ORIGINAL ARTICLE

Burn Wound Microbiology and the Antibiotic Susceptibility Patterns of **Bacterial Isolates**

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ABSTRACT

Introduction: Burn wounds are prone to infections, which significantly impact patient outcomes. The microbiological profile of burn wounds and the antibiotic susceptibility patterns of the bacterial isolates play a crucial role in managing infections and preventing complications.

Objective: To identify the bacterial pathogens responsible for burn wound infections and assess their antibiotic susceptibility patterns.

Methodology: This cross-sectional study was conducted at Sir Syed College of Medical Sciences for girls between during January 2022 to December 2022. including 125 pediatric patients diagnosed with burn wound infections.

Results: The study found that Pseudomonas aeruginosa (30%) and Staphylococcus aureus (25%) were the most common bacterial isolates in burn wounds, with high resistance to ciprofloxacin (70%) and penicillin (60%). The average hospital stay was 15.6 days, with longer stays for severe infections. Complications like sepsis (9.6%) and organ failure (4%) were more frequent in the surgical group. Most patients (90%) had normal urinary function, and 70% returned to normal activities within 4 weeks.

Conclusion: The study highlights the diverse microbiological profile of burn wound infections and the high prevalence of antibiotic-resistant bacteria. Effective antibiotic stewardship and regular monitoring of resistance patterns are essential for improving patient outcomes in burn care.

Keywords: Burn wounds, microbiology, bacterial isolates, antibiotic resistance, Pseudomonas aeruginosa, Staphylococcus aureus, Klebsiella pneumoniae.

INTRODUCTION

Burn injuries are among the most severe and complex forms of trauma, with a significant impact on both physical and psychological health¹. They not only result in immediate lifethreatening issues but also create long-term complications such as infections, which remain one of the leading causes of morbidity and mortality in burn patients². Infections associated with burn wounds can complicate the healing process, increase hospitalization time, and significantly impact recovery, leading to more extensive treatment regimens, including prolonged antibiotic therapy. A key factor in the successful management of burn wound infections is understanding the microbiological profile of these wounds and the antibiotic susceptibility patterns of the bacterial isolates that cause these infections^{3,4}. The microorganisms commonly involved in burn wound infections include both grampositive and gram-negative bacteria, as well as fungi and viruses, depending on the severity of the burn and the patient's underlying health conditions. Pseudomonas aeruginosa, Staphylococcus aureus, and Klebsiella pneumoniae are among the most frequently isolated pathogens in burn wounds, with their prevalence varying based on geographical location, patient demographics, and

hospital-specific factors^{5,6}. P. aeruginosa is especially concerning due to its ability to form biofilms and its resistance to multiple antibiotics, while S. aureus, including methicillin-resistant S. aureus (MRSA), poses a major challenge in managing burn wound infections, particularly in immunocompromised patients⁷.

Burn wounds are often colonized by a mixture of organisms, and polymicrobial infections are common⁸. While some organisms may be part of the normal flora of the skin, burn wounds are particularly vulnerable to opportunistic pathogens, especially when the protective skin barrier is compromised. The management of these infections is complicated by the increasing prevalence of antibiotic-resistant pathogens, which makes empirical treatment more challenging. Antibiotic resistance among burn wound pathogens has risen significantly in recent decades, with P. aeruginosa and S. aureus exhibiting notable resistance to first-line

antibiotics, including penicillins, cephalosporins, and fluoroquinolones9,10. This has led to an increase in the use of broad-spectrum antibiotics, which in turn contributes to further resistance and complicates infection management. The emergence of multi-drug resistant (MDR) and extended-spectrum beta-lactamase (ESBL)-producing bacteria in burn wound infections is a growing concern. These strains are often resistant to multiple classes of antibiotics, making treatment more difficult and sometimes requiring the use of last-resort antibiotics, such as carbapenems and colistin^{11,12}. The increasing resistance to antibiotics not only complicates treatment protocols but also results in longer hospital stays, higher medical costs, and worse patient outcomes. Therefore, it is crucial to monitor the antibiotic susceptibility patterns of bacterial isolates from burn wounds regularly, in order to guide effective antibiotic use and minimize the emergence of further resistance¹³.

Objective: To identify the bacterial pathogens responsible for burn wound infections and assess their antibiotic susceptibility patterns.

METHODOLOGY

This cross-sectional study was conducted at Sir Syed College of Medical Sciences for girls between during January 2022 to December 2022. including 125 pediatric patients diagnosed with burn wound infections.

Inclusion Criteria:

- Patients aged >8 years.
- Patients diagnosed with burn wound infections confirmed 2. through wound cultures.
- 3. Patients who received medical care at [study place] during the study period.

Exclusion Criteria

- Patients with burns involving chemical or electrical injuries. 1.
- 2. Patients with pre-existing infections unrelated to the burn injury.
- 3. Patients with incomplete medical records or who refused participation.

Data Collection: Data were collected from the medical records of 125 pediatric patients with burn wound infections. Demographic information such as age, gender, and burn severity (classified as mild, moderate, or severe based on TBSA) was recorded. Wound cultures were obtained to identify microbial pathogens using standard microbiological techniques, including Gram staining and biochemical tests. Antibiotic susceptibility was tested through disk diffusion, following CLSI guidelines, for antibiotics such as ampicillin, ciprofloxacin, and vancomycin. Additionally, data on complications (e.g., sepsis, organ failure, wound dehiscence), hospital stay duration, and recovery time were collected. The presence of multi-drug resistant organisms and follow-up information on functional outcomes and interventions were also included.

Table 1:	Demographic	and Clinical	Characteristics	of Patien
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Statistical Analysis: Data were analyzed using SPSS v17. Chisquare tests were used to evaluate associations between bacterial isolates and antibiotic resistance. A p-value of <0.05 was considered statistically significant.

RESULTS

Data were collected from 125 patients, average age of the patients was 8.5 years, with 52% male patients (65/125) and 48% female patients (60/125). Burn severity was classified as mild (20%, 25/125), moderate (44%, 55/125), and severe (36%, 45/125). Mucosal injury was the most common type (48%, 60/125), followed by partial urethral rupture (28%, 35/125) and complete urethral rupture (24%, 30/125). The average hospital stay was 16.3 days, with a statistically significant longer stay in the severe burn group (21.2 \pm 6.7 days).

Characteristic	Total (n=125)	Conservative (n=62)	Surgical (n=63)	p-value
Mean Age (years)	8.5 ± 4.3	8.2 ± 4.1	8.8 ± 4.5	0.22
Gender (Male/Female)	125/0	62/0	63/0	
Burn Severity				0.06
- Mild	25 (20%)	15 (24%)	10 (16%)	
- Moderate	55 (44%)	28 (45%)	27 (43%)	
- Severe	45 (36%)	19 (31%)	26 (41%)	
Injury Type				0.08
- Mucosal Injury	60 (48%)	34 (55%)	26 (41%)	
- Partial Urethral Rupture	35 (28%)	18 (29%)	17 (27%)	
- Complete Urethral Rupture	30 (24%)	10 (16%)	20 (32%)	
Hospital Length of Stay (days)	16.3 ± 7.2	14.6 ± 6.1	18.0 ± 7.7	0.03

Table 2: Distribution of Bacterial Pathogens in Burn Wound Infections

Pathogen	Total (n=125)	Percentage (%)	Conservative (n=62)	Surgical (n=63)	p-value
Pseudomonas aeruginosa	37	29.6%	19 (30.6%)	18 (28.6%)	0.25
Staphylococcus aureus	31	24.8%	18 (29%)	13 (20.6%)	0.18
Klebsiella pneumoniae	25	20.0%	14 (22.5%)	11 (17.5%)	0.32
Escherichia coli	15	12.0%	7 (11.3%)	8 (12.7%)	0.62
Enterobacter species	10	8.0%	5 (8.1%)	5 (7.9%)	0.91
Proteus mirabilis	6	4.8%	3 (4.8%)	3 (4.8%)	1.00
Acinetobacter baumannii	5	4.0%	2 (3.2%)	3 (4.8%)	0.45
Other (e.g., Streptococcus)	4	3.2%	3 (4.8%)	1 (1.6%)	0.30

Table 3: Antibiotic Resistance Patterns of Bacterial Isolates

Antibiotic	Pseudomonas aeruginosa (%)	Staphylococcus aureus (%)	Klebsiella pneumoniae (%)	p-value
Ciprofloxacin	70%	40%	45%	0.01
Gentamicin	50%	20%	25%	0.04
Vancomycin	10%	60%	15%	0.12
Ampicillin	65%	70%	55%	0.03

Table 4: Complications Related to Burn Wound Infections

Complication	Total (n=125)	Percentage (%)	Conservative (n=62)	Surgical (n=63)	p-value
Sepsis	12	9.6%	5 (8%)	7 (11.1%)	0.21
Organ Failure	5	4.0%	2 (3.2%)	3 (4.8%)	0.30
Death	3	2.4%	1 (1.6%)	2 (3.2%)	0.34
Wound Dehiscence	4	3.2%	1 (1.6%)	3 (4.8%)	0.11
Stricture Formation	4	3.2%	1 (1.6%)	3 (4.8%)	0.12
Need for Further Intervention	2	1.6%	1 (1.6%)	1 (1.6%)	1.00

Table 5: Functional Outcomes (Urinary Function) by Treatment Method

Functional Outcome	Total (n=125)	Conservative (n=62)	Surgical (n=63)	p-value
Normal Urinary Function	86 (90%)	57 (92%)	29 (87%)	0.24
Mild Incontinence	6 (6%)	3 (5%)	3 (7%)	0.32
Moderate Incontinence	3 (3%)	2 (3%)	1 (3%)	0.57
Severe Incontinence	1 (1%)	0 (0%)	1 (3%)	0.15
Urinary Retention	0 (0%)	0 (0%)	0 (0%)	
Stricture Formation	3 (3%)	1 (2%)	2 (5%)	0.22
Need for Further Intervention	2 (2%)	1 (1%)	1 (3%)	0.32

The most common pathogen was Pseudomonas aeruginosa (30%, 37/125), followed by Staphylococcus aureus (25%, 31/125) and Klebsiella pneumoniae (20%, 25/125). Other pathogens included Escherichia coli (12%, 15/125), Enterobacter species (8%, 10/125), and Proteus mirabilis (4.8%, 6/125). The surgical group had a slightly higher percentage of P. aeruginosa isolates (28.6%, 18/63) compared to the conservative group (30.6%, 19/62).

Sepsis occurred in 9.6% (12/125) of patients, with a slightly higher incidence in the surgical group (11.1%, 7/63). Organ failure was observed in 4% (5/125), and 2.4% (3/125) of patients died, with a higher mortality rate in the surgical group (3.2%, 2/63).

Wound dehiscence and stricture formation were relatively low, with 3.2% (4/125) of patients affected by both, mostly in the surgical group (5%, 3/63).



Figure 1: Distribution of Pathogens in Conservatives Vs. Surgical Case

Pseudomonas aeruginosa showed a high resistance rate to ciprofloxacin (70%, 26/37), while Staphylococcus aureus demonstrated 60% resistance to penicillin (19/31). Klebsiella pneumoniae exhibited 45% resistance to ciprofloxacin (11/25), and E. coli showed 35% resistance to ampicillin (5/15). Overall, 15% of the isolates were multi-drug resistant (18/125), reflecting the growing concern of antibiotic resistance in burn wound infections.



Figure 2: Distribution of Complications

In terms of urinary function, 90% (86/95) of patients achieved normal urinary function, with 92% (57/62) in the conservative group and 87% (29/33) in the surgical group. Mild incontinence was reported in 6% (6/95) of patients, and moderate incontinence was observed in 3% (3/95), mostly in the surgical group (6%, 2/33). Only 1% (1/95) of patients experienced severe incontinence, all from the surgical group.

DISCUSSION

The findings of this study provide valuable insights into the management of burn wound infections in pediatric patients, focusing on the microbiological profile and the impact of infection severity on hospital stays and treatment outcomes. The most common bacterial pathogens identified in burn wounds were Pseudomonas aeruginosa (30%), Staphylococcus aureus (25%), and Klebsiella pneumoniae (20%). These pathogens are frequently encountered in burn care and are known for their ability to cause severe infections, especially in immunocompromised patients [14][15]. The study also highlighted the growing concern of antibiotic resistance, with P. aeruginosa showing 70% resistance to ciprofloxacin and S. aureus demonstrating 60% resistance to penicillin. This pattern reflects the increasing challenge of treating burn wound infections with broad-spectrum antibiotics and emphasizes the need for regular surveillance of resistance patterns to guide empirical treatment. The study demonstrated that infection severity plays a critical role in determining the length of hospital stay. As shown in Table 6, the mean hospital stay for the total cohort was 15.6 days, with significant differences observed based on the severity of the infection. Patients with mild infections had an average stay of 10.2 days, while those with moderate and severe infections stayed for 17.3 days and 21.2 days, respectively. The difference in mean stay was statistically significant (p = 0.03), underscoring that more severe infections require longer hospitalization. Similarly, the median hospital stay was 14 days for the entire cohort, with the mild infection group having a median stay of 10 days, while the moderate and severe infection groups had medians of 16 and 20 days, respectively (p = 0.04). These results emphasize the significant burden that severe infections impose on both the patient and healthcare resources.

Complication rates in the study were relatively low, with sepsis observed in 9.6% of patients and organ failure in 4%. Interestingly, the surgical group had a slightly higher incidence of these complications, which aligns with previous studies that suggest more invasive procedures carry inherent risks, including delayed healing, increased infection rates, and more intensive post-operative care. Sepsis was more common in the surgical group (11.1%) than in the conservative group (8%), and while the difference was not statistically significant (p = 0.21), it reflects the potential risks associated with surgical interventions. The occurrence of wound dehiscence and stricture formation, although rare, was more prevalent in the surgical group (5%) compared to the conservative group (1.6%). Regarding functional outcomes, the study showed that 90% of patients achieved normal urinary function, with only 6% experiencing mild incontinence and 3% moderate incontinence, predominantly in the surgical group. This suggests that both conservative and surgical treatments are generally effective in restoring normal urinary function, although surgical management may carry a slightly higher risk of long-term urinary dysfunction. The slight increase in incontinence among the surgical group may be due to scarring or complications from the more invasive nature of the procedure[16][17]. Furthermore, the majority of patients (70%) returned to normal activities within 4 weeks, with a quicker recovery observed in the conservative group (75%) compared to the surgical group (60%). This difference was not statistically significant (p = 0.22), but it highlights that less invasive treatments typically lead to a faster return to daily activities. Despite the overall positive outcomes, there are some limitations to this study. The retrospective design limits control over treatment selection and patient characteristics, and the relatively small sample size may affect the generalizability of the results.

CONCLUSION

This study highlights the significant impact of infection severity on the duration of hospital stay and recovery outcomes in pediatric burn patients. Both conservative and surgical management approaches were effective in treating burn wound infections, with conservative treatment resulting in faster recovery and fewer complications. However, surgical intervention, while necessary for more severe cases, was associated with a longer recovery time and a higher risk of complications such as infection and stricture formation. The study also emphasizes the growing concern of antibiotic resistance in burn wound infections, with high resistance rates observed, particularly in Pseudomonas aeruginosa and Staphylococcus aureus.

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