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RESEARCH ARTICLE

# Aerobic Bacteriological Isolates of Burn Wound Infections and Their Antimicrobial Sensitivity Pattern in the Burn Unit of a Tertiary Care Hospital in Bihar: A Prospective Observational Study

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## ABSTRACT

**Background:** Burn wound infections are among the leading causes of morbidity and mortality in burn patients due to loss of skin barrier, immunosuppression, prolonged hospitalization, and emergence of antimicrobial-resistant organisms. Continuous monitoring of the bacteriological profile and antimicrobial susceptibility pattern is essential for effective management of burn wound infections.

**Aim:** To study the aerobic bacteriological isolates of burn wound infections and evaluate their antimicrobial sensitivity pattern among patients admitted to the Burn Unit of Patna Medical College & Hospital (PMCH), Patna.

**Materials and Methods:** A hospital-based prospective observational study was conducted in the Burn Unit of PMCH, Patna, from October 2022 to September 2023. A total of 100 burn wound patients clinically suspected of wound infection were included. Wound swabs/pus samples were collected under aseptic precautions and processed using standard microbiological techniques for aerobic bacterial isolation and identification. Antimicrobial susceptibility testing was performed by Kirby–Bauer disc diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines. Statistical analysis was performed using SPSS version 25.0.

**Results:** Among the 100 burn wound samples studied, bacterial growth was obtained in 79 samples, while 21 samples showed no growth. Of the culture-positive samples, 69 (87.34%) demonstrated monomicrobial colonization and 10 (12.66%) demonstrated polymicrobial colonization. A total of 89 bacterial isolates were recovered. *Pseudomonas aeruginosa* was the predominant isolate accounting for 41.57% of isolates, followed by *Staphylococcus aureus* (25.84%), coagulase-negative staphylococci (14.60%), *Klebsiella pneumoniae* (8.98%), *Escherichia coli* (5.61%), and *Proteus mirabilis* (3.37%). Gram-negative organisms constituted 59.55% of isolates, whereas Gram-positive organisms accounted for 40.45%. Imipenem demonstrated the highest sensitivity against Gram-negative isolates, while vancomycin and linezolid showed 100% sensitivity against Gram-positive isolates.

**Conclusion:** *Pseudomonas aeruginosa* was the predominant aerobic bacterial isolate recovered from burn wound infections in the present study, followed by *Staphylococcus aureus*. Gram-negative organisms were more common than Gram-positive organisms. Imipenem showed excellent activity against Gram-negative isolates, while vancomycin and linezolid remained highly effective against Gram-positive isolates. Regular bacteriological surveillance and rational antibiotic use are essential for effective management of burn wound infections and prevention of antimicrobial resistance.

**Keywords:** Burn wound infection; Aerobic bacteria; Antimicrobial sensitivity; *Pseudomonas aeruginosa*; Burn unit; Antibiotic resistance

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## Introduction

Burn injury is one of the most devastating forms of trauma and remains a major public health problem worldwide. Burn patients are highly susceptible to infections because thermal injury destroys the skin barrier and impairs local as well as systemic immune defense mechanisms.[1] Burn wound infection continues to be a major cause of morbidity, prolonged hospital stay, septicemia, and mortality among hospitalized burn patients.[2]

Thermal injury produces coagulation necrosis and creates a protein-rich environment that favors microbial colonization and proliferation.[3] The burn wound consists of three zones, namely the zone of coagulation, zone of stasis, and zone of hyperemia.[4] The avascular necrotic tissue present in burn wounds acts as a suitable medium for microbial growth and reduces the penetration of systemically administered antimicrobial agents.[5]

Immediately following thermal injury, burn wounds are sterile. However, colonization occurs rapidly from endogenous skin flora, gastrointestinal tract flora, respiratory tract flora, and the hospital environment.[6] Gram-positive organisms predominate during the early post-burn period, whereas Gram-negative bacteria become increasingly prevalent during prolonged hospitalization.[7]

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Among the various microorganisms implicated in burn wound infections, *Pseudomonas aeruginosa* and *Staphylococcus aureus* are the most frequently isolated pathogens.[8] *Pseudomonas aeruginosa* possesses several virulence factors, including exotoxin production, elastase activity, collagenase production, protease activity, and biofilm formation, which contribute to tissue invasion and persistence in burn wounds.[5]

The immunosuppression associated with major burns further increases susceptibility to infectious complications.[9] Burn injuries involving more than 25% of the total body surface area are associated with significant impairment of host defense mechanisms.[9]

Several studies have demonstrated changing trends in the bacteriological profile of burn wound infections over time.[10] Prior to the antibiotic era, *Streptococcus pyogenes* was considered a major pathogen; however, following the widespread use of antibiotics, *Staphylococcus aureus* and subsequently *Pseudomonas aeruginosa* emerged as the leading pathogens in burn care units.[11]

The emergence of antimicrobial-resistant organisms in burn units has become a major therapeutic challenge.[12] Inappropriate and indiscriminate use of broad-spectrum antibiotics contributes to the development of resistant bacterial strains, limiting available treatment options and increasing healthcare burden.[13]

Several Indian studies have reported *Pseudomonas aeruginosa* as the predominant isolate from burn wounds, followed by *Staphylococcus aureus*, *Klebsiella* species, and *Escherichia coli*. Agnihotri et al. reported *Pseudomonas aeruginosa* in 58.95% of isolates recovered from burn wound infections.[14,15]

Studies by Singh et al. and Mehta et al. also highlighted the predominance of Gram-negative bacilli among burn wound pathogens and emphasized the importance of regular antimicrobial susceptibility monitoring.[10,15]

In recent years, increasing antimicrobial resistance among burn wound pathogens has significantly reduced therapeutic options.[16] Rational antibiotic therapy based on culture and sensitivity testing, combined with effective infection control practices, plays a crucial role in reducing morbidity and mortality among burn patients.[17]

Therefore, the present study was undertaken to identify aerobic bacteriological isolates from burn wound infections and determine their antimicrobial sensitivity pattern among patients admitted to the Burn Unit of Patna Medical College & Hospital (PMCH), Patna.

## Materials And Methods

### Study Design

This was a hospital-based prospective observational study conducted to evaluate the aerobic bacteriological profile of burn wound infections and the antimicrobial susceptibility pattern of the isolated organisms.

### Study Place

The study was carried out in the Department of Microbiology in collaboration with the Burn Unit, Department of Surgery, Patna Medical College & Hospital (PMCH), Patna, Bihar.

### Study Duration

The study was conducted over a period of one year from October 2022 to September 2023.

### Study Population and Sample Size

A total of 100 patients admitted to the Burn Unit with clinically suspected burn wound infections were included in the study. One wound swab specimen was collected from each patient, yielding a total of 100 samples for microbiological analysis.

### Inclusion Criteria

- Patients admitted to the burn unit with clinical evidence of burn wound infection.
- Patients of all age groups and both sexes.
- Patients willing to participate in the study.

### Exclusion Criteria

- Patients receiving prolonged antibiotic therapy before admission.
- Patients with non-infected burn wounds.
- Patients unwilling to participate in the study.

### Sample Collection

Wound swab specimens were collected aseptically from burn wounds using sterile cotton swabs after cleaning the wound surface with sterile normal saline. Samples were immediately transported to the microbiology laboratory for further processing.

### Laboratory Processing

The collected specimens were inoculated onto Blood Agar and MacConkey Agar media and incubated aerobically at 37°C for 24–48 hours. Bacterial isolates were identified based on colony morphology, Gram staining characteristics, and standard biochemical reactions.

### Identification of Bacterial Isolates

The isolates were identified using conventional microbiological methods including:

- Gram staining
- Catalase test
- Coagulase test
- Oxidase test
- Indole test
- Citrate utilization test
- Urease test
- Nitrate reduction test
- Triple Sugar Iron (TSI) agar reactions
- Other relevant biochemical tests as required

### Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed by the Kirby–Bauer disc diffusion method on Mueller–Hinton agar according to Clinical and Laboratory Standards Institute (CLSI) guidelines.

### Antibiotics Tested for Gram-negative Isolates

- Ampicillin
- Cefazolin
- Amoxyclav
- Ciprofloxacin
- Amikacin
- Gentamicin
- Ceftriaxone
- Imipenem
- Piperacillin
- Piperacillin–Tazobactam
- Ceftazidime

### Antibiotics Tested for Gram-positive Isolates

- Penicillin
- Azithromycin
- Ceftriaxone
- Gentamicin
- Ciprofloxacin
- Cefoxitin
- Vancomycin
- Linezolid

### Data Collection

Data regarding age, sex, occupation, culture results, bacterial isolates, and antimicrobial susceptibility patterns were recorded in a predesigned proforma and entered into Microsoft Excel for analysis.

### Statistical Analysis

Data were analyzed using SPSS version 25.0. Results were expressed as frequencies and percentages. Descriptive statistical methods were used to summarize demographic characteristics, culture positivity rates, bacterial isolates, and antimicrobial susceptibility patterns. The findings were presented in the form of tables and figures.

### Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee of Patna Medical College & Hospital, Patna. Informed consent was obtained from patients or their attendants whenever applicable. Patient confidentiality and anonymity were maintained throughout the study.

### Results

A total of 100 burn wound patients admitted to the Burn Unit of Patna Medical College & Hospital (PMCH), Patna, during the study period from October 2022 to September 2023 were included in the study. One hundred wound swab samples were collected from these patients and processed for aerobic bacteriological analysis.

### Age Distribution of Patients

The majority of patients belonged to the age group of 21–30 years (28%), followed by 31–40 years (23%). Patients aged 0–10 years and 41–50 years each accounted for 15% of cases. The least affected age groups were 51–60 years (3%) and 61–70 years (4%). Overall, the age group of 21–40 years constituted more than half of the study population (Table 1, Figure 1).

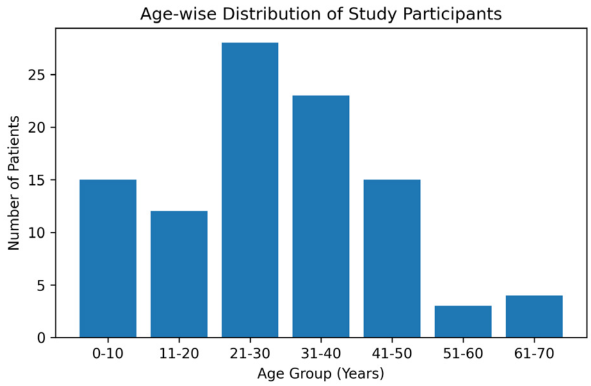


**Figure 1:** Age-wise Distribution of Study Participants

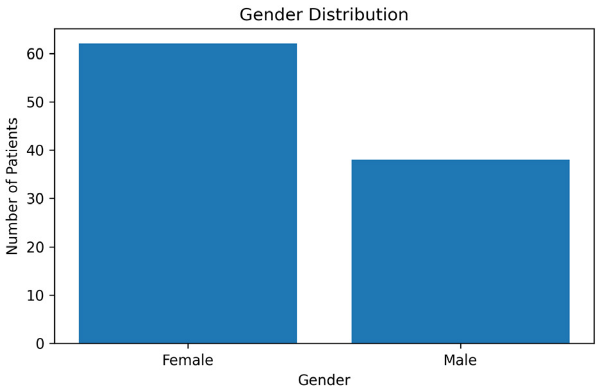


**Figure 2:** Gender Distribution of Study Participants

**Table 1:** Age-wise Distribution of Study Participants (n=100)

| *Age Group (Years)* | *Number of Patients* | *Percentage (%)* |
|---|---|---|
| 0–10 | 15 | 15 |
| 11–20 | 12 | 12 |
| 21–30 | 28 | 28 |
| 31–40 | 23 | 23 |
| 41–50 | 15 | 15 |
| 51–60 | 3 | 3 |
| 61–70 | 4 | 4 |
| Total | 100 | 100 |

## Gender Distribution

Among the 100 patients studied, 62 (62%) were females and 38 (38%) were males, indicating female predominance among burn wound infection cases (Table 2, Figure 2).

## Distribution of Cases According to Age and Sex

The highest number of female patients was observed in the 21–30 years age group (22 cases), while among males the highest frequency was observed in the 0–10 years age group (9 cases). Overall, the age group of 21–40 years represented the largest proportion of burn cases in both sexes (Table 3).

**Table 2:** Gender Distribution of Study Participants

| *Gender* | *Number of Patients* | *Percentage (%)* |
|---|---|---|
| Female | 62 | 62 |
| Male | 38 | 38 |
| Total | 100 | 100 |

**Table 3:** Distribution of Cases According to Age and Sex

| *Age group (Years)* | *Female* | *Male* | *Total* |
|---|---|---|---|
| 0–10 | 6 | 9 | 15 |
| 11–20 | 5 | 7 | 12 |
| 21–30 | 22 | 6 | 28 |
| 31–40 | 15 | 8 | 23 |
| 41–50 | 10 | 5 | 15 |
| 51–60 | 2 | 1 | 3 |
| 61–70 | 2 | 2 | 4 |
| Total | 62 | 38 | 100 |

## Distribution of Cases According to Occupation

Housewives constituted the largest occupational group affected by burn injuries, accounting for 48% of cases. Students represented 26% of patients, followed by workers (12%). Children, servicemen, and farmers accounted for smaller proportions of the study population (Table 4, Figure 3).

## Yield of Microorganisms from Burn Wounds

Among the 100 wound swab samples processed, 79 (79.0%) yielded bacterial growth, while 21 (21.0%) showed

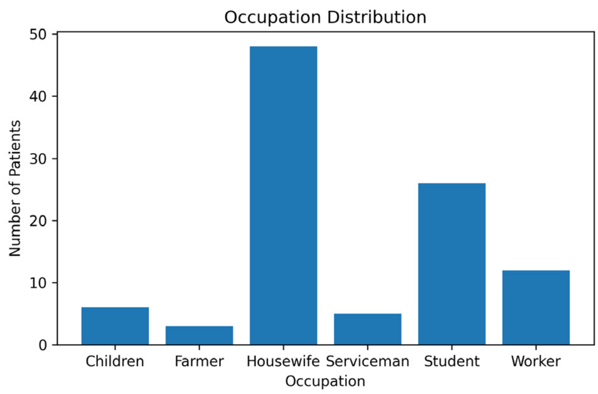


**Figure 3:** Distribution of Cases According to Occupation

**Table 4:** Distribution of Cases According to Occupation

| *Occupation* | *Number of Patients* | *Percentage (%)* |
|---|---|---|
| Children | 6 | 6.0 |
| Farmer | 3 | 3.0 |
| Housewife | 48 | 48.0 |
| Serviceman | 5 | 5.0 |
| Student | 26 | 26.0 |
| Worker | 12 | 12.0 |
| Total | 100 | 100 |

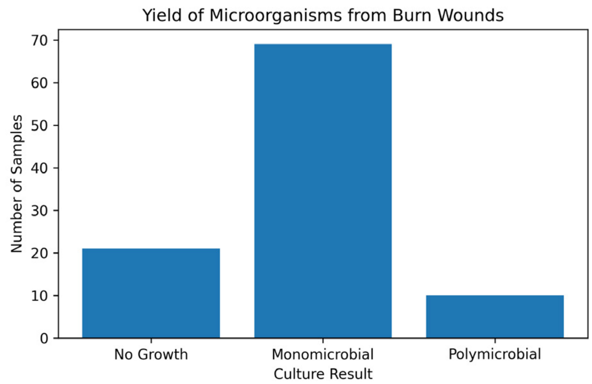


**Figure 4:** Yield of Microorganisms from Burn Wounds

no growth. Among the 79 culture-positive samples, 69 (87.34%) demonstrated monomicrobial growth and 10 (12.66%) demonstrated polymicrobial growth (Table 5, Figure 4).

## Distribution of Aerobic Bacterial Isolates

A total of 89 bacterial isolates were recovered from burn wound samples. *Pseudomonas aeruginosa* was the predominant isolate accounting for 41.57% of isolates, followed by *Staphylococcus aureus* (25.84%) and coagulase-negative staphylococci (CONS) (14.60%). Other isolates included *Klebsiella pneumoniae* (8.98%), *Escherichia coli* (5.61%), and *Proteus mirabilis* (3.37%) (Table 6, Figure 5).

**Table 5:** Yield of Microorganisms from Burn Wounds

| *Culture Result* | *Number* | *Percentage (%)* |
|---|---|---|
| No Growth | 21 | 21.0 |
| Monomicrobial Growth | 69 | 69.0 |
| Polymicrobial Growth | 10 | 10.0 |
| Total | 100 | 100 |

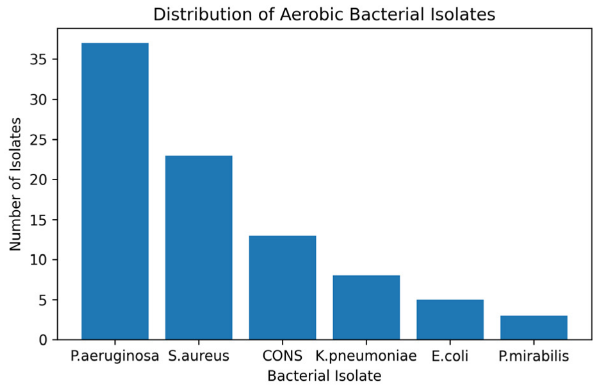


**Figure 5:** Distribution of Aerobic Bacterial Isolates

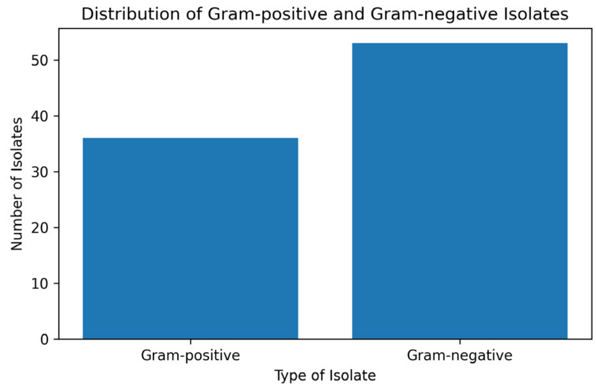


**Figure 6:** Distribution of Gram-positive and Gram-negative Isolates

**Table 6:** Distribution of Aerobic Bacterial Isolates (n=89)

| *Organism Isolated* | *Number of Isolates* | *Percentage (%)* |
|---|---|---|
| Pseudomonas aeruginosa | 37 | 41.57 |
| Staphylococcus aureus | 23 | 25.84 |
| CONS | 13 | 14.60 |
| Klebsiella pneumoniae | 8 | 8.98 |
| Escherichia coli | 5 | 5.61 |
| Proteus mirabilis | 3 | 3.37 |
| Total | 89 | 100 |

## Distribution of Gram-positive and Gram-negative Isolates

Gram-negative organisms predominated among the isolates and accounted for 53 (59.55%) isolates, whereas Gram-positive organisms accounted for 36 (40.45%) isolates (Table 7, Figure 6).

**Table 7:** Distribution of Gram-positive and Gram-negative Isolates

| *Type of Isolate* | *Number* | *Percentage (%)* |
|---|---|---|
| Gram-positive | 36 | 40.45 |
| Gram-negative | 53 | 59.55 |
| Total | 89 | 100 |

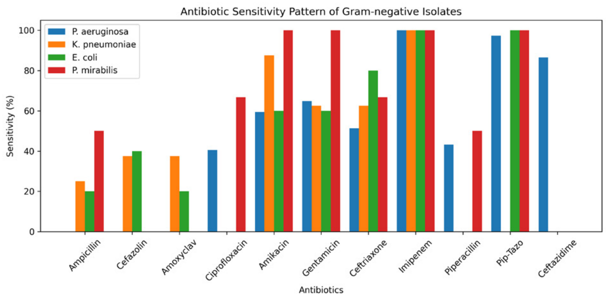


**Figure 7:** Antibiotic Sensitivity Pattern of Gram-negative Isolates

### Antibiotic Sensitivity Pattern of Gram-negative Isolates

Among Gram-negative isolates, *Pseudomonas aeruginosa* demonstrated highest sensitivity to imipenem (100%), followed by piperacillin–tazobactam (97.29%) and ceftazidime (86.48%). *Klebsiella pneumoniae* showed 100% sensitivity to imipenem and 87.50% sensitivity to amikacin. *Escherichia coli* and *Proteus mirabilis* also demonstrated complete sensitivity to imipenem and piperacillin–tazobactam. Lower sensitivity rates were observed for commonly used cephalosporins and fluoroquinolones (Table 8, Figure 7).

### Antibiotic Sensitivity Pattern of Gram-positive Isolates

Vancomycin and linezolid demonstrated 100% sensitivity against both *Staphylococcus aureus* and coagulase-negative

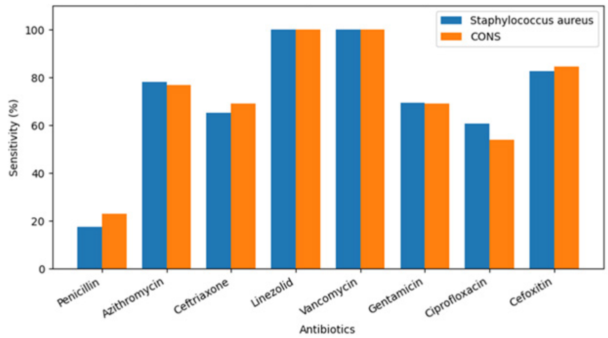


**Figure 8:** Antibiotic Sensitivity Pattern of Gram-positive Isolates

staphylococci. Azithromycin, gentamicin, and ceftriaxone also showed good activity against Gram-positive isolates. Penicillin demonstrated the lowest sensitivity among Gram-positive organisms (Table 9, Figure 8).

### Statistical Analysis

Descriptive statistical analysis demonstrated that females constituted a larger proportion of burn wound infection cases than males (62% vs 38%). The majority of patients belonged to the economically productive age group of 21–40 years (51%). Gram-negative bacteria predominated over Gram-positive bacteria among burn wound isolates (59.55% vs 40.44%). *Pseudomonas aeruginosa* was identified as the predominant pathogen, accounting for 41.57% of all isolates. Imipenem exhibited the highest sensitivity against all Gram-negative isolates, while vancomycin and linezolid demonstrated complete sensitivity against Gram-positive isolates.

## Discussion

In the present study, the highest proportion of patients belonged to the 21–30 years age group (28%), followed

**Table 8:** Antibiotic Sensitivity Pattern of Gram-negative Isolates

| *Antibiotic* | *P. aeruginosa (%)* | *K. pneumoniae (%)* | *E. coli (%)* | *P. mirabilis (%)* |
|---|---|---|---|---|
| Ampicillin | – | 25.00 | 20.00 | 50.00 |
| Cefazolin | – | 37.50 | 40.00 | – |
| Amoxyclav | – | 37.50 | 20.00 | – |
| Ciprofloxacin | 40.54 | – | – | 66.66 |
| Amikacin | 59.45 | 87.50 | 60.00 | 100 |
| Gentamicin | 64.86 | 62.50 | 60.00 | 100 |
| Ceftriaxone | 51.35 | 62.50 | 80.00 | 66.66 |
| Imipenem | 100 | 100 | 100 | 100 |
| Piperacillin | 43.24 | – | – | 50.00 |
| Piperacillin–Tazobactam | 97.29 | – | 100 | 100 |
| Ceftazidime | 86.48 | – | – | – |

**Table 9:** Antibiotic Sensitivity Pattern of Gram-positive Isolates

| *Antibiotic* | *Staphylococcus aureus (%)* | *CONS (%)* |
|---|---|---|
| Penicillin | 17.39 | 23.07 |
| Azithromycin | 78.26 | 76.92 |
| Ceftriaxone | 65.21 | 69.23 |
| Linezolid | 100 | 100 |
| Vancomycin | 100 | 100 |
| Gentamicin | 69.56 | 69.23 |
| Ciprofloxacin | 60.86 | 53.84 |
| Cefoxitin | 82.60 | 84.61 |

by the 31–40 years age group (23%). More than half of the patients were within the economically productive age group of 21–40 years. Similar findings have been reported by Kulkarni et al.[18] and Saleem et al.[19], who observed a higher incidence of burn injuries among young adults. This age distribution may be related to greater domestic, occupational, and social exposure to burn hazards.

Females constituted 62% of the study population, indicating a female predominance. Similar observations have been reported from several studies conducted in developing countries, where women are more frequently affected because of their involvement in cooking and other household activities associated with exposure to open flames and hot liquids.[18,19] Housewives represented the largest occupational group affected in the present study (48%), further supporting the predominance of domestic burn injuries.

Among the 100 burn wound samples processed, 79% yielded bacterial growth, whereas 21% showed no growth. Monomicrobial growth was observed in 87.34% of culture-positive samples, while polymicrobial growth was observed in 12.65%. Similar findings have been reported by Agnihotri et al.[14] and Rajput et al.[20], who demonstrated that burn wound infections are predominantly monomicrobial, particularly during the early stages of wound colonization.

A total of 89 aerobic bacterial isolates were recovered in the present study. *Pseudomonas aeruginosa* was the predominant isolate (41.57%), followed by *Staphylococcus aureus* (25.84%) and coagulase-negative staphylococci (14.60%). Similar predominance of *P. aeruginosa* has been reported by Agnihotri et al.[14], Rajput et al.[20], Kulkarni et al.[18], and Saleem et al.[19]. The ability of *P. aeruginosa* to survive in moist hospital environments, form biofilms, and develop resistance to multiple antimicrobial agents contributes to its persistence and predominance in burn units.[5]

Gram-negative organisms accounted for 59.55% of isolates, whereas Gram-positive organisms constituted 40.45%. This predominance of Gram-negative bacteria is consistent with findings reported by Singh et al.[10] and Mehta et al.[15], who observed that Gram-negative bacilli increasingly predominate in hospitalized burn patients because of prolonged hospital stay, invasive procedures, and exposure to nosocomial flora.

The antimicrobial susceptibility pattern observed in the present study demonstrated that imipenem was the most effective antibiotic against Gram-negative isolates, with 100% sensitivity among *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Escherichia coli*, and *Proteus mirabilis*. Piperacillin–tazobactam and ceftazidime also showed good activity against *P. aeruginosa*. Similar observations have been reported by Mehta et al.[15] and Sathya Bhama et al.[21], who found carbapenems to be among the most effective agents against Gram-negative burn wound pathogens.

Among Gram-positive isolates, vancomycin and linezolid demonstrated 100% sensitivity against both *Staphylococcus aureus* and coagulase-negative staphylococci. Comparable findings have been reported by Appelgren et al.[22] and Ekrami et al.[23], who observed excellent susceptibility of Gram-positive burn wound pathogens to vancomycin and other reserve antimicrobial agents.

The findings of the present study emphasize the importance of periodic bacteriological surveillance and antimicrobial susceptibility testing in burn units. Continuous monitoring of local microbial flora and resistance patterns is essential for guiding empirical antibiotic therapy, optimizing patient management, and limiting the emergence of antimicrobial resistance.

The present study has certain limitations. It was conducted at a single tertiary care centre with a relatively small sample size. Only aerobic bacterial isolates were studied, while anaerobic bacteria and fungal pathogens were not evaluated. In addition, molecular characterization of antimicrobial resistance mechanisms was not performed. Nevertheless, the study provides valuable information regarding the current bacteriological profile and antimicrobial susceptibility pattern of burn wound infections in this region.

Regular microbiological surveillance, strict infection-control practices, appropriate wound care, and rational use of antibiotics are essential for reducing infection-related complications and improving clinical outcomes among burn patients.

## Conclusion

The present study identified Pseudomonas aeruginosa as the most common aerobic bacterial isolate from burn wound infections, followed by Staphylococcus aureus. Gram-negative organisms predominated overall. Imipenem and piperacillin–tazobactam were the most effective antibiotics against Gram-negative isolates, while vancomycin and linezolid showed 100% sensitivity against Gram-positive isolates.

The study highlights the importance of regular bacteriological surveillance, antimicrobial susceptibility testing, rational antibiotic use, and strict infection control measures for effective management of burn wound infections and prevention of antimicrobial resistance.

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