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Research Article

Bacterial Profile and Antimicrobial Susceptibility Pattern of Patients with Burn Injuries in a Tertiary Care Hospital

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ABSTRACT

Background: Burn wound infections are a major cause of morbidity and mortality in hospitalized patients, particularly in developing countries. The disruption of the skin barrier and immunosuppression predispose burn patients to colonization and infection by various microorganisms. Continuous surveillance of bacterial profile and antimicrobial susceptibility is essential for effective management.
Objective: To determine the bacterial profile and antimicrobial susceptibility pattern of isolates from burn patients admitted to a tertiary care hospital in Jammu & Kashmir over a period of one year.
Methods: This prospective observational study included 150 burn patients admitted over one year. A total of 210 clinical samples (wound swabs, pus, and blood) were collected and processed using standard microbiological techniques. Identification of isolates was done by conventional methods, and antimicrobial susceptibility testing was performed using the Kirby–Bauer disc diffusion method as per Clinical and Laboratory Standards Institute.
Results: Out of 210 samples, 162 (77.1%) showed significant bacterial growth. Gram-negative organisms (71.5%) predominated over Gram-positive organisms (28.5%). Pseudomonas aeruginosa (32.1%) was the most common isolate, followed by Staphylococcus aureus (25.3%), Klebsiella pneumoniae (18.5%), Acinetobacter baumannii (12.3%), and Escherichia coli (8.6%). High resistance was observed to cephalosporins and fluoroquinolones. Carbapenems and polymyxins showed the highest sensitivity among Gram-negative organisms, while vancomycin and linezolid were highly effective against Gram-positive isolates. A significant proportion of isolates exhibited multidrug resistance.
Conclusion: Gram-negative bacteria, particularly Pseudomonas aeruginosa, are the predominant pathogens in burn wound infections. The high level of antimicrobial resistance observed highlights the need for regular surveillance, strict infection control measures, and rational antibiotic use to improve patient outcomes.

Keywords: *Burn wound infection, antimicrobial resistance, Pseudomonas aeruginosa, Burn unit, Antibiogram.*

INTRODUCTION

Burn injuries are a major global public health problem and contribute significantly to morbidity and mortality, particularly in developing countries [1]. They result in disruption of the skin barrier, leading to loss of innate immune defense mechanisms and creating a favorable environment for microbial colonization and infection [2]. Infection remains one of the leading causes of death in burn patients, especially in those with extensive burns and prolonged hospital stays [3].

The microbial profile of burn wounds is dynamic and changes over time. Initially, Gram-positive organisms such as *Staphylococcus aureus* colonize the wound surface, followed by the predominance of Gram-negative organisms including *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Acinetobacter baumannii* during later stages of hospitalization [4,5]. Among these, *Pseudomonas aeruginosa* is particularly significant due to its intrinsic resistance mechanisms and ability to thrive in moist hospital environments, making it a common cause of nosocomial infections in burn units [6].

The increasing prevalence of multidrug-resistant (MDR) organisms has further complicated the management of burn wound infections [7]. Pathogens such as *Acinetobacter baumannii* and extended-spectrum β-lactamase (ESBL)-producing *Klebsiella pneumoniae* have shown high resistance to commonly used antibiotics, limiting therapeutic options [8]. Moreover, the emergence of methicillin-resistant *Staphylococcus aureus* (MRSA) poses additional challenges in the treatment of Gram-positive infections [9].

Timely identification of bacterial pathogens and their antimicrobial susceptibility patterns is essential for guiding appropriate empirical and targeted antibiotic therapy. The use of standardized guidelines, such as those provided by the Clinical and Laboratory Standards Institute, ensures accurate interpretation of susceptibility results and helps in optimizing antimicrobial stewardship practices [10].

Given the regional variations in bacterial flora and antimicrobial resistance patterns, continuous surveillance is necessary, particularly in tertiary care centers where severe burn cases are managed. However, data from northern regions of India, especially Jammu & Kashmir, remain limited.

Therefore, the present study was undertaken to determine the bacterial profile and antimicrobial susceptibility patterns among burn patients admitted to a tertiary care hospital in Jammu & Kashmir over a period of one year.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was carried out in the Department of Microbiology, Government Medical College, Srinagar, over a period of one year from July 2024 to July 2025. The study was carried out in collaboration with the Department of Microbiology for processing and analysis of clinical samples.

Study Population

All patients admitted with burn injuries during the study period were included in the study.

Inclusion Criteria

- Patients of all age groups and both genders with burn injuries
- Patients showing clinical signs of infection (e.g., fever, purulent discharge, delayed wound healing)

Exclusion Criteria

- Patients who had received prolonged antibiotic therapy prior to admission
- Patients who were discharged or died before sample collection
- Patients who did not provide consent

Sample Size

A total of 150 patients were included in the study. From these patients, 210 clinical samples (wound swabs, pus, and blood samples) were collected and processed.

Sample Collection

Clinical samples were collected under strict aseptic precautions. Wound swabs and pus samples were obtained from the burn site after proper cleaning with sterile saline, while blood samples were collected in sterile blood culture bottles.

All samples were transported immediately to the microbiology laboratory for further processing to minimize contamination and ensure viability of organisms [1].

Microbiological Processing

The samples were inoculated onto standard culture media, including Blood agar and MacConkey agar, and incubated aerobically at 37°C for 24–48 hours. Identification of bacterial isolates was performed based on:

- Colony morphology
- Gram staining
- Standard biochemical tests

These procedures were carried out according to standard microbiological methods [2].

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed using the Kirby–Bauer disc diffusion method on Mueller-Hinton agar. The results were interpreted according to the guidelines of the Clinical and Laboratory Standards Institute [3].

A panel of antibiotics appropriate for Gram-positive and Gram-negative organisms was tested. The zone diameters were measured and categorized as sensitive, intermediate, or resistant based on CLSI criteria.

Definition of Multidrug Resistance (MDR)
Multidrug resistance was defined as resistance of an isolate to three or more classes of antimicrobial agents [4].

Quality Control
Quality control of media and antibiotic discs was ensured using standard reference strains such as:

- *Escherichia coli* ATCC 25922
- *Staphylococcus aureus* ATCC 25923
- *Pseudomonas aeruginosa* ATCC 27853

These were used to validate culture and susceptibility testing procedures [3].

Data Collection and Analysis
All clinical and microbiological data were recorded in a structured proforma and entered into Microsoft Excel. The data were analyzed using descriptive statistics and expressed as frequencies, percentages, and proportions.

RESULTS
A total of 150 patients with burn injuries were included in the present study conducted over a period of one year in a tertiary care hospital in Jammu & Kashmir. Among these, 88 (58.7%) were males and 62 (41.3%) were females, with a male-to-female ratio of 1.4:1. The majority of patients belonged to the age group of 21–40 years, indicating that young adults were the most commonly affected group.

A total of 210 clinical samples, including wound swabs, pus, and blood samples, were collected from these patients for microbiological analysis. Out of these, 162 samples (77.1%) yielded significant bacterial growth, while 48 samples (22.9%) showed no growth.

Table 1: Culture Positivity among Samples

Total Samples	Culture Positive	Culture Negative	Positivity Rate (%)
210	162	48	77.1%

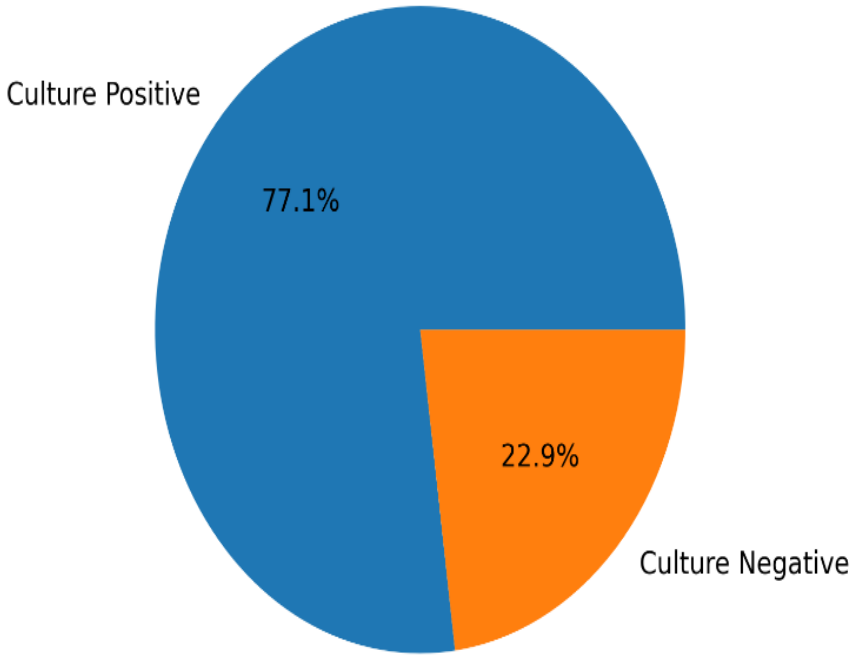

Figure 1: Distribution of Culture Positive and Negative Samples

Further analysis of the culture-positive samples demonstrated a clear predominance of Gram-negative organisms. Out of 162 isolates, 116 (71.5%) were Gram-negative bacteria, whereas 46 (28.5%) were Gram-positive bacteria.

Table 2: Distribution of Isolates Based on Gram Staining

Type of Organism	Number (n=162)	Percentage (%)
Gram-negative	116	71.5%
Gram-positive	46	28.5%

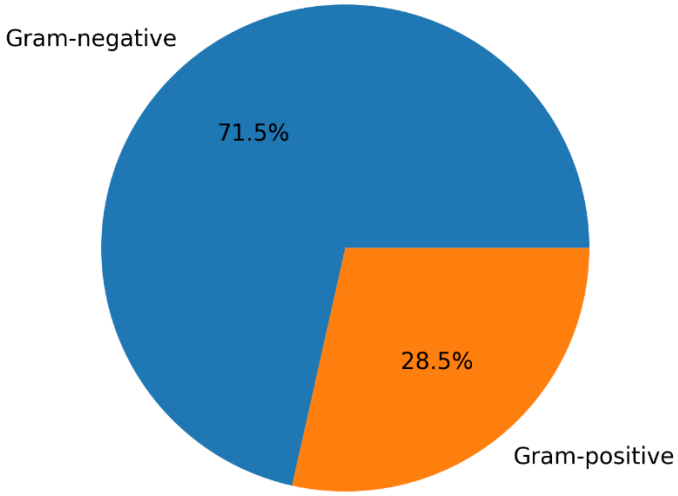

Figure 2: Distribution of Gram-negative and Gram-positive Isolates

On evaluating the distribution of individual bacterial isolates, *Pseudomonas aeruginosa* emerged as the most common pathogen, accounting for 32.1% of total isolates. This was followed by *Staphylococcus aureus* (25.3%), *Klebsiella pneumoniae* (18.5%), *Acinetobacter baumannii* (12.3%), and *Escherichia coli* (8.6%). Other organisms contributed to a small proportion (3.2%) of the isolates.

Table 3: Distribution of Bacterial Isolates

Organism	Number (n=162)	Percentage (%)
Pseudomonas aeruginosa	52	32.1%
Staphylococcus aureus	41	25.3%
Klebsiella pneumoniae	30	18.5%
Acinetobacter baumannii	20	12.3%
Escherichia coli	14	8.6%
Others	5	3.2%

Overall, the findings indicate that Gram-negative organisms, particularly *Pseudomonas aeruginosa*, are the predominant pathogens in burn wound infections in the present setting. Detailed organism-wise antimicrobial susceptibility patterns are presented in Tables 4–8.

Antimicrobial Susceptibility Pattern

Antimicrobial susceptibility testing was performed by the Kirby–Bauer disc diffusion method and interpreted according to Clinical and Laboratory Standards Institute. A comprehensive panel of antibiotics relevant to each organism group (Gram-negative and Gram-positive) was tested.

***Pseudomonas aeruginosa* (n = 52)**

Pseudomonas aeruginosa exhibited high resistance to cephalosporins and fluoroquinolones, while maintaining good susceptibility to carbapenems and colistin.

Table 4: Susceptibility Pattern of *Pseudomonas aeruginosa*

Antibiotic	Sensitive (%)	Resistant (%)
Piperacillin	55%	45%
Piperacillin-Tazobactam	62%	38%
Ceftazidime	28%	72%
Cefepime	35%	65%
Aztreonam	30%	70%
Ciprofloxacin	34%	66%
Levofloxacin	38%	62%
Amikacin	68%	32%
Gentamicin	60%	40%
Tobramycin	65%	35%
Imipenem	84%	16%
Meropenem	81%	19%
Doripenem	78%	22%
Colistin	98%	2%

Polymyxin B	96%	4%

***Staphylococcus aureus* (n = 41)**
A significant proportion of isolates were MRSA. Glycopeptides and oxazolidinones showed complete sensitivity.

Table 5: Susceptibility Pattern of *Staphylococcus aureus*

Antibiotic	Sensitive (%)	Resistant (%)
Penicillin	15%	85%
Cefoxitin (MRSA screen)	68%	32%
Oxacillin	70%	30%
Erythromycin	38%	62%
Clindamycin	65%	35%
Gentamicin	72%	28%
Ciprofloxacin	50%	50%
Levofloxacin	55%	45%
Tetracycline	60%	40%
Doxycycline	68%	32%
Trimethoprim-Sulfamethoxazole	75%	25%
Linezolid	100%	0%
Vancomycin	100%	0%
Teicoplanin	100%	0%

***Klebsiella pneumoniae* (n = 30)**
High resistance to cephalosporins indicates probable ESBL production. Carbapenems and polymyxins remain effective.

Table 6: Susceptibility Pattern of *Klebsiella pneumoniae*

Antibiotic	Sensitive (%)	Resistant (%)
Ampicillin	5%	95%
Amoxicillin-Clavulanate	30%	70%
Ceftriaxone	25%	75%
Ceftazidime	28%	72%
Cefepime	35%	65%
Aztreonam	32%	68%
Ciprofloxacin	40%	60%
Levofloxacin	45%	55%
Amikacin	58%	42%
Gentamicin	50%	50%
Piperacillin-Tazobactam	63%	37%
Imipenem	86%	14%
Meropenem	84%	16%
Colistin	95%	5%
Polymyxin B	94%	6%

***Acinetobacter baumannii* (n = 20)**
This organism showed extensive drug resistance, with limited susceptibility mainly to colistin and partially to carbapenems.

Table 7: Susceptibility Pattern of *Acinetobacter baumannii*

Antibiotic	Sensitive (%)	Resistant (%)
Ampicillin-Sulbactam	40%	60%
Ceftriaxone	10%	90%
Ceftazidime	15%	85%
Cefepime	20%	80%
Ciprofloxacin	20%	80%
Levofloxacin	25%	75%
Amikacin	35%	65%
Gentamicin	30%	70%
Piperacillin-Tazobactam	40%	60%
Imipenem	65%	35%
Meropenem	60%	40%
Doxycycline	55%	45%
Minocycline	60%	40%

Colistin	92%	8%
Polymyxin B	90%	10%

***Escherichia coli* (n = 14)**
Moderate resistance to cephalosporins and fluoroquinolones was observed, with good susceptibility to aminoglycosides and carbapenems.

Table 8: Susceptibility Pattern of *Escherichia coli*

Antibiotic	Sensitive (%)	Resistant (%)
Ampicillin	20%	80%
Amoxicillin-Clavulanate	45%	55%
Ceftriaxone	30%	70%
Ceftazidime	35%	65%
Cefepime	40%	60%
Ciprofloxacin	45%	55%
Levofloxacin	50%	50%
Amikacin	70%	30%
Gentamicin	65%	35%
Piperacillin-Tazobactam	68%	32%
Imipenem	88%	12%
Meropenem	85%	15%
Nitrofurantoin	72%	28%
Colistin	96%	4%

DISCUSSION

Burn wound infections remain a major cause of morbidity and mortality in hospitalized patients, particularly in resource-limited settings. In the present study, the culture positivity rate was found to be 77.1%, which is comparable to findings reported in similar tertiary care settings across India and other developing countries, where positivity rates range from 65% to 85% [11,12]. The high rate of culture positivity reflects the vulnerability of burn wounds to microbial colonization due to disruption of the skin barrier and compromised host immunity.

In the present study, a male predominance (58.7%) was observed, which is consistent with previous studies suggesting higher exposure of males to occupational hazards and burn injuries [13]. The majority of patients belonged to the 21–40 years age group, indicating that economically productive age groups are most affected, a finding also reported in earlier studies [14].

A key finding of this study was the predominance of Gram-negative organisms (71.5%) over Gram-positive organisms (28.5%). This shift toward Gram-negative flora has been consistently documented in burn units, particularly in patients with prolonged hospital stays [15]. Similar studies have reported Gram-negative isolation rates ranging from 60% to 80%, supporting our findings [16].

Among the isolates, *Pseudomonas aeruginosa* was the most common pathogen (32.1%), followed by *Staphylococcus aureus* (25.3%) and *Klebsiella pneumoniae* (18.5%). The predominance of *Pseudomonas aeruginosa* is well documented in burn wound infections due to its ability to survive in moist environments, form biofilms, and exhibit intrinsic resistance to multiple antibiotics [17]. Comparable studies from tertiary care centers have also reported *Pseudomonas aeruginosa* as the leading isolate, with prevalence ranging between 25% and 40% [18].

The presence of *Acinetobacter baumannii* (12.3%) in our study highlights the growing importance of this organism as a nosocomial pathogen in burn units. Its ability to survive on environmental surfaces and develop multidrug resistance makes it particularly challenging to manage [19].

The antimicrobial susceptibility pattern observed in this study revealed a high level of resistance to commonly used antibiotics such as third-generation cephalosporins and fluoroquinolones among Gram-negative isolates. This finding is consistent with recent reports indicating widespread resistance to these antibiotic classes due to overuse and inappropriate prescribing practices [20].

Carbapenems (imipenem and meropenem) and polymyxins (colistin) demonstrated the highest sensitivity against Gram-negative organisms, including *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. Similar trends have been reported in recent studies, where colistin remains one of the last-resort drugs for multidrug-resistant Gram-negative infections [21]. However, the emergence of carbapenem-resistant strains is an alarming trend that warrants close monitoring.

Among Gram-positive isolates, *Staphylococcus aureus* showed high resistance to penicillin and erythromycin, while maintaining complete sensitivity to vancomycin, linezolid, and teicoplanin. The detection of methicillin-resistant *Staphylococcus aureus* (MRSA) in approximately one-third of isolates aligns with previous reports from burn units, where MRSA prevalence ranges from 25% to 40% [22].

The presence of multidrug-resistant (MDR) organisms, particularly *Acinetobacter baumannii* and *Pseudomonas aeruginosa*, further complicates the management of burn infections. MDR rates reported in our study are comparable to those observed in recent literature, highlighting the growing challenge of antimicrobial resistance in hospital settings [23]. The findings of this study emphasize the importance of regular microbiological surveillance and adherence to antibiotic stewardship programs. The use of standardized susceptibility testing guidelines, such as those provided by the Clinical and Laboratory Standards Institute, plays a crucial role in guiding appropriate antimicrobial therapy and reducing the emergence of resistance.

Overall, the present study highlights a predominance of Gram-negative organisms with a high burden of antimicrobial resistance in burn wound infections. These findings underscore the need for strict infection control practices, rational antibiotic use, and continuous monitoring of resistance patterns in tertiary care hospitals.

CONCLUSION

The present study demonstrates that burn wound infections in a tertiary care hospital in Jammu & Kashmir are predominantly caused by Gram-negative organisms, with *Pseudomonas aeruginosa* being the most frequently isolated pathogen, followed by *Staphylococcus aureus* and *Klebsiella pneumoniae*. A high culture positivity rate reflects the significant burden of infection among burn patients.

The antimicrobial susceptibility pattern revealed a concerning level of resistance to commonly used antibiotics, particularly third-generation cephalosporins and fluoroquinolones. Carbapenems and polymyxins remained the most effective agents against Gram-negative organisms, while glycopeptides and oxazolidinones retained excellent activity against Gram-positive isolates. The presence of multidrug-resistant organisms, especially *Acinetobacter baumannii* and *Pseudomonas aeruginosa*, highlights the growing challenge of antimicrobial resistance in burn units.

Overall, the findings underscore the need for continuous surveillance of bacterial profiles and antimicrobial susceptibility patterns to guide appropriate empirical therapy and improve clinical outcomes in burn patients.

Recommendations

Based on the findings of the present study, the following recommendations are proposed:

1. **Implementation of Antibiotic Stewardship Programs-** Rational and judicious use of antibiotics should be promoted to minimize the emergence of antimicrobial resistance.
2. **Regular Microbiological Surveillance-** Periodic monitoring of bacterial profiles and antibiograms in burn units should be conducted to guide empirical therapy.
3. **Strict Infection Control Measures-** Adherence to infection control practices, including hand hygiene, sterilization protocols, and isolation precautions, is essential to prevent nosocomial infections.
4. **Early Culture and Sensitivity Testing-** Routine and timely microbiological evaluation of burn wounds should be performed to ensure targeted antimicrobial therapy.
5. **Restricted Use of Last-Resort Antibiotics-** Drugs such as colistin and carbapenems should be reserved for confirmed multidrug-resistant infections to preserve their efficacy.
6. **Training and Awareness-** Healthcare personnel should be regularly trained regarding infection control practices and antimicrobial resistance trends.
7. **Multidisciplinary Approach-** Collaboration between clinicians, microbiologists, and infection control teams is essential for optimal management of burn patients.
8. **Further Research-** Larger multicentric studies and molecular characterization of resistance mechanisms are recommended to better understand evolving resistance patterns.

Conflict of Interest: The authors declare that there is no conflict of interest.

Ethical Issues: None

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