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Original Research Article

A Hospital Based Observational Evaluation to Determine Clinical, Microbiological, and Histopathological Characteristics of Patients Diagnosed with Burn Wound Infection

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Abstract

Aim: The objective of the study was to determine clinical, microbiological, and histopathological characteristics of patients diagnosed with Burn wound infection along with a positive quantitative biopsy culture and their relationship with early diagnosis and progression to burn wound sepsis.

Methods: This study included all the patients admitted in the last 6 months to the Nalanda Medical College and Hospital, Patna, Bihar, India and who were diagnosed with BWI and BWS, according to the American's Burn Association (ABA) criteria. A total of 500 burned patients were admitted to the Burn Unit, out of these 50/500 (10%) developed BWI, based on clinical diagnosis, and 11/50 (22%) progressed to BWS.

Results: Scalds were the most frequent cause, followed by contact burns; second-degree burns predominated. The majority had less than 20% TBSA burns in adults and less than 10% TBSA burns in children. However, 23 (46%) had major burns. Of these, 30 (60%) were adults and 20 (40%) children. Most of them presented with more than one burned anatomical area, and the most frequent regions involved were the upper limbs, followed by the lower limbs. All patients with BWS had major burns. Among the signs of infection, erythema was predominant (redness greater than 1 cm from the burn wound border), followed by edema, and exudate and eschar discoloration. With regard to clinical presentation, latency period was defined as the time between burn wound and first signs of infection; early if clinical signs were evidenced into the first 72 hours since admission in Burn Unit and late if occurred after this time. Most cases developed signs in the first 72 hours after arrival at Burn Unit (47; 94%), corresponding to early infection.

Conclusion: BWI increases hospitalization time and number of surgeries, increasing the risk of sepsis and death. The QBC allows an accurate diagnosis with lesser false-positive cases that impact antibiotic resistance and mortality. Protocols targeting this problem are needed to decrease the impact of this.

Keywords: Burn Wound, Burn Wound Infection, Burn Wound Sepsis, Quantitative Biopsy Culture.

Introduction

Infections are one of the most common complications encountered in patients hospitalized with severe burns. Mortality due to infections is alarming as most of them are caused by multidrug resistant bugs harbored in the hospital environment. [1] Infections persist as an important complication and cause of mortality in the burn patients. [2] Disrupted skin barrier, involvement of larger burnt area, immunocompromised effects of burns and prolonged stays at the hospitals were major risk factors for initiating infection. [3] The burn wound infection is characterized by the change in the manifestation of burn wounds, such as rapid eschar separation, dark brown, black or violaceous discoloration of the eschar or edema at wound margin. It is also illustrated by the organism isolated from blood culture in the absence of other identifiable infection with following characteristic: fever (>37.5 C) or hypothermia (<35.5 C), hypotension (systolic pressure below 90 mmHg), oliguria (<20 mL/h), hyperglycemia or mental confusion. [4]

Burn wound infection (BWI) is a significant cause of morbidity and mortality in burn patients. The implementation of an early and aggressive debridement and silver sulfadiazine in the 90s pushed BWI from being the main cause of death to the second position, preceded only by pneumonia. [5] However, this complication is associated with high mortality, especially in major burn patients (adults > 20% total body surface area [TBSA]; children > 10% TBSA), due to a rapid progression following immunosuppression induced by burn injuries. [6]

BWI is usually caused by nosocomial microorganisms with high virulence in patients with major burns who are treated in a critical care facility. Initially, burn wound (BW) surface is sterile but rapidly colonized by bacteria of skin flora, creating a dynamic exchange with the external environment, denominated biofilms. [7] The objective of surgical debridement is to remove biofilms and control their multiplication using topical derivatives of sulfadiazine. Thus, BW must be assessed during each wound dressing change by a trained surgeon to differentiate clinical signs of normal BW from signs of burn wound infection (BWI). [8]

Many clinical variables such as comorbidities, clinical presentation, and microbiological virulence have been associated with the progression of burn wound sepsis (BWS). 6 For BWI assessment, qualitative techniques such as burn surface swab and culture by standard agar are used, but these have a higher rate of false positives, and over diagnosis is common. There is not enough evidence to recommend one over the other, owing to the few studies in BWI confirmed by quantitative biopsy culture (QBC). [9,10]

The objective of the study was to determine clinical, microbiological, and histopathological characteristics of patients diagnosed with Burn wound infection along with a positive quantitative biopsy culture and their relationship with early diagnosis and progression to burn wound sepsis.

Materials and Methods

This study included all the patients admitted in the last 6 months to the Nalanda Medical College and Hospital, Patna, Bihar, India and who were diagnosed with BWI and BWS, according to the American's Burn Association (ABA) criteria. [11] A total of 500 burned patients were admitted to the Burn Unit, out of these 50/500 (10%) developed BWI, based on clinical diagnosis, and 11/50 (22%) progressed to BWS.

In all cases, the diagnosis was confirmed by QBC; two samples were taken in all cases, and mediums used for sample

transfer were saline solution 0.9% for culture that was processed in blood agar and formaldehyde for histopathologic study. [5] The patients were monitored from clinical diagnosis until their discharge or mortality. Medical records and laboratory and pathology results were reviewed. Patients with a diagnosis of BWI prior to admission, those who had received antibiotic treatment before QBC test, and those with no clinical history data and/or incomplete histopathological and laboratory studies were excluded. All patients were taken to surgical debridement before admission to the burn unit. Data were tabulated with the help of Microsoft Excel and processed in 14th STATA version program. A univariate analysis was performed based on medians, means, proportions, and ranges. A bivariate analysis was used to find possible variables associated with outcomes, using Chi-square (or Fischer) and Mann–Whitney test.

Results

Table 1: Sociodemographic and clinical characteristics

Variables	N (%)
Gender	
Male	28 (56)
Female	22 (44)
Age group	
Under 18 years	20 (40)
Above 18 years	30 (60)
Comorbidities	
Yes	15 (30)
No	35 (70)
Mechanism	
Scalds	28 (56)
Direct contact	20 (40)
Electric	2 (4)
Depth	
Second degree	36 (72)
Third degree	14 (28)
Extension	
Minor (less than 20% TBSA adults or 10% in children)	27 (54)
Major (above those percentages)	23 (46)
Location	
Upper limb	36 (72)
Lower limb	32(64)
Head and neck	30 (60)
Anterior torso	20 (40)
Posterior torso	14 (28)
Sign of infection	
Erythema	37 (74)
Edema	30 (60)
Exudate	22 (44)
Eschar discoloration	17 (34)
Pain increasing	10 (20)
Separation of eschar	8 (16)
Loss of skin grafts	1 (2)
Lymphangitis	1 (2)

Scalds were the most frequent cause, followed by contact burns; second-degree burns predominated. The majority had less than 20% TBSA burns in adults and less than 10% TBSA burns in children. However, 23 (46%) had major burns. Of these, 30 (60%) were adults and 20 (40%) children. Most of them presented with more than one burned anatomical area, and the most frequent regions involved were the upper limbs, followed by the lower limbs. All patients with BWS had major burns. Among the signs of infection, erythema was predominant (redness greater than 1 cm from the burn wound border), followed by edema, and exudate and eschar discoloration.

Table 2: Clinical evaluation

Clinical evaluation	N (%)
Latency period	
Early-onset (before 72 hours)	47 (94)
Late-onset (after 72 hours)	3 (6)
Infection	
Yes	30 (60)
No	20 (40)
Initial treatment	
Yes	43 (86)
No	3 (6)
Not reported	4 (8)
Debridement	
Yes	43 (86)
No	7 (14)
Skin graft	
Yes	35 (70)
No	15 (30)
Health care-associated infection	
Yes	13 (26)
No	37 (74)
Mortality	
Yes	48 (96)
No	2 (4)

With regard to clinical presentation, latency period was defined as the time between burn wound and first signs of infection; early if clinical signs were evidenced into the first 72 hours since admission in Burn Unit and late if occurred after this time. Most cases developed signs in the first 72 hours after arrival at Burn Unit (47; 94%), corresponding to early infection.

Table 3: Histopathological findings

Histopathological findings	N (%)
Invasion	
Deep	6 (12)
Superficial	7 (14)
Not determined	37 (74)
Infiltration	
I	3 (6)
IA	0

IB	3 (6)
II	6 (12)
IIA	5 (10)
IIB	8 (16)
IIC	10 (20)
Not observed	15 (30)
Etiological agents	
S. aureus	15 (30)
P. aeruginosa	8 (16)
K. pneumoniae	3 (6)
S. marcescens	2 (4)
A. baumanii	2 (4)
S. saprophyticus	1 (2)
A. veronni	1 (2)
P. mirabilis	1 (2)
P. penneri	1 (2)
E. faecalis	1 (2)
E. aerogenes	1 (2)
Fungi	1 (2)
Other	1 (2)
Bacterial resistance	
Beta-lactams	15 (30)
Carbapenems	2 (4)
Aminoglycosides	1 (2)
Lincosamides	2 (4)
Quinolones	3 (6)
Sulfonamides	8 (16)
Ureidopenicillins	1 (2)

QBC was positive in 30 patients (60%); all of them presented quantitative culture with more than 10^3 colony-forming units (CFUs) per gram of tissue. However, in histopathological reports, the microbial invasion was not differentiated between IIB and IIC grades, according to Mitchell et al classification.

Discussion

Nosocomial infection in the burnt patients is major challenge for a clinician. [12] It has been estimated that 75% of all deaths in burnt patients were associated with infections. [13] Prolonged use of antibiotics leads to the development as well as selection of multidrug resistant (MDR) bacteria which results in treatment failure and intensifies the complications. Thus, the information of microbial flora and the current antibiotic susceptibility patterns are important for the clinician treating burn sepsis.

BWI is a clinical diagnosis, based on the evaluation of burn wound surface. In noninfected BW, overdiagnosis results in unnecessary antibiotic therapy, which has seen increased antibiotic resistance in the last decade. [14-16] Discoloration and separation of the eschar are the signs with the highest correlation with positive QBC and BWI, in others studies [11] skin graft loss has been reported too, although these were not evident in these cohort of patients. There are few studies using QBC according to Mitchell et al. Techniques (taking two samples with at least 0.5 grams of tissue) that evaluated their impact in early detection of BWI diagnosis were early specific antibiotic treatment, lower

nosocomial infections, lesser surgical procedures and lesser time of hospitalization, as reported by Halstead et al. [17] in their systematic review; however the evidence based on the utility and reliability of quantitative microbiology for diagnosing or predicting clinical outcomes in burned patients is limited and poorly reported. [11,14-16]

Probably, the major utility of QBC is in the diagnosis of BWI in microbial barrier property (MBP), where signs of infection are inconsistent, due to immunosuppression induced by the burn. [9,18] Once white blood cells (WBCs) are colonized, qualitative techniques has a higher rate of false positives; 43% of our patients corresponded to MBP, of these 23% progressed to BWS with positive QBC in all cases, and an early and specific antibiotic therapy was started, compared with Ramirez et al study in the same unit burn care, where there was a reduction of 6% reduction of mortality after implementation of QBC in a longer follow-up time. [18-20]

Histopathological changes did not correlate with BWS progression, and the level of invasion did not determine BWS progression; however, in this study, many samples were not were differentiated like Wolfrey et al study. [21] Prevention of BWI requires an early clinical diagnosis and a specific antibiotic treatment to prevent progression to BWS. QBC allows an accurate diagnosis with lesser false-positive cases that impact the long-term reduction in antibiotic resistance and mortality. [19] Large scale studies on microbial profile and susceptibility pattern of burns isolates are required in future. This would provide an insight on predominant resistance patterns and thus help clinicians to make targeted empiric antibiotic therapy for burns patients. [22]

Conclusion

BWI is a frequent complication in BW patients, and over diagnosis is also common, as signs of infection are often confused with signs of burn wound healing. Confirmation of the diagnosis is the main goal, and quantitative techniques are an accurate way to select a specific antibiotic therapy and prevent progression to sepsis.

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