Section: Microbiology

Original Research Article

BACTERIOLOGICAL PROFILE AND ANTIMICROBIAL SUSCEPTIBILITY PATTERN OF PUS ISOLATES IN A TERTIARY CARE HOSPITAL

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Received : *11/06/2025*
Received in revised form : *27/07/2025*
Accepted : *17/08/2025*

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DOI: 10.70034/ijmedph.2025.3.550

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (3); 2992-2996

ABSTRACT

Background: Pyogenic infections are a significant cause of morbidity in hospital settings, and their management is complicated by the rising burden of antimicrobial resistance. Surveillance of bacterial isolates from pus samples is essential to guide empirical therapy and support antimicrobial stewardship.
Objective: To determine the bacteriological profile and antimicrobial susceptibility pattern of pus isolates in a tertiary care hospital.
Materials and Methods: In this Hospital based cross sectional study, 1,100 pus/wound swab samples from clinically suspected cases were processed using standard microbiological techniques. Isolates were identified by colony morphology, Gram staining, and biochemical tests. Antimicrobial susceptibility testing was performed by the Kirby–Bauer disc diffusion method according to CLSI 2023 guidelines.
Results: Of 1,100 samples, 211 (19.18%) yielded positive bacterial growth. Staphylococcus aureus (MRSA) was the predominant isolate (48.34%), followed by methicillin-resistant coagulase-negative staphylococci (18.48%). Among Gram-negative bacilli, Klebsiella pneumonia (10.43%) and Escherichia coli (8.53%) were most common. MRSA showed high resistance to penicillin (97%) and levofloxacin (89%), but retained susceptibility to vancomycin (79%) and linezolid (94%). All MR-CoNS isolates were sensitive to vancomycin and linezolid. Among Gram-negatives, Klebsiella pneumonia and E. coli exhibited the highest sensitivity to amikacin (71% and 83%, respectively), while Pseudomonas spp. and Acinetobacter spp. were most responsive to amikacin, polymyxin B, and levofloxacin.
Conclusion: Staphylococcus aureus and Gram-negative bacilli are the major causes of pyogenic infections, with significant resistance to commonly used antibiotics. The preserved efficacy of vancomycin, linezolid, and amikacin highlights their importance in therapy. Strengthening antimicrobial stewardship and routine susceptibility testing is imperative.
Keywords: Pus isolates; Antimicrobial resistance; Antibiotic susceptibility pattern.

INTRODUCTION

Pus formation is a classic sign of infection, consisting of dead leukocytes, cellular debris, and microorganisms at the site of inflammation.[1] Pyogenic infections occur in a variety of clinical contexts, including post-surgical wounds, abscesses, diabetic foot ulcers, traumatic injuries, and deep-seated organ infections, and they remain an important cause of morbidity and, in severe cases, mortality worldwide, particularly in hospitalized patients undergoing invasive procedures or with compromised immunity.[2,3] The spectrum of organisms responsible for these infections is diverse and influenced by the anatomical site, host immune status, local epidemiology, and patterns of antimicrobial usage. Commonly isolated pathogens include Staphylococcus aureus, Enterococcus spp, Escherichia coli, Klebsiella spp, Pseudomonas spp, Proteus mirabilis, Candida albicans.[4, 5] Shifts in the etiological profile over time have been observed, largely due to antibiotic selection pressure and the emergence of multidrug-resistant (MDR) strains.[6] The rise of antimicrobial resistance (AMR) is a pressing global health concern, with the World Health Organization (WHO) identifying it as a major threat to effective infection management. Inappropriate and excessive use of antibiotics has accelerated the emergence and spread of resistant organisms.[7] In tertiary care settings, hospital-acquired pathogens such as MRSA, extended-spectrum β-lactamase (ESBL)-producing Enterobacterales, and carbapenem-resistant Pseudomonas and Acinetobacter spp. pose serious challenges to treatment, often necessitating prolonged hospital stays, escalating healthcare costs, and contributing to poorer clinical outcomes.[8,9] Regular surveillance of the bacteriological profile and antimicrobial susceptibility patterns of pus isolates is essential for guiding empirical therapy, monitoring resistance trends, and updating institutional antibiotic stewardship policies.[10,11] This is particularly important in tertiary care hospitals, which often manage complicated and referred cases and therefore encounter a higher proportion of drug-resistant organisms. In this context, the present study was undertaken to determine the bacteriological profile and antimicrobial susceptibility pattern of pus isolates in a tertiary care hospital, thereby generating data that can inform both clinical decision-making and local antimicrobial policy.

MATERIALS AND METHODS

This hospital based cross sectional study was conducted in the Department of Microbiology, Government Medical College, Baramulla, over a period of 10 months from June 2024 to March 2025. In this study, a total of 1,100 pus/wound swab samples were received from patients with clinically suspected pyogenic infections from various clinical departments of the Institute, were include. Repeated and improperly handled samples from the same patient were excluded from the study.

Pus specimens were collected under strict aseptic precautions by trained healthcare personnel. Depending on the site and type of lesion, samples were obtained either by aspiration using sterile disposable syringes and needles or by sterile cotton swabs. Whenever possible, aspiration was preferred to minimize contamination.

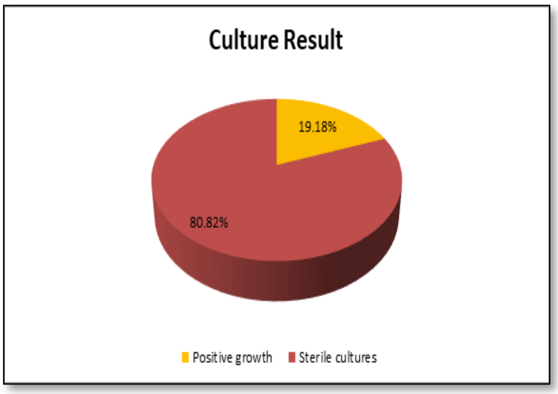
All specimens were inoculated on Blood agar, MacConkey agar, and Nutrient agar plates and incubated aerobically at 37°C for 24-48 hours. In cases where anaerobic infection was suspected, anaerobic culture media and incubation conditions were used. Gram staining was performed on growth obtained in positive cultures. Isolates were identified on the basis of colony morphology, Gram staining, and a battery of standard biochemical tests as per the guidelines of the Clinical and Laboratory Standards Institute (CLSI).

Antibiotic susceptibility testing was performed using the Kirby–Bauer disc diffusion method on Mueller–Hinton agar in accordance with CLSI guidelines (CLSI, 2023).[12]

Data Analysis: The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Frequencies and percentages were calculated to determine the distribution of isolates and resistance patterns.

RESULTS

211 samples (19.18%), out of 1100 showed positive bacterial growth, while 889 (80.82%) were sterile (Figure 1).



Pie Chart 1: Culture positivity rate of pus samples

Table 1: Bacterial isolates from culture-positive pus samples (n = 211).

Organism	Number of Isolates	Percentage (%)
MRSA	102	48.34
MR-Cons	39	18.48
Klebsiella pneumonia	22	10.43
Escherichia coli	18	8.53
Pseudomonas spp.	15	7.11
Acinetobacter spp.	8	3.79
Proteus mirabilis	3	1.42
Mixed bacterial flora	3	1.42
Total	211	100

Among the culture-positive samples, Staphylococcus aureus (MRSA) was the most frequent isolate (48.34%), followed by methicillin-resistant coagulase-negative staphylococci (MR-CoNS) (18.48%). Gram-negative bacilli were isolated in 69 cases (32.70%), with Klebsiella pneumonia (10.43%) and Escherichia coli (8.53%) being the most common. The complete distribution is shown in Table 1.

Table 2: Antibiotic susceptibility pattern of Gram-positive isolates.

Antibiotic	MRSA Sensitive (%)	MR-CoNS Sensitive (%)
Penicillin	3%	5%
Erythromycin	14%	8%
Clindamycin	23%	23%
Gentamicin	19%	38%
Vancomycin	79%	100%
Linezolid	94%	100%
Tetracycline	72%	38%
Levofloxacin	11%	15%

MRSA isolates showed low susceptibility to penicillin (3%), erythromycin (14%), clindamycin (23%), gentamicin (19%), and levofloxacin (11%), while higher susceptibility was noted for vancomycin (79%) and linezolid (94%). In MR-CoNS, susceptibility to penicillin (5%), erythromycin (8%), and levofloxacin (15%) was low, while all MR-CoNS isolates showed 100% sensitive to vancomycin and linezolid (Table 2).

Table 3: Antibiotic susceptibility pattern of Gram-negative isolates

Antibiotic	K. pneumonia Sensitive (%)	E. coli Sensitive (%)	Pseudomonas spp. Sensitive (%)	Acinetobacter spp. Sensitive (%)	Proteus mirabilis Sensitive (%)
Ampicillin	23%	0%	0%	0%	33%
Cefotaxime	14%	0%	20%	0%	67%
Ciprofloxacin	0%	43%	60%	25%	0%
Gentamicin	0%	38%	0%	75%	0%
Amikacin	71%	83%	80%	75%	67%
Piperacillin-Tazobactam	29%	78%	0%	63%	100%
Imipenem	0%	0%	0%	63%	0%
Levofloxacin	43%	29%	80%	63%	0%
Polymyxin B	29%	71%	80%	75%	0%
Meropenem	71%	43%	0%	0%	33%
Ertapenem	43%	51%	0%	0%	0%
Cotrimoxazole	14%	0%	0%	38%	0%
Tetracycline	21%	0%	0%	25%	0%
Cefpodoxime	14%	0%	0%	0%	0%

Among Gram-negative isolates, Klebsiella pneumonia showed highest susceptibility to amikacin (71%) and meropenem (71%), while Escherichia coli was most sensitive to amikacin (83%) and piperacillin-tazobactam (78%). Pseudomonas spp. demonstrated highest sensitivity to amikacin, levofloxacin, and polymyxin B (80% each), whereas Acinetobacter spp. showed maximum susceptibility to gentamicin, amikacin, and polymyxin B (75% each). Proteus mirabilis was fully sensitive to piperacillin-tazobactam (100%), followed by (67%) sensitivity to amikacin and cefotaxime (Table 3).

DISCUSSION

Regarding infections, pus and wound swab cultures remain an essential diagnostic tool for identifying the causative pathogens and guiding targeted antimicrobial therapy. Pus, a collection of dead leukocytes, bacteria, and cellular debris, is typically a hallmark of supportive infections caused by pyogenic organisms. Isolation and characterization of these pathogens from clinical specimens help in understanding the local bacteriological profile, antibiotic resistance patterns, and epidemiological trends, which is crucial for timely and effective management. The spectrum of organisms and their antimicrobial susceptibility may vary across geographical regions and healthcare settings, influenced by patient demographics, infection control practices, and antibiotic usage patterns.

The present study provides an insight into the spectrum of bacterial pathogens and their antimicrobial resistance patterns isolated from clinical samples at a tertiary care hospital in North Kashmir. Out of the 1100 samples processed, the overall culture positivity rate was 19.18%, whereas the majority of samples (80.82%) were sterile. In contrast, other Indian studies have reported higher culture yields; for instance, Gill MK et al. (2019).[13] documented a yield of 66.45%, Mukherjee S et al. (2020).[14] reported 65%, and Swain B et al. (2022).[15] found 62.9%. These variations may be attributed to differences in patient demographics, sample collection protocols, and the prevalence of prior empirical antibiotic use. The high proportion of sterile cultures in the present study could plausibly be explained by factors such as prior antimicrobial therapy before specimen collection, inadequate sample volume, or infections caused by anaerobic or fastidious organisms that were not recoverable using the culture techniques employed.

In our study, Gram-positive bacteria constituted the highest proportion of isolates, accounting for 66.82% of the total. This predominance of Gram-positive organisms in pyogenic wound infections is consistent with findings from several other studies. Rijal BP et al. (2017).[5] reported a prevalence of 57% Gram-positive bacteria in wound infections, while Rai S et al. (2017).[16] observed a slightly higher prevalence of 61%, both supporting the trend seen in our results. The predominance of Gram-positive organisms may also be influenced by factors such as the high frequency of skin-originating infections, inappropriate or incomplete antibiotic therapy, and the growing prevalence of methicillin-resistant S. aureus (MRSA) in community and hospital settings, which has been documented as a significant public health concern in developing countries. This pattern underscores the need for vigilant infection control measures, timely diagnosis, and targeted antimicrobial therapy to effectively manage pyogenic wound infections and prevent complications.

Among the culture-positive specimens, Staphylococcus aureus (all methicillin-resistant strains) emerged as the predominant pathogen, accounting for 48.34% of isolates. Mixed bacterial flora was identified in 1.42% of cases. This predominance of S. aureus aligns with the observations reported in multiple studies conducted by Rao et al., Mantravadi et al. and Tiwari et al., reinforcing the organism's established role in pyogenic infections.[1,17,18] Staphylococcus aureus is a Gram-positive coccus that has long been recognized as the principal causative agent of a wide spectrum of suppurative conditions, ranging from superficial skin abscesses to deep-seated infections involving bones, joints, and internal organs. Its dominance in pyogenic infections is attributable to several key factors. First, it is a common commensal of the skin, anterior nares, and other mucosal surfaces, allowing it ready access to breach sites when skin integrity is compromised due to trauma, surgery, or medical procedures. Second, S. aureus possesses a wide array of virulence factors, including surface proteins that promote adherence, enzymes such as coagulase and hyaluronidase that facilitate tissue invasion, and toxins such as Panton–Valentine leukocidin that damage host cells and impair immune defenses. Third, methicillin-resistant S. aureus (MRSA) strains exhibit resistance to multiple β-lactam antibiotics, complicating treatment and increasing the risk of persistent or recurrent infection. The detection of mixed bacterial flora in a small proportion of cases suggests possible polymicrobial infections, particularly in wounds with prolonged exposure, poor vascularity, or secondary contamination. However, the overwhelming predominance of S. aureus underscores its clinical importance and the necessity for vigilant antimicrobial stewardship, prompt microbiological diagnosis, and targeted therapy to prevent complications and limit the spread of resistant strains.

In the present study, Staphylococcus aureus demonstrated a markedly high level of resistance to penicillin (97%), a finding consistent with the results reported by Khanam et al., where 84.5% of isolates exhibited penicillin resistance.[19] Penicillin, being one of the earliest discovered and most extensively used antibiotics, has been subjected to decades of widespread and often indiscriminate use, leading to the emergence and dissemination of penicillin-resistant strains, largely mediated by β-lactamase production. This long-standing selective pressure has rendered penicillin largely ineffective against S. aureus in most clinical settings.

Despite this high level of resistance, our study found that susceptibility to vancomycin (79%) and linezolid (94%) remains relatively preserved. These results align with multiple Indian studies that have documented minimal resistance to these agents. For instance, Mantravadi HB et al. (2015).[17] and Taneja S et al. (2020).[20] both reported high sensitivity of S. aureus to vancomycin and linezolid, reflecting their continued efficacy as frontline agents against methicillin-resistant S. aureus (MRSA). Similarly, Duggal et al. observed that S. aureus isolates exhibited a high sensitivity rate to linezolid (94.8%), corroborating our findings.[21] The sustained effectiveness of these drugs may be attributed to their relatively restricted use, stringent prescription policies, and the absence of widespread resistance mechanisms against them in the Indian subcontinent.

Among Gram-negative bacterial isolates, amikacin, piperacillin–tazobactam, meropenem, and polymyxin B emerged as the most effective antibiotics, showing the highest susceptibility rates. These findings are consistent with previous reports by Chakraborty A et al. (2021) and Tameez-ud-Din A et al. (2020), where these agents demonstrated superior activity against multidrug-resistant Gram-negative bacilli.[22,23]

A notable observation in the present study was the high level of resistance to commonly used antibiotics, particularly ampicillin, where resistance was almost universal. Exceptions included Klebsiella pneumoniae (23% susceptible) and Proteus mirabilis (33% susceptible), although susceptibility remained low. Similarly, resistance to third-generation cephalosporins was alarmingly high; for instance, Escherichia coli showed 0% susceptibility to both cefotaxime and cefpodoxime. Such resistance patterns mirror those reported by Biradar A et al. (2016), Duggal S et al. (2015), Roopa C et al. (2017) and Rugira Trojan et al. (2016), highlighting a persistent and widespread challenge in the empirical treatment of Gram-negative infections.[6,21,24,25] These results underscore the need for judicious antibiotic use, strict antimicrobial stewardship programs, and periodic surveillance to track emerging resistance trends and guide empirical therapy effectively.

Implications for empirical therapy and infection control: Given the resistance patterns observed, empirical treatment of pyogenic infections in our setting should prioritize vancomycin or linezolid for Gram-positive coverage and amikacin or piperacillin-tazobactam for Gram-negative coverage, with escalation to polymyxins if required. Routine empirical use of penicillin, erythromycin, third-generation cephalosporins, or ampicillin appears unjustified. High MRSA prevalence and emerging resistance to even last-line agents necessitate strict adherence to infection control measures, including contact precautions, environmental cleaning, and MRSA decolonization strategies where feasible. For Gram-negative pathogens, antimicrobial stewardship programs aimed at reducing unnecessary broad-spectrum β-lactam use and regular antibiogram-based updates to hospital prescribing policies are essential. Finally, our findings underscore the need for continuous local surveillance. Resistance trends are dynamic, and periodic microbiological audits are critical to guide evidence-based empirical therapy and limit the spread of multidrug-resistant organisms in healthcare settings.

CONCLUSION

The present study highlights that Staphylococcus aureus exhibits alarmingly high resistance to penicillin, reflecting the long-standing consequences of extensive antibiotic use and aligning with findings from previous Indian studies. However, the preserved susceptibility to vancomycin and linezolid underscores their continued utility as effective treatment options. These results emphasize the urgent need for rational antibiotic prescribing, routine antimicrobial susceptibility testing, and the implementation of robust infection control measures to prevent further escalation of resistance patterns.

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