and clindamycin the most reliable therapeutic options, as also reflected in our sensitivity data (>95% efficacy). Coagulase-negative staphylococci (CoNS), recovered from 5 cases, may represent skin contaminants; however, in compromised hosts they are increasingly recognized as true pathogens and contributors to nosocomial infections.[12]

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Our antibiogram revealed clear stratification of antibiotic efficacy. Highly effective drugs included clindamycin, vancomycin, linezolid, carbapenems, and aminoglycosides, while β-lactam/β-lactamase inhibitor combinations showed only moderate activity (40–65%). Strikingly, fluoroquinolones, cephalosporins, and sulfonamides demonstrated poor efficacy (<30%), highlighting their limited role in complicated wound infections. These findings align with global trends showing increasing resistance to fluoroquinolones and third-generation cephalosporins among both Gram-positive and Gram-negative pathogens as noted by Klinker et al.[15]

Taken together, our findings emphasize the need for judicious antibiotic stewardship. Empirical treatment of complicated wound infections should prioritize agents with consistently high efficacy (carbapenems, aminoglycosides, clindamycin, vancomycin, linezolid), while avoiding overuse of fluoroquinolones and cephalosporins, which are increasingly compromised by resistance. The detection of MRSA in a substantial fraction of cases further reinforces the importance of routine screening, infection control practices, and the consideration of anti-MRSA coverage in empirical regimens. Furthermore, the unusual recovery of Yersinia pseudotuberculosis underscores the importance of microbiological vigilance in detecting rare but clinically relevant pathogens.[16]

CONCLUSION

The findings underscore the importance of regular surveillance of wound pathogens and their antibiograms. MRSA remains a leading challenge, while the diversity of Gram-negative isolates highlights the need for broad empiric coverage initially, guided by culture results and sensitivity testing to ensure effective management and to prevent further AMR escalation.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Rabia Ali:** Data collection, manuscript writing.
2	**Shahzad Amjad Khan:** Data analysis.