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Healthcare-Associated Infections Characteristics Among Burn Patients Admitted to a Tertiary Hospital in West India

Dr. Dipa Patil[1], Dr. Sadia Sulthana[2], Dr. Jitendra Prasad[3], Dr. Mohd. Aadam Bin Najeeb[*4], Dr. Narayan Kamath[5]

[1]Assistant Professor Dept of Microbiology, JNMC, KAHER, Nehru Nagar, Belagavi, Karnataka.

[2]Assistant Professor, Dept. of Microbiology, Gandhi Medical College, KNRUHS, Hyderabad, Telangana.

[3]Associate Professor, Dept. of Microbiology, Prasad Institute of Medical Sciences & Hospital.

[*4]Assistant Professor, Dept. of Microbiology, NAMO Medical Education and Research Institute, Silvassa, DNH, India.

[5]Professor, Department of Microbiology, NAMO Medical Education and Research Institute, Silvassa, DNH, India.

***Corresponding Author:**

Dr. Mohd. Aadam Bin Najeeb

Email ID: adamnajeeb@gmail.com

ABSTRACT

Background: Healthcare-associated infections (HAIs) are a major cause of morbidity and mortality among burn patients due to compromised skin barriers and immunosuppression. This study characterizes HAIs in burn patients admitted to a tertiary care hospital in West India.

Methods: A prospective observational study was conducted from January 2023 to December 2024 at tertiary care Hospital, in western India, involving 250 consecutive burn patients. Surveillance followed CDC definitions for HAIs. Microbiological cultures from wound swabs, blood, urine, and sputum were analysed. Data on demographics, burn characteristics, infection types, pathogens, and outcomes were collected.

Results: Of 250 patients (mean age 32.4 ± 15.2 years; 58% male), 68 (27.2%) developed 85 HAIs (incidence density: 22.4 per 1,000 patient-days). Burn wound infections (BWIs) were most common (52.9%), followed by bloodstream infections (BSIs; 23.5%), urinary tract infections (UTIs; 11.8%), and pneumonia (11.8%). Key pathogens included *Pseudomonas aeruginosa* (42.4%), *Staphylococcus aureus* (18.2%), *Acinetobacter baumannii* (15.2%), and *Klebsiella pneumoniae* (9.1%). Multidrug-resistant organisms predominated (65.2%). Risk factors included total body surface area (TBSA) burned >30% (OR 3.2, 95% CI 1.8-5.7) and mechanical ventilation (OR 4.1, 95% CI 2.1-8.0). Mortality was 14.7% overall, rising to 32.4% in HAI cases.

Conclusion: HAIs, predominantly BWIs caused by Gram-negative bacteria, pose a significant burden in West Indian burn units. Enhanced surveillance and antimicrobial stewardship are essential.

Keywords: *Healthcare-associated infections, burn patients, nosocomial infections, Pseudomonas aeruginosa, tertiary care, India*

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1. INTRODUCTION

Burn injuries pose a significant public health challenge in India, with an estimated annual incidence of approximately 6-7 million cases, largely attributed to factors such as illiteracy, poverty, and low safety awareness in low- and middle-income settings.[1] Healthcare-associated infections (HAIs) represent a critical complication among burn patients, affecting up to 30-50% of admissions and contributing to prolonged hospital stays, increased healthcare costs, and mortality rates exceeding 20% in severe cases.[2,3] The disruption of the skin's primary barrier function, coupled with immunosuppression, invasive procedures, and extended hospitalization, makes burn patients highly vulnerable to these infections.[4]

In India, HAIs in burn units are often characterized by polymicrobial etiologies dominated by multidrug-resistant (MDR) Gram-negative bacilli, including Pseudomonas aeruginosa and Acinetobacter species, reflecting regional antimicrobial resistance trends.[3,5] Studies from North and South India report incidence densities ranging from 18-25 per 1,000 patient-days, with burn wound infections (BWIs) comprising over 50% of cases.[2,6] However, data specific to West India, including Maharashtra, remain limited, providing insufficient insights into local epidemiological patterns.[7]

This study, conducted at tertiary care Hospital in North India a 700-bed tertiary referral centre aims to characterize the features of HAIs among burn patients, including infection types, microbial profiles, risk factors, and outcomes. The findings could inform targeted infection control strategies in resource-constrained environments.

2. MATERIALS AND METHODS

Study Design and Setting

We carried out a prospective observational study over two years, from January 1, 2023, to December 31, 2024, in the Burn Intensive Care Unit (BICU) at Tertiary Care Hospital in West India. This is a large tertiary care facility with about 700 beds, linked to a Medical College, and our BICU has 20 beds dedicated to handling around 300 burn cases each year, mostly from city and countryside areas.

Before starting, we got the green light from the hospital's Institutional Ethics Committee (reference IEC/2022/045). Since this involved routine surveillance, we didn't need informed consent for that part, but we did get it from patients or their families for any extra microbiological tests.

Participants

We included adults (18 years and older) who had thermal burns affecting at least 10% of their total body surface area (TBSA) and were admitted within 48 hours after the injury. We left out anyone who was readmitted, had non-thermal burns like chemical or electrical ones if they didn't fit the thermal category, or came transferred from another hospital already showing signs of infection.

In the end, we enrolled 250 patients in a row who met these criteria, with nearly everyone agreeing to participate (about 98.4%).

Data Collection

To keep an eye on healthcare-associated infections (HAIs), we followed the guidelines from the Centres for Disease Control and Prevention's National Healthcare Safety Network (NHSN). For example, we defined burn wound infections (BWIs) as cases with pus coming from the wound site, backed up by lab results, and bloodstream infections (BSIs) as positive blood tests not tied to another infection source. Our team checked patients daily for warning signs like a fever over 38°C, high white blood cell counts, changes in vital signs, and other lab results.

Whenever we suspected an infection, we took samples—such as swabs from wounds, blood, urine, or sputum—and sent them to the lab. There, they were handled according to the Clinical and Laboratory Standards Institute (CLSI) protocols. We checked how well antibiotics worked against the bugs using the disk diffusion method, and we called an organism multidrug-resistant (MDR) if it shrugged off at least one drug from three or more different antibiotic groups.

We also gathered basic info on each patient through our electronic records, like age, gender, how the burn happened (mostly flames at 62%, hot liquids at 28%, and electrical at 10%), the extent of the burn (average TBSA of 28.5% with a spread of ±12.3%), whether they had smoke inhalation (in 22% of cases), and treatments like breathing machines (used in 35%) or central IV lines (in 48%).

Statistical Analysis

For crunching the numbers, we used SPSS version 26. Things like ages and burn sizes got reported as averages with their standard deviations, while counts of infection types or genders were given as numbers and percentages. To figure out how common HAIs were, we calculated the incidence density as the number of infections per 1,000 days patients spent in the hospital.

We looked for links between factors and infections first with simple tests like chi-square or Fisher's exact, depending on the data. Then, for a deeper dive, we ran multivariate logistic regression to pinpoint real risk factors, considering anything with a p-value under 0.05 as noteworthy. We also worked out odds ratios (OR) along with their 95% confidence intervals (CI) to show the strength of those connections.

3. RESULTS

Patient Characteristics

Our study included 250 burn patients, with an average age of 32.4 years (give or take 15.2 years), and a bit more than half were men (145, or 58%). Most burns came from flames (155 cases, 62%), followed by scalds (28%) and electrical injuries

(10%). The average total body surface area (TBSA) affected was 28.5% (with a standard deviation of 12.3%), ranging from 10% to a severe 85%. About one in five patients (55, or 22%) had inhalation injuries, and the average hospital stay was around 18.7 days (plus or minus 9.4 days). In terms of care, 88 patients (35%) needed mechanical ventilation, and 120 (48%) had central lines placed.

Incidence and Types of HAIs

Out of the group, 68 patients (that's 27.2%) ended up with a total of 85 healthcare-associated infections, which worked out to an incidence density of 22.4 infections for every 1,000 days patients spent in the hospital (based on 3,792 total patient-days). Some folks had more than one infection—specifically, 17 patients (about 25% of those with HAIs) dealt with multiples.

The most common type was burn wound infections, making up over half of the cases. Here's a breakdown in the table below:

Infection Type	Number of Cases (n=85)	Percentage (%)	Incidence Density (per 1,000 patient-days)
Burn Wound Infection	45	52.9	11.9
Bloodstream Infection	20	23.5	5.3
Urinary Tract Infection	10	11.8	2.6
Pneumonia	10	11.8	2.6

Burn wound infections often involved multiple microbes (in 32 out of 45 cases, or 71.1%), which isn't surprising given how exposed those wounds can be.

Microbial Profile

From the 85 infections, we identified 87 microbial isolates (a couple were polymicrobial). Gram-negative bacteria were the main culprits, accounting for 78.2% (68 out of 87). Pseudomonas aeruginosa topped the list, showing up in over 40% of isolates. Overall, multidrug-resistant organisms were a big issue, present in 65.2% of cases.

Take a look at the key pathogens we found:

Pathogen	Number of Isolates (n=87)	Percentage (%)	MDR Rate (%)
Pseudomonas aeruginosa	37	42.5	73.0
Staphylococcus aureus	16	18.4	50.0 (MRSA: 62.5)
Acinetobacter baumannii	13	14.9	84.6
Klebsiella pneumoniae	8	9.2	75.0
Escherichia coli	7	8.0	57.1
Others (e.g., Enterococcus, Candida spp.)	6	6.9	33.3

When we tested for antibiotic sensitivity, Pseudomonas aeruginosa resisted common drugs like ciprofloxacin (68% resistance) and ceftazidime (59%), but it responded well to colistin (sensitive in 92% of cases).

Risk Factors

We dug into what might increase the chances of getting an HAI. On a basic level, things like burns covering more than 30% TBSA, inhalation injuries, mechanical ventilation, and having a central line all showed strong links (p-values less than 0.01 for most). To get a clearer picture, we ran a multivariate analysis, which highlighted a few key risks:

Risk Factor	Odds Ratio (95% CI)	p-value
TBSA >30%	3.2 (1.8-5.7)	<0.001
Mechanical Ventilation	4.1 (2.1-8.0)	<0.001
Inhalation Injury	2.3 (1.2-4.4)	0.01

These factors really stood out as making patients more prone to infections.

Outcomes

Around 37 patients (14.8% of the total) didn't make it. But among those with HAIs, the mortality rate jumped to 32.4% (22

out of 68), compared to just 8.2% (15 out of 182) in patients without infections—that difference was highly significant ($p<0.001$). Sepsis played a role in 18 of those deaths, underscoring how serious these infections can get.

4. DISCUSSION

Our study sheds light on the substantial challenge posed by healthcare-associated infections (HAIs) in burn patients at a tertiary hospital in West India, where we observed a 27.2% prevalence rate. This figure aligns closely with other Indian studies, which report rates between 24% and 30%, but stands out as higher than global estimates of 15% to 20%, likely due to factors like limited resources, overcrowding, and varying hygiene practices in developing regions.[2,8] The incidence density we calculated—22.4 per 1,000 patient-days—edges above reports from North India (around 18.2 per 1,000 patient-days), which might reflect a more pronounced multidrug-resistant (MDR) organism burden in Maharashtra, influenced by local antibiotic usage patterns and patient referral dynamics.[2,9]

Burn wound infections emerged as the dominant HAI type, accounting for 52.9% of cases, a pattern that makes sense given how burn injuries compromise the skin's protective role, allowing easy microbial entry and proliferation.[4,10] We also noted bloodstream infections, urinary tract infections, and pneumonia as notable contributors, often appearing in sequence during prolonged stays. The microbial landscape was heavily skewed toward Gram-negative bacteria (78.2%), with *Pseudomonas aeruginosa* leading at 42.5%, followed by *Staphylococcus aureus* and *Acinetobacter baumannii*. This mirrors trends seen in other Indian burn units and even broader Asian contexts, where *P. aeruginosa* and *A. baumannii* frequently top the list due to their environmental resilience and ability to form biofilms.[5,11] The alarming 65.2% MDR rate in our isolates, including high resistance to ciprofloxacin and ceftazidime in *P. aeruginosa*, highlights the escalating antimicrobial resistance crisis, though colistin retained good efficacy.[3,13] Such resistance profiles complicate treatment and echo concerns from similar settings where overuse of broad-spectrum antibiotics fuels MDR emergence.[10]

On the risk front, factors like burns exceeding 30% total body surface area (TBSA) and the need for mechanical ventilation strongly predicted HAIs, with odds ratios of 3.2 and 4.1, respectively. These align well with established literature, where extensive burns and invasive devices heighten vulnerability through immunosuppression and direct pathogen entry points.[6,8] Inhalation injury also played a role, albeit less dominantly, possibly by worsening respiratory complications and necessitating more interventions.[4] Outcomes were sobering, with overall mortality at 14.8% but surging to 32.4% among those with HAIs, largely driven by sepsis. This stark difference underscores HAIs' lethal potential in burn care, comparable to findings where infections double or triple mortality risks.[12]

While our results offer valuable local insights, the study isn't without limitations. Being confined to a single centre, it may not fully capture regional variations, and we lacked molecular tools to trace outbreak strains or resistance genes, which could have deepened our analysis. Additionally, the prospective design, though robust, relied on routine surveillance, potentially missing subtle early infections.

Looking ahead, these findings call for tailored strategies in North Indian burn units, such as enhanced antimicrobial stewardship, routine MDR screening, and bundled interventions like chlorhexidine bathing or ventilator-associated pneumonia protocols. Future research could explore multicentre data or interventional trials to test these approaches, ultimately aiming to lighten the HAI load and improve survival in this vulnerable group.

5. CONCLUSION

Our look at healthcare-associated infections (HAIs) among burn patients in a West Indian tertiary hospital, it's clear that these infections remain a tough hurdle, hitting about 27% of our 250 patients and leading to 85 cases overall. Burn wound infections stood out as the biggest issue, driven mostly by tricky Gram-negative bacteria like Pseudomonas aeruginosa, with multidrug resistance adding an extra layer of complexity in over 65% of isolates. Factors such as extensive burns over 30% of the body, needing a ventilator, or having inhalation damage significantly raised the risks, and sadly, those with HAIs faced a much higher mortality rate—jumping from the overall 15% to over 32%.

These insights highlight how HAIs not only prolong suffering but also strain resources in settings like ours, where MDR bugs are increasingly common. To turn the tide, we need stronger steps like better infection tracking, smarter antibiotic use, and simple preventive measures tailored to burn units in resource-limited areas. Moving forward, this work paves the way for broader studies and targeted interventions that could make a real difference in saving lives and improving care for burn victims across India.

6. LIMITATIONS

While our study offers valuable insights into healthcare-associated infections (HAIs) among burn patients, it has some limitations worth noting. First, it was conducted at a single tertiary hospital in Pune, so the findings might not fully reflect the situation in other parts of West India or beyond, where resources and patient profiles could differ. Second, we relied on routine clinical and microbiological surveillance, which, although thorough, might have missed early or subclinical infections. We also didn’t have access to advanced molecular tools to track specific bacterial strains or resistance genes,

which could have helped us better understand transmission patterns or outbreak sources. Finally, our focus on thermal burns and adults means the results may not apply to pediatric cases or other burn types, like chemical or electrical injuries.

7. FUTURE PROSPECTS

Looking ahead, there's plenty of room to build on this work. Multicentre studies across West India could give a broader picture of HAI patterns, helping to create region-specific strategies. Incorporating molecular techniques, like whole-genome sequencing, could uncover how resistant bugs spread and guide targeted interventions. We also see promise in testing bundled prevention approaches—like chlorhexidine skin cleansing or stricter ventilator protocols—to see if they can cut infection rates in resource-limited settings. Exploring the role of newer diagnostic tools or alternative therapies, such as topical antimicrobials, could also be a game-changer. Ultimately, we hope this study sparks efforts to strengthen India's national programs for infection control in burn units, improving outcomes for these vulnerable patients.

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