Retrospective Analysis of Bacterial Pathogens Isolated from Burn Wound infections in a Tertiary Care Hospital

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Abstract

Introduction and Objectives: Burn wound infections are a major complication in burn care, contributing to significant morbidity and mortality. Opportunistic and nosocomial pathogens, many exhibiting antimicrobial resistance, commonly colonize burn wounds, but findings have a regional variation. This study aims to analyse and identify predominant species, and assess temporal trends in microbial prevalence to inform evidence-based infection control and therapeutic strategies.

Material and Methods: This retrospective observational study was conducted from 1st February 2025 to 31st January 2026 at a tertiary care hospital. Data from 51 patients with positive wound swab cultures were reviewed for analysis of Bacterial pathogens isolated from burn wound infections by studying pathogen prevalence, antibiotic sensitivity patterns, and the association of particular pathogen type with clinical variables.

Results: Klebsiella spp. (species) was the most common isolate (68.6%), followed by Pseudomonas aeruginosa (29.4%), Acinetobacter spp. (23.5%) and Polymicrobial infections (25.4%). Klebsiella infections were associated with significantly longer hospital stays (mean 37.3 days vs 17.3 days, p=0.003). No significant associations were found between pathogens and burn mode, outcome, total body surface area (TBSA), or age. Antibiotic sensitivities highlighted reliance on levofloxacin, tigecycline, and piperacillin-tazobactam, with multidrug-resistant (MDR) Klebsiella noted in 9.8% cases.

Conclusion: These findings underscore the predominance of Gram-negative pathogens and the need for tailored antibiotic stewardship in burn units.

Keywords: Burn wound infections, bacterial pathogens, antibiotic resistance, Klebsiella, retrospective study.

Introduction

Burn injuries are among the most devastating forms of trauma, often resulting in significant morbidity, prolonged hospitalization, and mortality. Infection remains a leading cause of death in burn patients due to the disruption of the skin's protective barrier and immune suppression following trauma, creating an ideal environment for microbial colonization[1,2]. Opportunistic and nosocomial pathogens, many exhibiting antimicrobial resistance, commonly colonize burn wounds. Globally, Pseudomonas aeruginosa, Staphylococcus aureus (including MRSA), Acinetobacter spp., and Enterobacteriaceae are frequently isolated in burn units[3,4]. However, pathogen distribution and antibiotic susceptibility vary by institution and region.

Regular microbiological surveillance is critical to guide empirical treatment, inform antibiotic stewardship, and improve patient outcomes[5,6,7]. Retrospective studies provide valuable insights into local pathogen trends and resistance patterns[8,9,10]. This study aims to analyse bacterial pathogens isolated from burn wound infections in a tertiary care hospital, identify predominant species, and assess temporal trends in microbial prevalence to inform evidence-based infection control and therapeutic strategies thus ensuring that antibiotics are selected according to local antimicrobial sensitivity patterns to

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improve treatment efficacy and minimize resistance development. The antimicrobial sensitivity patterns show regional variations and our study aims to highlight the microbial patterns in surgical burn unit at our institute.

Materials and Methods

Study Design and Setting: This retrospective, observational study was conducted at the Burn Unit of a tertiary care teaching hospital. Study Period: Data were collected from records spanning a 12-month period from 1stFebruary 2025 to 31stJanuary 2026. Inclusion Criteria: included burn wound swab samples submitted for culture and sensitivity testing, positive cultures with identifiable bacterial growth, and patients of all ages and genders. Exclusion Criteria: included samples with no bacterial growth, contaminants, or fungal-only isolates, incomplete records.

Sample size: 51 patients admitted in the burn unit of our institute during the period of study who met the inclusion criteria were included. (Consecutive sampling strategy) Data Collection: Data were extracted from laboratory registers and electronic medical records, including patient demographics (age, sex), burn type, co morbidities, admission duration, management (operative or non-operative), bacterial isolates, antibiotic susceptibility patterns, and burn characteristics like percentage total body surface area (TBSA), and depth. Microbiological Processing: Samples were processed using standard microbiological procedures. Bacterial identification utilized conventional biochemical tests and/or automated systems (VITEK 2). Antimicrobial susceptibility testing (AST) was performed via the Kirby-Bauer disk diffusion method, interpreted per Clinical and Laboratory Standards Institute (CLSI) guidelines.

Statistical Analysis: All data was collected systematically and entered into Microsoft Excel. Analysis was conducted using SPSS version 24.0. Descriptive statistics summarized the frequency and percentage of isolated organisms. Prevalence of multidrug-resistant (MDR) strains, including MRSA (Methicillin resistant staphylococcus aureus), Extended spectrum beta lactamase (ESBL)-producing Enterobacteriaceae, and carbapenem-resistant organisms, was calculated. The results were presented in tables and charts. Statistical tests included: Chi-square tests for categorical associations, T-tests and one-way ANOVA for continuous variables, with post-hoc Bonferroni-corrected t-tests where applicable.

Ethical Considerations: Institutional Ethical Committee clearance was taken for the study. The committee approved after thoroughly reviewing the study purpose, methodology and potential risks and benefits to ensure that the research adhered to ethical standards and guidelines for human research. The approval was granted after confirming that the study would be conducted with the utmost consideration for participant safety, privacy and well-being, in accordance with established ethical principles and regulatory requirements. Parents and guardians of all the patients were thoroughly informed about the study objectives, methodology and potential risks and benefits in their native language. Written informed consent was obtained before inclusion in the study. The collected data were strictly used for research purposes. Patient identities and personal details were anonymised and safeguarded. No personal information was disclosed without prior explicit consent.

Results

Bacterial Prevalence:(as shown in Figure 1) Among 51 patients, Klebsiella spp. was the most prevalent pathogen, isolated in 35 patients (68.6%), followed by Pseudomonas aeruginosa (15 patients, 29.4%) and Acinetobacter spp. (12 patients, 23.5%). Polymicrobial infections were observed in 13 patients (25.5%). Table 1 summarize the demography, mode of burns, % TBSA involved, hospital stay and outcome.

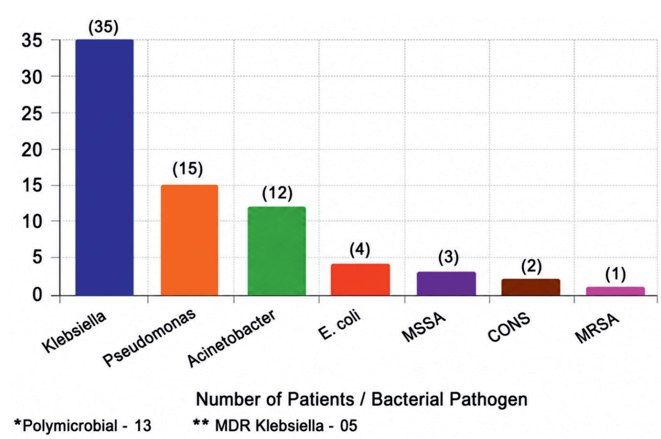

Figure 1: showing Prevalence of Bacterial Pathogens in Burn Wound Infections (E. coli - Escherichia coli, MSSA - Methicillin sensitive Staphylococcus aureus, CONS - Coagulase Negative Staphylococcus, MRSA - Methicillin Resistant Staphylococcus Aureus)

For Continuous Variables (as shown in Table number 1 & 2) one-way ANOVA compared age, TBSA, and admission duration across burn modes: Post-hoc tests showed scald patients were significantly younger than flame ($p = 0.0003$) and electric ($p = 0.0002$) patients. Flame burns had significantly higher TBSA than electric burns ($p = 0.01$). Flame burns resulted in significantly longer stays than scald burns ($p = 0.001$).

Table 1: Clinical characteristics by burn mode.

Characteristic	Scald (n = 20)	Flame (n = 17)	Electric (n= 14)
Average Age (years)	10.0	35.8	37.4
Average TBSA (%)	18	29	12
Average Hospital stay (days)	18.6	42.6	30.6
Discharged (%)	95 (19/20)	88.2 (15/17)	100 (14/14)
Mortality (%)	5 (1/20)	11.8 (2/17)	0 (0/14)

Table 2: Comparison of continuous variables across burn modes

Variable	F (df)	P value	Post-hoc findings
Age	11.42 (2, 48)	< 0.001	Scald patients were significantly younger than flame and electric patients
TBSA (%)	3.84 (2, 48)	0.028	Flame burns had significantly higher TBSA than electric burns (p = 0.01)
Hospital stay (days)	6.70 (2, 48)	0.003	Flame burns resulted in significantly longer stays than scald burns (p = 0.001).

For Categorical Variables (as shown in Table number 3) Chi-square tests assessed associations. No significant association between burn mode and outcome were seen (χ^2 (2) = 2.65, p = 0.27). For Polymicrobial Infections there was no significant differences seen (χ^2 (2) = 1.46, p = 0.48). There were no significant associations with burn mode for Klebsiella (χ^2 (2) = 1.34, p = 0.51), Pseudomonas (χ^2 (2) = 0.72, p = 0.69), or Acinetobacter (χ^2 (2) = 2.80, p = 0.25). Among antibiotic sensitivities Levofloxacin sensitivity trended higher in electric burns (χ^2 (2) = 5.38, p = 0.07).

Table 3: Association between burn mode and categorical variables

Variable	χ^2 (df)	p value	Interpretation
Outcome	2.65 (2)	0.266	Not significant
Polymicrobial infection	1.46 (2)	0.482	Not significant
Klebsiella prevalence	1.34 (2)	0.512	Not significant
Pseudomonas prevalence	0.72 (2)	0.699	Not significant
Acinetobacter prevalence	2.80 (2)	0.246	Not significant
Levofloxacin sensitivity	5.38 (2)	0.068	Trend toward significance

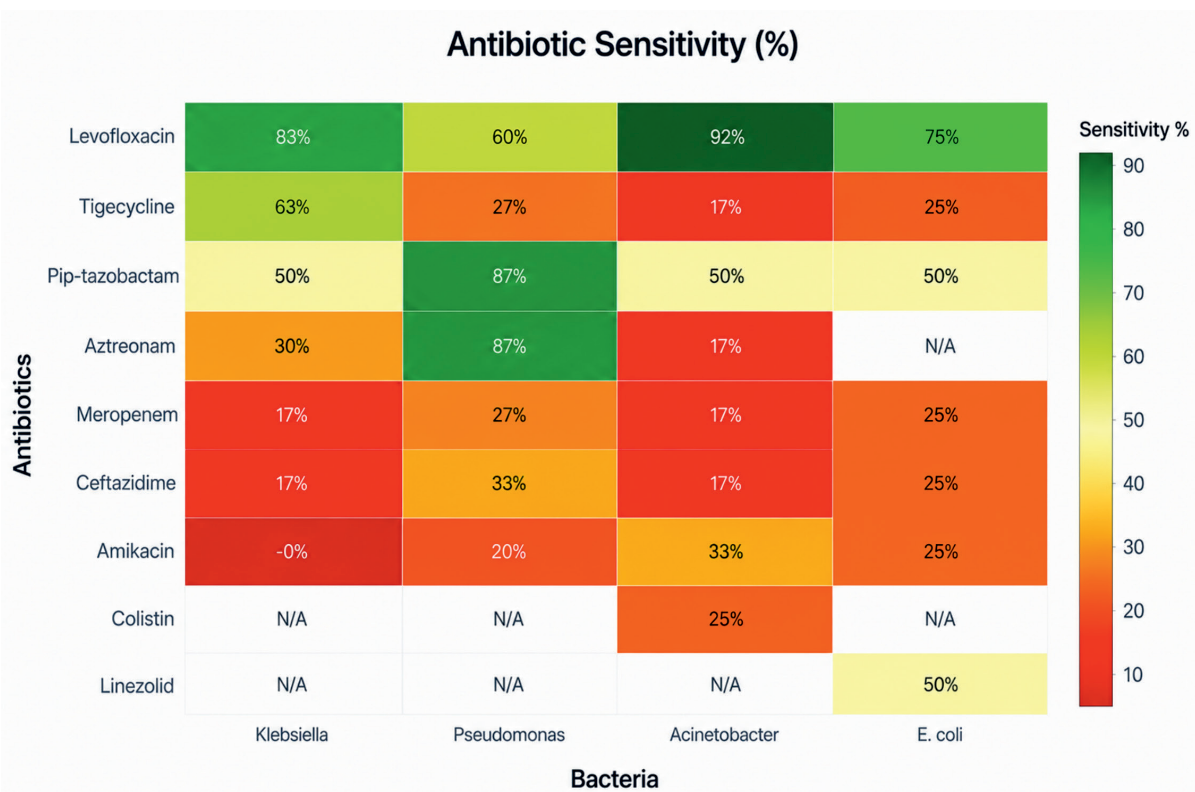

Figure 2 summarizes antibiotic sensitivities for the top bacteria.

Associations with Clinical Variables: T-tests examined differences in admission duration by bacterial presence with Klebsiella showing significantly longer admission duration (37.3 vs. 17.3 days, p = 0.003) and Acinetobacter showing marginally shorter admission duration (18.6 vs. 33.3 days, p = 0.06).

Table 4: Association of bacterial isolate with admission duration

Isolate	Mean Duration present (days)	Mean Duration absent (days)	p value
Klebsiella	37.31	17.32	0.003
Acinetobacter	18.58	33.33	0.060

Figure 3: 'A' series showing scalp burn in 60 years old male with diabetes sustained 9 % flame burns colonized by Acinetobacter sensitive to levofloxacin. A1 showing typical all 3 zones of healing. A2 showing infected wound. A3 showing wound post grafting. 'B' series showing facial and neck burn in 12 years old female sustained 15 % flame burns colonized by Pseudomonas sensitive to piperacillin-tazobactam. B1 showing wound at week 1. B2 showing wound week 3 and B3 showing wound post grafting.

Discussion

As the fourth most common type of trauma across the world, the World Health Organization (WHO) has estimated that approximately11 million burn patients require medical attention and result in 265,000 deaths each year[11]. With advancements in burn care over the last 50 years, infection is now the leading cause of death after extensive burn injuries. Multiple studies over the last decade have shown that 42%–65% of deaths in burn victims are attributable to infection[12,13,14,15]. In addition, burn patients with infections have more than twice the mortality rate of uninfected patients[16].

The various clinical challenges in treating burns include balancing the parameters that affect wound healing to reduce the duration of hospital stay, the chances of infection, the time to wound closure, and the overall functional recovery. The treatment of burn wounds has improved over years through dedicated research. Significant advancements have been made in patient care, including tracking wound healing, developing novel graft and coverage options, controlling inflammation, optimizing dietary needs, and testing unique pharmacological interventions. (Figure 3) and treatment decisions must be tailored to each patient's needs. Current and future research will continue to identify novel targets and treatment paradigms to further improve burn wound care[17].

Surface wound swabs and cultures may help identify the predominant pathogen and can be used as surveillance if there is any clinical concern about changes in the burn wound[18,19,20]. Diagnosis of burn wound infections can be complicated and requires comprehensive consideration. This study confirms the predominance of Gram-negative pathogens in burn wound infections, with Klebsiella spp. being the most prevalent, followed by Pseudomonas aeruginosa and Acinetobacter spp. (Figure1) This was found to be consistent with other studies.[1-3]Klebsiella dominated the cohort, consistent with global burn wound infection trends[21,22].The high prevalence of Klebsiella, potentially including ESBL-producing strains, suggests possible nosocomial transmission or environmental persistence, necessitating enhanced infection control measures[5,23].Pseudomonas and Acinetobacter, known for intrinsic resistance mechanisms, underscore the need for vigilant surveillance[4, 21].

The prevalence of multidrug-resistant (MDR) bacteria in burn units may lead to a vicious cycle of increasing antibiotic resistance by selecting antibiotics empirically that target MDR bacteria[22]. Longer hospital stays with Klebsiella infections (p = 0.003) in our study may reflect multidrug resistance challenges, noted in 9.8% of cases. Staphylococcus aureus is a serious public health concern and an important clinical pathogen that can cause a variety of infections in the skin and soft tissue, respiratory tract, bloodstream, and catheter[24,25]. S. aureus, particularly methicillin-resistant S. aureus(MRSA), remains a leading cause of gram-positive burn wound infections worldwide and has been one of the major contributors to increase the morbidity and mortality rates[26].The low prevalence of Gram-positive organisms, particularly MRSA (2.0%) in our study, may indicate effective infection control practices but warrants continued monitoring due to its virulence[3].Striking predominance of Klebsiella in our study compared to regional and international studies suggests a potential localized outbreak or microbial ecology shift, warranting strain typing and environmental surveillance as suggested in few other studies[23, 27]. Our study showed only 6 % of patients died during the study period. This finding is very low compared to studies done in Nigeria, which showed a 29.9 % death rate[28].It is comparable to study done earlier that showed mortality of 5.6 percent[29].The low mortality rate in our study can be explained by the reason that this study did not count the outcome of burns patients at the emergency department as the data was collected from the patients admitted in the burn unit.

Scalds patients were significantly younger than flame burn patients in our study which was found to consistent with the findings in other studies as children are more prone to injury by hot liquids because of their playful nature[28]. Flame burns had significantly higher TBSA than electric burns owing to the fact that flame burns involve the clothes worn by the patients. Flame burns resulted in significantly longer stays than other modes because of involving higher TBSA. (Table 1) There were no significant association found between burn mode and outcome in our study. (Table 3) A study done in Nigeria showed the majority of patients with electrical burns ended up with limb amputation, majorly contributing to functional loss. Various studies showed similar findings that electrical burns cause deeper burns, leading patients to more chronic complications, including functional loss, cosmetic disturbance, and prolonged hospital stay[28].

A study published in 2016 through National Burn Repository Report mentioned that seven out of ten most frequent complications in burn patients are attributed to polymicrobial burn wound infections (BWIs)[30]. Polymicrobial infections in our study accounted for 25.4% patients and may complicate treatment due to synergistic bacterial interactions[22].After a burn injury, the duration of hospitalization was found to be directly proportional to the types of bacterial species that infect the patients in a study, with the major contributor to infection being Staphylococcus aureus[31].But in our study the Klebsiella group showed longer hospital stay and Acinetobacter group had relatively shorter duration.

Antimicrobial resistance (AMR) has provoked a global health issue. Antimicrobial stewardship programs should be implemented to overcome this issue. Culture sensitivity reports help to rationalize the empirical use of antibiotics in clinical practice in addressing the challenge of antimicrobial resistance. This study showed that levofloxacin was the most effective antibiotics against Klebsiella, Acinetobacter and E. coli isolates. Pseudomonas was highly susceptible to piperacillin-tazobactam and aztreonam. Levofloxacin sensitivity trended higher in electric burns. (Figure 2) Updated antibiograms should be used by clinicians to evaluate bacterial susceptibility patterns and rationalize antibiotic empiric therapy. emphasizes the importance of evidence-based prescribing practices, ensuring that antibiotics are selected according to local antimicrobial sensitivity patterns to improve treatment efficacy and minimize resistance development. It stresses the necessity for strict adherence to antibiotic guidelines to prevent misuse and overuse, both of which contribute significantly to antibiotic resistance[8,9,10,32].

Conclusion

This study highlights the dominance of Klebsiella spp., followed by Pseudomonas aeruginosa and Acinetobacter spp., in burn wound infections at a tertiary care hospital in North India, with significant polymicrobial infections. The association of Klebsiella with longer hospital stays emphasizes the need for targeted antibiotic stewardship and infection control. Continued microbiological surveillance and further studies on resistance profiles and clinical outcomes are essential to optimize burn care management.

Recommendations: The small sample size (n=51) and few expired cases (n=3) limit statistical power for outcome analyses. The dataset reports only sensitivities, not resistance profiles, potentially overestimating resistance issues. Larger studies with complete antibiograms and minimum inhibitory concentration (MIC) values are needed for broader generalizability.

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