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ORIGINAL ARTICLE

Bacteriological Profiling of Burn Wound Infections at the National Burn Care Centre of Pakistan

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Abstract

Objective: Burn wound infection is the second most important cause of death in burn patients. The current study goal was to assess the prevalence of burn wound infection including burn types and burn-related infections, in the national burn care centre of Pakistan.

Methodology: This was a prospective investigation of all burn patients (n=371) admitted to the National Burn Care Centre, Shaheed Zulfiqar Ali Bhutto Medical University, Pakistan Institute of Medical Sciences, Islamabad, Pakistan, between November 2021 to April 2022. Patients with less than 24 hours of hospital stay and those with incomplete records were excluded (n=23). Analysis was performed using a data-collection sheet to record demographic, microbiological, and burn data. No randomization was necessary as all patients were included. Results were deemed significant when the p-value was < 0.05.

Results: In total, 348 burn patients were included. The mean age was 17.81 years. The common burns were scald burns in the paediatric age group while in the adult age group, flame burns were the most common. The mean total burned body surface area (TBSA) was 48.64%, while the mean length of stay in the hospital was 21.4 days for swab culture-positive patients while 13.6 for remaining individuals. The most common isolated organism was *Pseudomonas aeruginosa* (68.60%), followed by Klebsiella *pneumoniae (32.55%), and Methicillin-resistant Staphylococcus aureus* (16.27%).

Conclusion: Our burn patients were most commonly infected with P. aeruginosa. Surveillance and management of these microorganisms must be instigated to reduce the rate of morbidity and mortality of burn patients with infections.

Keywords: Burn, Infection, Wound.

Cite this article: Rehan M, Iqbal T, Ghaffar N, Komal N, Khan MS, Sarwar M, Tariq MH, Waheed U. Bacteriological Profiling of Burn Wound Infections at the National Burn Care Centre of Pakistan. BMC J Med Sci. 2023. 4(1): 43-48.

Introduction

Burn injury is a common cause of morbidity and mortality in Pakistan. The immune system is adversely affected as a result of burn injury predisposing patients to infection.[1] The most palpable effect is the damage to the skin, the natural barrier that is replaced by a protein-rich, vascular environment providing a favourable niche for microbial growth. These infections in burn patients are the main cause of morbidity and mortality.[2,3]A variety of factors escalate the possibility of developing burn wound infection such as the type of the burn, a lengthy stay in the burn unit, catheter use and other invasive devices and immune compromising effects of burn injury.[4,5]

Heggers et al., remarked that burn wounds become infected because of the immunosuppressed condition of the patient and the wound environment, which are perfect for the proliferation of infecting microorganisms.[6] With progress in the care of burn injuries over the last few decades, burn wound infection is at present the leading cause of mortality after severe burn injuries. Numerous studies during the last 10-15 years indicate that 42%-65% of deaths in burn patients are attributed to bacterial infection.[7] Besides, burn injury patients with infections have more than twice the mortality rate when compared with non-infected patients.[8]

Authorship Contribution: [1-7]Substantial contributions to the conception or design of the work; or the acquisition, data analysis, drafting the work or revising it critically for important intellectual content, [2,8]Final approval of the version to be published & supervision

Funding Source: none
Conflict of Interest: none

Received: Oct 22, 2022
Accepted: Feb 28 , 2023

The obstacle faced by clinicians in the treatment of these burn wound infections is the resistance to antimicrobial therapy. Prevalent pathogenic microorganisms identified from burn patients who had wound infections, include *Pseudomonas aeruginosa, Acinetobacter baumannii, Staphylococcus aureus, Klebsiella pneumoniae* and various coliform bacilli.[9] A systematic review of burn wound infections revealed that Gram-negative microbes are the commonest microorganisms in burn wounds, and largely *Pseudomonas aeruginosa* is the most prevalent organism.[10] It is pertinent to mention that the prevalence of burn wound infections changes with time and is also influenced by geography. It is vital to be mindful of the flora and susceptibility of microorganisms in every burn care unit to be proficient in treating burn wound infections successfully.

There are a limited number of studies performed to study the epidemiological pattern of burn wound infections in Pakistan highlighting the fact that this area remains understudied. The primary objective of the current study was to isolate and identify the bacteria recovered from patients with severe burn injuries.

Material and Methods

This was a single-centre, cross-sectional study conducted at the National Burn Care Centre (BCC), Pakistan Institute of Medical Sciences (PIMS), Islamabad, Pakistan. The burn care centre is the leading unit in Pakistan in terms of capacity. It consists of 20 beds and has an average ICU admission rate of 600-700 patients per annum.

Patients from the north of the country, including Azad Jammu and Kashmir state, Gilgit-Baltistan province, Khyber Pakhtunkhwa province, and Punjab province (northern part), visit the hospital. The BCC acts as the Department of Burn and Reconstructive Surgery for post-graduate training affiliated with the Shaheed Zulfiqar Ali Bhutto Medical University, Islamabad.

All patients who present with burns at the PIMS are referred to the BCC, where an expert staff begins immediate burn management and collects epidemiological data using HMIS (hospital management information system).

The BCC features four functional units, including two cutting-edge, fully functional operating rooms, an intensive care unit with an adjacent bathroom that has air-fluidized beds, low air loss mattresses, water therapy rooms, a general ward, and emergency services available around the clock. Each patient has a private room with specialized monitoring technology for the burn unit. 20 beds are available, with 12 in the intensive care unit and 8 in the regular ward. The BCC carries out flap reconstruction, split-thickness skin grafting, and full-thickness skin grafting.

Ethical approval was granted by the ethical review board of the home institution. The research study was carried out between November 2021 and April 2022. We included all acute burn patients (n=371), regardless of age or gender, with or without blood or wound cultures, hospitalized during the time frame mentioned above. To avoid affecting the microorganism profile, all patients with persistent burn wounds and those admitted from other hospitals were not included. A total of 23 individuals were excluded including those with hospital stays of less than 24 hours and incomplete information, giving a sample size of 348. Patients 14 years of age or under were considered to be in the paediatric age category. The diagnosis of burn wound infection was made using clinical symptoms and routinely taken surface swabs twice a week for microbiologic surveillance. From the time of admission until the time of release, microbial colonization of all wounds was investigated. Only when there were local and systemic indicators of infection, such as deepening burn wounds, erythema, and fever, were wound cultures performed.

Prior to any cleansing, clinically deep portions of the burn wound were swabbed during the sampling procedure at the time of admission. Swabbing was then performed twice a week while burn wounds were being dressed. Swab samples were taken from the area of the wound where the burn severity was maximum. Prior to changing the dressings, additional attention was made to the areas where the infection was most noticeable when samples were taken. Never were the oral, vaginal, scalp, or anal regions used to collect samples. According to Levine's method, a sterile cotton swab was soaked with sterile normal saline, and the centre was then swabbed for 30 sec.[11] The swabs were placed in the proper containers when it was determined that they were saturated with wound exudates. The samples were brought to the lab to be processed right away.

The information was gathered using a validated data collection form, which contained demographic (patients' age and gender) and burn-related information (type of burn, total burn body surface area, culture results, and

length of hospital stay). After reviewing, organizing, and tabulating the data in a spreadsheet format, IBM SPSS Statistics software was used to analyze it (IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.).

Mean, median, and interquartile range were used to depict quantitative data. On the other hand, frequencies and percentages were used to depict qualitative data. The student t-test, Chi-square test, and Mann-Whitney test were used to compare the groups. The results were deemed significant when the p-value was < 0.05.

Results

A total of 348 burn victims were included. Table I summarizes the demographics of the patients. 194 patients were male (55.74%), and 51.72% of them were paediatric patients (n=180). The average age was 17.81 years. When compared to the adult age group, paediatric burns were more frequently scald burns (111/180; 61.66%), that is statistically significant (p < 0.001). Flame burns were most prevalent in the adult age group (101/168; 60.11%) (p < 0.001). Overall, scald burns were more prevalent (n=149; 42.81%) than flame burns (n=128; 36.78%. The types of burns are summarized in Figure 1.

Table I: Demographic features of burn patients between November 2021 and April 2022 (n=348)

Demographic features	N (%)	Mean	Median	Interquartile range
Age (years)		17.81	10	31
TBSA (%)		48.64	8	10
Length of stay (days)		15.4	12	17
Gender				
Male	194 (55.74%)			
Female	154 (44.25%)			
Mortality	27 (7.75%)			

The mean total burned body surface area (TBSA) was 48.64%, while the mean length of stay in the hospital was 15.4 days in total. This was 21.4 days for swab culture-positive patients while 13.6 for the remaining individuals. A TBSA burn of 40% or more was comparatively more common in the adult population (33/168; 19.64%) than in the paediatric group (10/180; 5.56%) (p<0.001).

About 348 of patients had their burn wounds cultured, in some cases a single patient had 3 swabs cultured. The burn wound culture returned with a 52.01% (181/348) positivity rate for infection. The majority (60.46%) were positive in the paediatric group while 39.54% were positive in adults. Wound cultures in the paediatric group were 74% positive when TBSA was 40% or more. A TBSA of ≥40% was not able to forecast a positive wound culture in either of the group (p<0.431 and p<0.486).

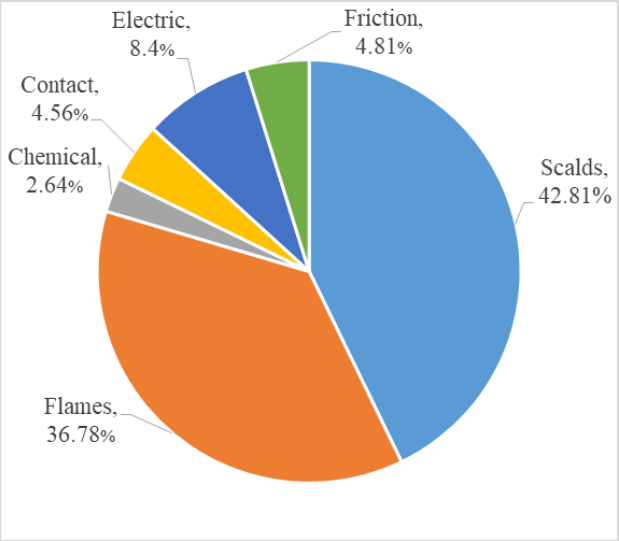

Figure 1. Summary of the burns types in studied patients (n=348)

Table II shows the microorganisms isolated from wound cultures. The most common isolated organism was *Pseudomonas aeruginosa* (68.60%), followed by *Klebsiella pneumoniae (32.55%), and Methicillin-resistant Staphylococcus aureus* (16.27%).

Table II: Microorganisms isolated from wound cultures

Organism	Burn wound cultures n (%)
Pseudomonas aeruginosa	124/181 (68.50%)
Klebsiella pneumoniae	59/181 (32.55%)
Methicillin-resistant Staphylococcus aureus	30/181 (16.27%)
Acinetobacter baummanii	12/181 (6.62%)
Methicillin-sensitive Staphylococcus aureus	10/181 (5.52%)
Candida albicans	4/181 (2.20%)
Others	6/181 (3.30%)

Burn wound cultures revealed *Staphylococcus aureus* (n=56; 33.3%) to be the most prevalent bacteria in patients with 40% or more TBSA burns, followed by *Pseudomonas aeruginosa* (n=41; 24%). Patients with ≥40% TBSA compared to patients with 40% (19% versus 2%) had significantly more *Acinetobacter baumannii* infections in their wounds (p=0.005). Other organisms did not display any statistical significance.

The impact of welcoming cultures on length of stay was investigated using the student t-test. (p=0.04) (95% CI: 0.97-19.58) Patients with positive burn wound cultures had significantly longer hospital stays. Additionally, the length of hospital stay increased with TBSA (p < 0.001). The length of the hospital stay was not significantly impacted by MRSA (p=0.71; 95% CI: 19.71-6.03).

Discussion

Serious burn injury patients need instant care in an extremely dedicated burn centre to lessen potential morbidity and mortality. While advances in burn care and management have increased the survival rates of burn victims, nosocomial infections still pose a substantial challenge for burn specialists handling burn patients and are known to result in more than 50% of burn-associated deaths.[12]

The present study's objective was to determine the epidemiological features of burn patients having wound infections and being admitted at the national burn care centre. In addition, the study documented the common bacterial pathogens associated with burn wound infections.

In the current study, the ratio of burn injuries was more in male patients (55.74% vs 44.25%). These results were in line with a study[13] conducted in 2014 in Morocco, which reported a higher incidence of burn injuries in male patients (64% vs 36%). Another study from our Centre reported a similar finding in 2017.[14] A study from Saudi Arabia also reported a higher incidence rate in males as compared to females (72.2% vs 27.8%).[12] Our results were however in incongruity with a study[15] by Hamzaoui et al., conducted in 2020 where the authors reported that the rate of burn injuries was the same in female and male patients (50.80% vs 49.20%). The data pooled by the World Health Organization vary, showing that females have slightly higher rates of burn injury as compared to males.[16]

The mean age was 17.81 years, a result that compares with the results reported by earlier studies.[13,17] This could be because this age group is the most active and is exposed to hazardous environments at both work and home.[9,18] A study by Barguigua et al., reported a mean age higher than our study, i.e. 38.4 ± 22.1 years.[19]

Earlier studies have indicated that burn injuries remain more frequent in the paediatric age group than in adults and our study concurs with this.[20] Scald burns were the most common type of burns, followed by flame burns. This was in line with a study by Mater et al., conducted in 2020.[21] However, a study from Morocco reported a higher rate of flame burns followed by scalds.[22] In paediatric patients, the most common burn injuries were due to scald burns (61.66%) whereas, in the adult age group, flame burns were the most common (60.11%). Earlier studies have also reported a similar pattern of a high rate of scald burns in the paediatric population.[21]

A direct relationship was observed between %TBSA and the positive cultures in the paediatric and adult populations. Wound cultures in the paediatric group were 100% positive when TBSA was 40% or more. Our results showed a 51.49% prevalence of burn infections in wound cultures. Wurtz et al., from the USA reported a percentage of infected patients[23] which was similar to that of our study.

Our results showed that the mean length of stay in the hospital was 21.4 days for swab culture-positive patients while 13.6 days for the remaining individuals. This was on the higher side when compared with a study that found that the length of stay in the burn ward was 5.3 ± 5.6 days in patients with wound infection and 12.8 ± 16.2 days in patients without wound infection.[19] Another study from the USA found the mean length of hospital stay was 12.0 ± 9.4 days.[24] Many studies have revealed that infections occur due to extended hospital stays. However, a lengthy hospital stay was a risk factor for infections with MDR microorganisms.[25,26] Our study highlighted that length of stay has a direct association with infection and is, therefore, a risk factor.

In the present study, we could not develop an association between patient sex and the development of infection; there was also no significant association between the type of burn injury and the development of infection. To the best of our understanding, there are no available figures about the effect of burn type on the progress of wound infections.

The most common isolated organism was *Pseudomonas aeruginosa* (68.60%), followed by *Klebsiella pneumonia (32.55%), and Methicillin-resistant Staphylococcus aureus* (16.27%). Earlier studies have indicated a high prevalence of *Staphylococcus (27.6% and 20%, respectively) and Pseudomonas aeruginosa* (12.3% and 39.5%, respectively) in burn wound cultures.[12,27] Some other studies have reported *S. aureus* to be the common cause of burn wound infection.[22]

In patients with 40% or more TBSA burns, burn wound cultures showed *Staphylococcus aureus* (33.3%) to be the most frequent microorganism. This was similar to a study by Mater et al., where *Staphylococcus aureus* was the commonest organism isolated from burn patients with ≥40% TBSA.

Limitation: The data of cultures were limited to burn wound cultures because they are commonly taken, and no data on the use of antibiotics was recorded. No data was recorded on any use of invasive devices since this was not the scope of our study.

Conclusion

Our burn patients were most commonly infected with *P. aeruginosa*. Surveillance and management of these microorganisms must be instigated to reduce the rate of morbidity and mortality of burn patients with infections.

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