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ORIGINAL ARTICLE

Infections and Burns: experience of the Burn Unit of Batna

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ABSTRACT

Introduction: Infections are a major complication in burn patients and constitute a significant cause of morbidity and mortality. This study aimed to describe the frequency, causative organisms, and factors associated with infections among burn patients hospitalized at the Batna University Hospital Center. **Materials and Methods:** This prospective descriptive study included 233 patients hospitalized in 2023. Infections were analyzed according to total body surface area burned (TBSA), burn depth, time to admission, prehospital care, length of hospital stay, and mortality. Statistical analysis was performed using SPSS software (χ^2 test, $p \leq 0.05$). Ethical standards were respected, including informed consent and patient confidentiality. **Results:** The overall infection rate was 43.8%. Infections occurred within the first three days in 43.5% of cases and were predominantly cutaneous (85.1%). The most frequently isolated organisms were *Pseudomonas aeruginosa* (33.3%) and *Staphylococcus aureus* (18.8%). Infection rates were significantly higher in patients with TBSA >30%, deeper burns (third-degree burns: 78.6%), use of traditional treatments (79.2%), delayed admission (>48 hours: 81.5%), and prolonged hospitalization (>30 days: 96.3%) ($p < 0.001$). Mortality was significantly higher among infected patients (29.4%, $p < 0.001$). **Conclusion:** Infections are a critical prognostic factor in burn patients. Their prevention relies on early management, strict adherence to aseptic measures, avoidance of traditional practices, and optimization of antibiotic therapy.

Keywords: Burns, Infection, Pathogens, TBSA, Burn depth.

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1. INTRODUCTION

Infections represent a major complication in burn patients, particularly in severe burns, where they are one of the leading causes of in-hospital mortality [1]. They occur in nearly half of patients admitted to specialized centers and account for approximately 50% of burn-related deaths [1].

This vulnerability results from several pathophysiological mechanisms: profound immune suppression due to systemic inflammation, malnutrition, and disruption of the skin barrier, which favor the occurrence of severe infections [1]. Pulmonary and urinary infections are the most frequent infectious foci [2].

Diagnosing infection is challenging, as classical signs (fever, leukocytosis, CRP) lack specificity [3]. Procalcitonin should be interpreted with caution [1]. Local wound examination combined with microbiological cultures remains essential for diagnosis [3].

2. MATERIALS AND METHODS

This prospective, descriptive study was conducted in the burn unit of CHU Batna, including all patients hospitalized for burns in 2023. The parameters studied included infection sites, sampling methods, isolated organisms, and the relationship between infection and certain variables (TBSA, burn depth, time to admission, prehospital care, length of hospital stay, and mortality). The study included all burn patients with TBSA >15% in adults and >10% in children, and burns in high-risk anatomical areas. Patients not meeting hospitalization criteria (minor burns <10% and/or absence of high-risk areas) were excluded.

Infection was defined on the basis of clinical criteria (local signs of wound infection, including changes in wound color, presence of discharge and pus, fibrin deposits, redness around the wound, necrosis, and foul odor) and/or bacteriological findings. Burn surface area (BSA) was assessed using Wallace's rule of nines in adults and the Lund and Browder chart in children. Burns were classified as second-degree, third-degree, or mixed forms according to clinical assessment (first-degree burns were excluded). Traditional management involved the application of non-medical substances such as henna, eggs, tomatoes, toothpaste, unidentified herbs, or various oily products.

Data were entered and analyzed using IBM SPSS version 26. Results are expressed as numbers and percentages. The chi-square test was used to compare categorical variables, with significance set at $p \leq 0.05$. Informed consent was obtained from patients, families, or legal representatives, and anonymity and confidentiality were maintained.

3. RESULTS

Infectious Profile of Burn Patients

Of the 233 hospitalized patients, 43.8% developed an infection. Infections occurred within the first three days in 43.5% of patients, 26.7% of whom were already infected at admission. Infections were primarily cutaneous (85.1%), followed by cutaneous-pulmonary (11.9%), urinary (2%), and osteoarticular (1%) infections. Cutaneous samples accounted for 91.3% of all cultures. Pseudomonas aeruginosa was the most frequently isolated pathogen (33.3%), followed by Staph aureus and Klebsiella pneumoniae (Table 1).

Table 1. Epidemiology of Infections in Burn Patients.

Variable	Percentage
Initial management in another healthcare facility	57.5 %
Infection rate	43.8 %
Time of infection onset	
At admission	26.7 %
Day 1–3	16.8 %
After day 3	56.4 %
Infection sites	
Skin	85.1 %
Skin + pulmonary	11.9 %
Urinary	2 %
Osteoarticular	1 %
Type of sample	
Skin	91.3 %
Blood culture	7.2 %
Joint	1.4 %
Identified pathogens	
Pseudomonas aeruginosa	33.3 %
Staphylococcus aureus	18.8 %
Klebsiella pneumoniae	13 %
Proteus mirabilis	8.7 %
Providencia sturtii	7.2 %
Proteus vulgaris	4.3 %
Acinetobacter spp	2.9 %
Enterobacter cloacae	2.9 %
Proteus spp	2.9 %
Serratia marcescens	2.9 %
Acinetobacter baumanii	1.4 %
Escherichia coli	1.4 %

Relationship Between Infection and Clinical Variables

TBSA and Burn Depth

Infection risk increased from 17.3% (<10% TBSA) to 84% (30–50% TBSA) (p < 0.001). Third-degree burns were infected in 78.6% of cases (p < 0.001) (Table 2).

Table 2. Relationship between TBSA, depth, and the occurrence of infection.

Variable	Infection		Total	P
	Yes	No		
TBSA				
<10 %	9 (17.3 %)	43 (82.7 %)	52 (100 %)	
11 – 20 %	**26 (33.3 %)**	52 (66.7 %)	78 (100 %)	
21 – 30 %	**23 (48.9 %)**	24 (51.1 %)	47 (100 %)	< 0.001
31 – 50 %	**21 (84 %)**	4 (16 %)	25 (100 %)	
> 50 %	**23 (74.2 %)**	8 (25.8 %)	31 (100 %)	
Burn depth				
2nd degree	47 (30.9 %)	105 (69.1 %)	152 (100 %)	
3rd degree	**11 (78.6 %)**	3 (21.4 %)	14 (100 %)	
Mixed (2nd and 3rd degree)	**44 (65.7 %)**	23 (34.3 %)	67 (100 %)	< 0.001

Prehospital Traditional Treatment

Traditional treatments were associated with a 79.2% infection rate (p < 0.001) (Table 3).

Table 3. Relationship Between Traditional Prehospital Treatment and the Occurrence of Infection.

Treatments applied to wounds	Infection		Total	P
	Yes	No		
Traditional methods	**19 (79.2 %)**	5 (20.8 %)	11 (100 %)	< 0.001

Admission Delay

81.5% of patients admitted after 48 hours were already infected at admission (p < 0.001) (Table 4).

Table 4. Relationship Between Admission Delay and the time of Infection.

Admission delay	Time to infection			Total	p
	At admission	Day 1 - 3	> day 3		
< 6h	2 (7.4 %)	5 (18.5 %)	**20 (74.1 %)**	27 (100 %)	
7 - 12h	3 (15 %)	3 (15 %)	**14 (70 %)**	20 (100 %)	
13 - 24h	2 (13.3 %)	3 (20 %)	**10 (66.7 %)**	15 (100 %)	< 0.001
24 - 48h	3 (23.1 %)	3 (23.1 %)	**7 (53.8 %)**	13 (100 %)	
> 2 days	**22 (81.5 %)**	1 (3.7 %)	**4 (14.8 %)**	27 (100 %)	

Length of Hospital Stay

Infection risk rose to 96.3% for stays >30 days (p < 0.001) (Table 5).

Table 5. Relationship Between Length of Hospital Stay and the Occurrence of Infection.

Length of Hospital Stay	Infection		Total	p
	Yes	No		
1-7 days	19 (20 %)	76 (80 %)	95 (100 %)	
8-14 days	19 (32.8 %)	39 (67.2 %)	58 (100 %)	
15-30 days	37 (69.8 %)	16 (30.2 %)	53 (100 %)	< 0.001
>30 days	**26 (96.3 %)**	1 (3.7 %)	27 (100 %)	

Mortality

Mortality was significantly higher in infected patients (29.4% vs 5.3% in non-infected, p < 0.001) (Table 6).

Table 6. Relationship Between Infection Occurrence and Mortality.

Infection	Outcome		Total	P
	Deceased	Survivor		
Yes	**30 (29.4 %)**	72 (70.6 %)	102 (100 %)	
No	7 (5.3 %)	124 (94.7 %)	131 (100 %)	< 0.001

4. DISCUSSION

This study has several limitations. The predominance of wound swab samples may have led to an underestimation of pulmonary, urinary, or systemic infections. The absence of antibiotic susceptibility testing limited the evaluation of antimicrobial resistance profiles. In addition, some important factors such as comorbidities, nutritional status, immune status, and mechanical ventilation were not taken into account, which may have influenced the interpretation of the infectious risk. The inclusion of patients already infected at admission introduced some heterogeneity between community-acquired and hospital-acquired infections. However, part of these patients had previously received initial management in other healthcare facilities before transfer to our burn unit, which may have exposed them to healthcare-associated infections. Furthermore, the size of some subgroups was very small (isolated third-degree burns), which may weaken the robustness of the statistical tests and the reliability of the reported p-values.

Infection is a major complication in burn patients [4], as shown by its frequency of 43.8% in our series. This rate is comparable to that reported by Essayagh M et al. [5] in Morocco (43%), but lower than those reported by El Hamzaoui N et al. [6] in Morocco (78.5%), Amengle AL et al. [7] in Cameroon (55.9%), Rashid A et al. [8] in Pakistan (84.5%), and López-Jácome LE et al. [9] in Mexico (72.9%). Conversely, lower rates were reported by Tsolakidis S et al. [10] in Germany (22.6%) and by Olaitan PB et al. [11] in Nigeria, with 27.8% wound infections.

In our series, *Pseudomonas aeruginosa* was the most frequently isolated microorganism (33.3%), followed by *Staphylococcus aureus* (18.8%). In India, Agnihotri N et al. [13] also reported a strong predominance of *Pseudomonas aeruginosa* (59%), followed by *Staphylococcus aureus* (17.9%). In Algeria, Chaibdraa A et al. [12] found a clear predominance of *Staphylococci* (58%), followed by *Pseudomonas* (20%). In Morocco, Siah S et al. [14], El Hamzaoui N et al. [6], and Orchi I [15] observed a predominance of *Staphylococcus aureus* (33.3%, 33.85%, and 20.8%, respectively), whereas Essayagh M et al. [5] reported a predominance of *Acinetobacter baumannii* (22.2%). In China, Ke Y et al. [17] mainly isolated *Staphylococcus aureus* (45.4%), followed by *Pseudomonas aeruginosa* (18.7%). In Pakistan, Rashid A et al. [8] reported a notable predominance of *Staphylococcus aureus* (65.6%), followed by *Pseudomonas aeruginosa* (43%). In France, Cremer R et al. [16] identified mainly *Pseudomonas sp* (49%). The high prevalence of *Pseudomonas aeruginosa* reflects its colonization capacity, resistance, and environmental contamination in burn units.

Delayed admission was significantly associated with the occurrence of infection, as patients admitted late had very high infection rates (81.5%), confirming the findings of Ozbek S et al. [18] in Turkey, who highlighted delayed admission as a major factor contributing to increased infection and wound contamination rates.

TBSA and burn depth strongly influenced infection risk, consistent with data from the literature [8,17]. According to Tsolakidis et al. (Germany) [10], patients who developed infections tended to have larger burned surfaces.

Traditional treatments applied before hospital arrival markedly increased the risk of infection (79.2% of patients who used these practices developed an infection), as reported in the study by Olaitan PB (Nigeria) [19], which highlighted the harmful effects of substances applied before admission, promoting wound contamination and complicating healing.

Length of hospital stay was also correlated with infectious risk (increasing from 20% in short stays to 96.3% for stays longer than 30 days), similarly to the findings of Chaibdraa A et al. [12] in Algeria. However, this relationship should be interpreted cautiously because of a possible reverse causality bias: while prolonged hospitalization increases exposure to nosocomial infections, infections themselves may also lead to longer hospital stays. As reported by Essayagh M et al. [5] in Morocco, prolonged hospitalization is mainly explained by burn severity, infectious complications, and patient comorbidities.

Finally, the high mortality rate among infected patients (29.4% vs. 5.3% among non-infected patients) confirms that infection remains a major prognostic factor. Norbury W et al. [20] (U.S. study) reported that infection accounted for 51% of post-burn deaths. Similarly, Mater ME et al. [21] (Saudi Arabia) identified infection as the cause of more than 50% of burn-related deaths.

Several authors have emphasized that infection is a major determinant of mortality in burn patients [4,5,22], due to the virulence of pathogens, which often exceeds the host's defense capacities. This creates a double risk: infection impairs wound healing, worsens tissue damage, and leads to graft failure, while also potentially causing sepsis [5], which is itself a major determinant of mortality in burn patients. The occurrence of infectious complications during hospitalization is associated with an unfavorable burn outcome [23].

5. CONCLUSION

Infections are a frequent and severe complication in burn patients. Several factors are associated with their occurrence, including burn extent and depth, delayed admission, traditional practices, and prolonged hospitalization. Prevention relies on early management, strict adherence to hygiene measures, public education to avoid traditional practices, and rational use of antibiotic therapy.

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