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CLINICAL & BASIC RESEARCH

Analysis of Blood Cultures from Major Burns Patients in a Tertiary Care Burn Unit in Oman

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abstract: ***Objectives:*** This study aimed to review the blood stream infections of major burn patients in a tertiary care burn unit to determine the most prevalent infecting organisms in order to have a better empirical therapy protocol. ***Methods:*** This retrospective study analysed the blood stream infection of 155 major burn (>20% Total Body Surface Area [TBSA]) patients in Khoula Hospital, Muscat, Oman between January 2014 to December 2019. ***Results:*** The median age was 33 years and 57.42% of patients were male. The median TBSA was 38%, mortality was 25.16% and 50.9% of patients had positive blood cultures. The expired patients had higher TBSAs, Abbreviated Burns Severity Index scores and earlier first positive blood cultures. *Candida* was commonly grown in all the blood cultures, but the most prevalent organisms were *Acinetobacter*, *Staphylococci*, *Klebsiella*, *Enterococcus* and *Pseudomonas*. All *Acinetobacter* species are multidrug resistant. Of the 17 patients who had *Kelbsiella* grown in the blood culture, 8 grew multidrug-resistant *Klebsiella*. Only 4 patients' blood cultures grew methicillin-resistant *Staphylococcus aureus*. The number of blood culture samples taken ranged between 1–28 (median = 6). The first positive blood culture showed that *Staphylococcus epidermidis* and *Acinetobacter* were the most common infecting organisms. ***Conclusions:*** Multidrug-resistant *Acinetobacter* was the most predominant microorganism grown from the blood cultures of major burn patients in a tertiary care burn unit. Empirical therapy should include antibiotics that are effective against this organism to reduce the mortality.
Keywords: Infection; Blood; Burn; Multidrug Resistance; Antibiotics; Culture.

Advances in Knowledge
- *Multidrug-resistant Acinetobacter was the most predominant microorganism grown from the blood cultures of major burn patients in a tertiary care burn unit in Oman.*

Application to Patient Care
- *When there are signs of sepsis in major burn patients, empirical therapy should include antibiotics that cover the multidrug-resistant organisms to reduce patients' mortality.*
- *Knowledge of the most prevalent organisms is important in designing empirical therapy protocols. The results showed a high prevalence of multidrug-resistant organisms.*

Burns are complex systemic injuries that have significant consequences. Major burns result in significant mortality, with one of the major causes being blood stream infection. There are many predisposing factors that contribute to infection and mortality in burn patients. Among the predisposing factors are reduced immunity, loss of skin barrier and possible bacterial gastrointestinal translocation.[1] As major burns are associated with severe systemic inflammatory responses and hypermetabolic states, fever, leucocytosis and other signs of inflammation will always be present, making it difficult to diagnose sepsis in burn patients. Consequently, Greenhalgh *et al*. introduced new criteria for the diagnosis of sepsis and septic shock in burn patients, including certain clinical signs, laboratory findings and positive cultures.[2]

The causative organisms obtained from blood cultures differ among burn centres and in different periods of time, and the incidence of blood stream infection in burn centres varies in the literature. This variation may be due to the patient selection criteria. The reported range in some studies is 27–68%.[1–8]

In recent years, a rise in multidrug-resistant microorganisms occurred, making the control of blood stream infection more difficult due to the limited availability of appropriate antibiotics.[3] This study reviews the blood stream infections of major burn patients in a tertiary care burn unit in Oman, with the aim of identifying the most prevalent infecting microorganisms.

Methods

This retrospective study reviewed the blood stream infections of patients with major burns who were admitted to the central burn unit in Khoula Hospital, Muscat, Oman. Major burns were defined as burns covering 20% or more Total Body Surface Area

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(TBSA). The study was conducted from January 2014 to December 2019. The inclusion criteria were all burns patients with major burns. All burns with less than 20% TBSA were excluded. The blood culture samples were analysed. The Statistical Package for Social Sciences (SPSS), Version 23 (IBM Corp., Armonk, New York, USA) and Microsoft Excel 365, Version 18.2311.1071.0 (Microsoft, Redmond, Washington, USA) were used to analyse the data. The Chi-squared test was used to compare the groups.

Ethical approval for the study was obtained from Khoula Hospital's ethical committee (MOH/DGKH/REC/2/6/26790).

Results

During the study period, 1,127 patients were admitted to Khoula Hospital's central burn unit. Of these, 155 patients fulfilled the inclusion criteria; 89 (57.4%) were males and 66 (42.6%) were females. The age range was 2–80 years (median = 33). The TBSA of the patients' burns ranged between 20–95% (median = 38%). From the sample size, 116 (74.8%) patients survived their burns, while 39 (25.2%) patients expired. A total of 79 (50.9%) patients had positive blood cultures; the mortality among these patients was 27 (34.2%). However, the mortality among patients with negative blood cultures was 12 (15.8%) [Table 1].

The Chi-squared test was used to compare the mortality of the patients with positive blood cultures and those with negative blood cultures. The *P* value was 0.008, which indicated significant mortality among the patients with positive blood cultures. The median TBSA was 42% among the patients with positive blood cultures and 60% among the expired patients. The Abbreviated Burn Severity Index (ABSI) scores ranged from 3 to 15 (median = 8). The ABSI score range was 4–14 (median = 9) for the patients with positive blood cultures and 7–15 (median = 11) for the expired patients. The first positive blood culture range was 1–47 days (median = 10 days). For the expired patients, this range was 3–37 days (median = 9 days).

Table 1: Comparison between patients with positive blood cultures and patients with negative blood cultures (N = 155).

	Positive blood culture	Negative blood culture
Frequency, n (%)	79 (50.9)	76 (49.1)
Median age in years	36	28.5
Median TBSA	42	30
Median ABSI	9	7
Mortality, n (%)	27 (34.2)	12 (15.8)

TBSA = total body surface area; ABSI = Abbreviated Burn Severity Index

Candida grew commonly in the blood cultures. However, the most prevalent organisms grown from all the blood cultures were *Acinetobacter* species, *Staphylococci, Klebsiella pneumonia, Enterococcus faecalis* and *Pseudomonas* species [Figure 1].

All *Acinetobacter* species were, as always, multidrug resistant. Eight out of 17 patients who had *Klebsiella* grown from their blood culture had multidrug-resistant *Klebsiella* grown; 5 of them had carbapenem-resistant *Enterobacteriaceae* (CRE) grown and 3 of them had extended-spectrum β-lactamase-producing *Klebsiella* (ESBL) grown. Only 4 patients had methicillin-resistant *Staphylococcus aureus* (MRSA) grown from their blood cultures.

Many of the patients had multiple positive blood cultures. The number of blood culture samples taken ranged between 1–28 (median = 6). The first positive blood cultures showed that *S. epidermidis* and *Acinetobacter* were the most common infecting organisms among the burn patients [Figure 2].

Candida species were commonly isolated in the expired patients' blood cultures and the most common organisms in this patient group were *Acinetobacter* species, *S. epidermidis, E. faecalis, K. pneumonia* and *Pseudomonas* species [Figure 3].

Discussion

There are many contributing factors to burn mortality, including the surface area involved, age, inhalation injury and blood stream infection. Since

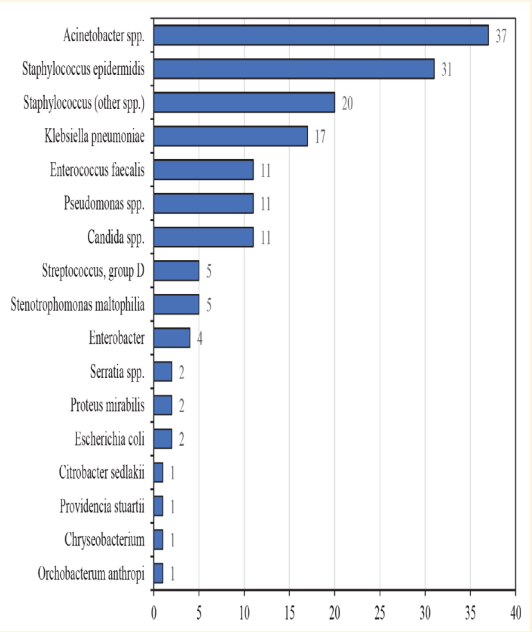

Figure 1: Prevalence of organisms in all positive blood cultures.

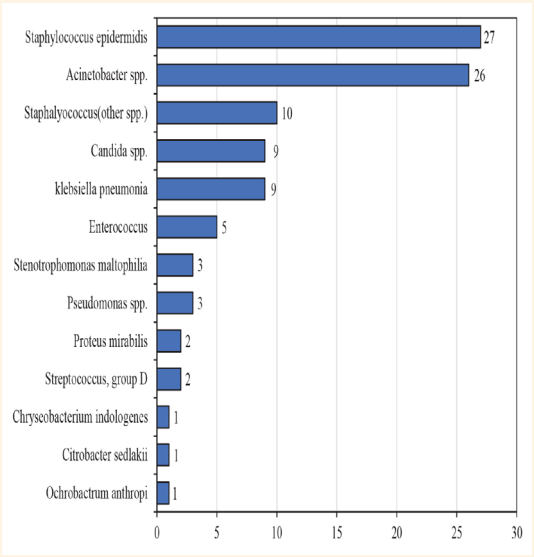

Figure 2: Prevalence of organisms in the first blood culture.

various organisms may cause blood stream infection, knowledge of the common causative organisms helps in designing better empirical therapy protocols. However, infecting organisms' prevalence constantly changes over time.[3] In recent years, a rise in multidrug-resistant organisms occurred, especially *Acinetobacter baumannii*.[4] This organism was previously not a common cause of infection in burn patients. A 2002 report from Sweden showed that MRSA and coagulase-negative *Staphylococcus* were the most common infecting organisms in the studied unit, while *A. baumannii* was one of the least common infecting organisms.[5] Similarly, a 2007 report from the USA showed coagulase-negative *Staphylococcus* and *S. aureus* to be the most common infecting organisms.[6]

Recently, *Acinetobacter* species have become one of the most commonly isolated organisms in

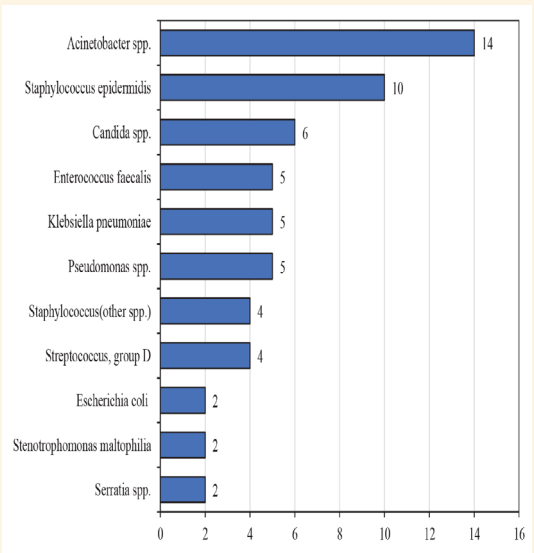

Figure 3: Prevalence of organisms in the expired patients' blood cultures.

burn cases worldwide. A 2011 report from Singapore identified multidrug-resistant *A. baumannii* as the most common prevalent organism in a burn intensive care unit (ICU).[7] A 2018 study from China showed that *A. baumannii, K. pneumoniae* and *Candida* were the most common infecting organisms in burn patients.[8] Similarly, a 2021 study from China showed that *A. baumannii* is the most frequently isolated organism in such patients.[9] The current study's findings do not differ from recent literature, since *A. baumannii* was found to be the most commonly isolated organism in the current burn patients. However, a recent regional report from Saudi Arabia showed that the most common organism isolated in burn patients was *S. aureus* and MRSA. This differs from the current study's findings and those of many other studies; it could be because this study considered minor burns only.[10]

Unfortunately, *A. baumannii* is resistant to almost all antibiotics. This led to the reintroduction of colistin, which was previously abandoned due to its nephrotoxicity.[4] In Khoula Hospital, all possible measures to control this organism were taken, including closing and relocating the burn unit and burn ICU; however, it seems difficult to control this organism. Its persistence can be ascribed to several factors, including its ability to colonise different surfaces and survive for prolonged periods of time under a wide range of environmental conditions, the presence of mobile genetic elements, the lack of antimicrobial stewardship policies and poor adherence to infection control measures. Colistin is still highly effective against this organism in Khoula Hospital's burn unit, but a report from Saudi Arabia showed high resistance.[11]

The second most commonly isolated organism found in the current study was *S. epidermidis*, a coagulase-negative *Staphylococcus. S. epidermidis* may sometimes be a contaminant, but it is well known as a common cause of bacteraemia.[12] The organism can form biofilms on indwelling medical devices and also produce toxins. Almost all patients in burn ICUs have indwelling catheters, which may be the main source of *S. epidermidis* infection.

Candida is a commensal organism, usually found in the urinary and gastrointestinal tracts. *Candida* infection among burn patients is significant, with infections rising significantly in ICUs.[13] This infection can be so severe that it can cause septic shock.[14] This study found that *Candida* was the third most prevalent organism in the expired patients. Since burn patients' immunity is compromised, *Candida* infection is significant among this population and should be kept in mind when considering empirical therapy in septicaemia, as immunodepression and burns are known risk factors for *Candida* sepsis.[15]

Klebsiella pneumonia is one of the most common organisms grown from blood cultures and 57.1% of the *K. pneumonia* grown from the burn patients' blood cultures were multidrug-resistant. As the CRE and ESBL rates in burn patients are high, appropriate empirical therapy is important. A study from Italy showed that inappropriate empirical therapy is associated with higher mortality rates.[16]

The expired patients had earlier positive cultures and higher TBSAs and ABSI scores. Positive blood cultures were found as early as the first day of admission, but this is not common. Usually, early death from burns (occurring within 5 days) is mostly due to multiorgan failure rather than sepsis.[17]

The early and proper use of antibiotics for sepsis is extremely important. Use of colistin as empirical therapy before culture results should be considered in patients with extensive burns to reduce mortality. However, this approach may produce colistin-resistant *Acinetobacter*, which will not respond to any other antibiotic.

Conclusion

More than 50% of the major burn patients had at least one positive blood culture. The mortality rate was significantly higher among the patients with positive blood cultures. The expired patients had higher TBSAs and ABSI scores and earlier positive blood cultures. Multidrug-resistant *Acinetobacter* was the most prevalent microorganism grown from the blood cultures of the major burn patients in Khoula Hospital's burn unit. Empirical therapy should include antibiotics that are effective against this organism to reduce mortality.

AUTHORS' CONTRIBUTION

AA, AAAH, MOA, MAS, KMH, ASE, SMG, AES, JJ, TA and AAJ collected the data. MTSA and SA performed the data analysis and drafted the article. ATE revised the manuscript. All authors approved the final version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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