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

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Abstract

Objectives: In this study we review blood stream infections of major burns in a tertiary care burn unit to determine the most prevalent organisms in order to have a better empirical therapy protocol. Methods: This is a retrospective study where blood stream infection of major burns (>20% Total Body Surface Area) were analysed. Results: 155 patients fulfilled the criteria. Median age was 33 years. Median TBSA was 38%. 57.42% were males and 42.58% were females. Mortality was 25.16%. 50.9% of patients had positive blood culture. Expired patients had higher TBSA, Abbreviated Burns Severity Index score and earlier first positive blood culture. The most prevalent organisms grown from all blood cultures were Acinetobacter, staphylococci, Klebsiella, Enterococcus and pseudomonas. Candida is also commonly grown in blood cultures. All Acinetobacter species are always multidrug resistant. 8 of 14 patients had multidrug resistant Klebsiella. There were only 4 patients who had Methicilin resistant Staphylococcus Aureus (MRSA) grown. The number of blood cultures samples taken ranged...
from 1 to 28 (median 6). First positive blood culture showed that *Staphylococcus epidermidis* and *Acinetobacter* are the most common organisms. **Conclusion:** In conclusion multidrug resistant *Acinetobacter* has become the most predominant microorganism grown in blood cultures of major burns in our unit. Empirical therapy should include antibiotics that are effective against it to reduce the mortality.

**Keywords:** Infection; Blood; Burn; Resistance; Antibiotics; Culture.

**Advances in knowledge:**
This article reviews the most common organisms that are grown from blood cultures of major burns in a tertiary care burn unit in Oman. Knowledge of the most prevalent organisms is important in designing empirical therapy protocols. The result showed high prevalence of multidrug resistant organisms.

**Application to patient care:**
Empirical therapy when there are signs of sepsis in major burn should include antibiotics that cover the multidrug resistant organism in order to reduce patients mortality.

**Introduction:**
Burn is a complex systemic injury that has significant consequences. Major burns result in significant mortality. One of major causes of mortality is blood stream infection. There are many predisposing factors that contribute to infection and mortality in burns. Among the predisposing factors are reduced immunity, loss of skin barrier, and possible bacterial gastrointestinal translocation.¹ As major burn injury is associated with severe systemic inflammatory response and hypermetabolic state there will be always fever, leucocytosis and other signs of inflammation making it difficult to diagnose sepsis in burns. As a result Greenhalgh et al introduced a new criteria for the diagnosis of sepsis and septic shock in burns. The criteria include certain clinical signs, laboratory findings and positive cultures.²

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

In recent years there was rise in multidrug resistant microorganisms which made the control of blood stream infection more difficult due to limited availability of antibiotics that can be used. In this study we review blood stream infections of major burns in a tertiary care burn unit with the aim of identifying the most prevalent microorganisms.

Methods:
This is a retrospective study in which the blood stream infection in patients with major burns who were admitted to the central burn unit in Khoula hospital, Muscat, Oman were reviewed. Major burn was defined as total body surface area burnt (TBSA) of 20% or more. The study period was January 2014 till December 2019. The inclusion criteria were all burns patients who had 20% or more TBSA. Statistical Package for Social Sciences (SPSS) and Microsoft excel were used for analysis of data. Chi square was used for comparison of the groups. Ethical approval of the study was obtained from Khoula hospital ethical committee.

Results:
1127 patients were admitted to the central burn unit during the study period. The total number of patients who fulfilled the criteria of inclusion was 155. Age range was 2 to 80 years (median: 33). The number of males was 89 (57.4%) and number of females was 66 (42.6%). Total body surface area (TBSA) burnt ranged from 20% to 95% (median: 38%). The number of patients who survived was 116 (74.8%) and number of expired patients was 39 (25.2%).

The total number of patients who had positive blood cultures was 79 (50.9%). Mortality among positive blood cultures patients was 27 (34.2%). Mortality among negative blood culture patients was 12(15.8%) (Table 1). Chi Square was used to compare mortality in both groups, p value was 0.008 which indicate significant mortality among the patients with positive blood culture.

Median TBSA among positive blood culture patients was 42%. Median TBSA among expired patients was 60%.
Abbreviated burn severity index (ABSI) ranged from 3 to 15 (median: 8). ABSI range for positive blood culture was 4 to 14 (median: 9). ABSI range for expired patients was 7 to 15 (median: 11).

First positive blood culture range was 1 to 47 days (median: 10). First positive blood culture of expired patients range was 3 to 37 days (median: 9 days).

The most prevalent organisms grown from all blood cultures were *Acinetobacter species*, *Staphylococci*, *Klebsiella pneumonia*, *Enterococcus faecalis* and *Pseudomonas species* (figure 1). *Candida* is also commonly grown in blood cultures.

All *Acinetobacter species* were always multidrug resistant. 8 of 14 patients had multidrug resistant *Klebsiella* grown. 5 had Carbapenem-resistant *Enterobacteriaceae* (CRE) and 3 had Extended-spectrum β-lactamase producing *Klebsiella* (ESBL). There were only 4 patients who had Methicillin-resistant *Staphylococcus aureus* (MRSA) grown.

Many of the patients had multiple positive blood cultures. The number of blood cultures samples taken ranged from 1 to 28 (median 6). First positive blood culture showed that *Staphylococcus epidermidis* and *Acinetobacter* are the most common organisms (figure 2).

Expired patients blood cultures showed that *Acinetobacter species, Staphylococcus epidermidis, Enterococcus faecalis, Klebsiella pneumonia and Pseudomonas species* are the most common organisms (figure 3). *Candida species* were also commonly isolated in this group of patients.

**Discussion:**

There are many contributing factors to burn mortality which include the surface area involved, age, inhalation injury and blood stream infection. Various organisms may cause blood stream infection. Knowledge of the common causative organisms helps in designing better empirical therapy protocols. Infecting organisms prevalence keeps changing over time. In recent years there was rise in organisms that are multidrug resistant especially *Acinetobacter baumannii*. This organism was not a common cause of infection previously in burns. A report from Sweden
published in 2002 showed MRSA and coagulase negative staphylococcus are the most common organisms in that unit while Acinetobacter baumannii was one of the least common infecting organisms.\textsuperscript{5} Similarly a report from USA published in 2007 showed coagulase negative Staphylococcus and Staphylococcus aureus are the most common organisms.\textsuperscript{6}

Acinetobacter species have become one of the most commonly isolated organisms in burn cases in recent years. This rise is worldwide. A report from Singapore published in 2011 showed MDR Acinetobacter baumannii as the most common prevalent organism in burn intensive care unit (ICU).\textsuperscript{7} A recent study from China published in 2018 showed Acinetobacter baumannii, Klebsiella pneumoniae and Candida were the most common organisms.\textsuperscript{8} Similarly another study from China published in 2021 showed Acinetobacter baumannii is the most frequently isolated organism.\textsuperscript{9} Our findings are not different from recent published literature, Acinetobacter baumannii is the most commonly isolated organism. A recent regional report from Saudi Arabia showed the most common organism isolated was staphylococcus aureus and Methicillin resistant Staphylococcus aureus (MRSA). This is different from our findings and findings of many other studies but this study included minor burns only.\textsuperscript{10}

Unfortunately, Acinetobacter baumannii is resistant to almost all antibiotics and that led to the reintroduction of colistin which has been abandoned previously due to nephrotoxicity.\textsuperscript{4} All possible measures were taken in our hospital to control this organism, including closing the burn unit and burn ICU as well as relocating the burn unit and burn ICU but it seems that it is difficult to control. There are several reasons for the persistence of this organism that include the ability of the organism to colonize different surfaces and its ability to 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 our unit, but a report from Saudi Arabia showed high resistance.\textsuperscript{11}

The second most commonly isolated organism in our study was Staphylococcus epidermedis. This is a coagulase negative Staphylococcus. Staphylococcus epidermedis has ability to form biofilms on indwelling medical devices, and also toxin production. Staphylococcus epidermedis
may be a contaminant sometimes but it is well known that it is a common cause of bacteremia.\textsuperscript{12} In burn ICU, almost all patients will have indwelling catheters and that may be the main source of infection of \textit{Staphylococcus epidermidis}.

\textit{Candida} infection is significant. Our findings that it is the third organism in prevalence among the expired patients. \textit{Candida} infection can be so severe to cause septic shock.\textsuperscript{13} \textit{Candida spp.} infection is rising in ICU.\textsuperscript{14} In burns it is know that the patient’s immunity is compromised, which make this infection significant. \textit{Candida} infection should be kept in mind when considering empirical therapy in septicaemia. \textit{Candida} is a commensal that usually found in urinary and gastronintestinal tract. Immunodepression and burns are known risk factors for \textit{Candida sepsis} infection.\textsuperscript{15}

\textit{Klebsiella pneumonia} grown was multidrug resistant organisms. \textit{Klebsiella pneumonia} is one of the most common organisms grown from blood cultures. As the rate of CRE and ESBL is high, appropriate empirical therapy is important. A study from Italy showed that inappropriate empirical therapy is associated with higher mortality rate.\textsuperscript{16}

Expired patients had earlier positive culture, higher TBSA and ABSI. We had positive blood culture as early as first day of admission, but this is not common. Usually, early death from burns that occur within 5 days is mostly due to multiorgan failure rather than sepsis.\textsuperscript{17} Early proper antibiotics use in sepsis is very important. Use of colistin as empirical therapy before culture results should be considered in patients with extensive burn in order to reduce the mortality. This approach on other hand may produce colistin resistant \textit{Acinetobacter} and this if developed will not respond to any other antibiotic.

\textbf{Conclusion:}

More than 50\% of patient with major burns had at least one positive blood culture. Mortality rate was significantly higher in the group who had positive blood culture. Expired patients had higher TBSA, ABSI and earlier positive blood culture. Multidrug resistant \textit{Acinetobacter} has become the most predominant microorganism grown in blood cultures of major burns in our unit.
Empirical therapy should include antibiotics that are effective against it in order to reduce mortality.

Authors’ Contribution
AJ, AH, MOK, MAS, KMH, ASD, SMG, AES, JJ, TA and AJ collected the data. MTB and SB analysed the data and drafted the manuscript. ATE revised the manuscript. All authors approved the final version of the manuscript.

Conflict of Interest
The authors declare no conflicts of interest.

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References:


Figure 1: Organism prevalence in all positive blood cultures.
Figure 2: Organisms prevalence in first blood culture.

Figure 3: Organisms prevalence in blood culture of expired patients.
Table 1: Comparison between positive and negative blood cultures groups

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<th>Positive blood culture</th>
<th>Negative blood culture</th>
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<tr>
<td>Number of patients</td>
<td>79 (50.9%)</td>
<td>76 (49.1%)</td>
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<td>Median Age</td>
<td>36</td>
<td>28.5</td>
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<tr>
<td>Median TBSA</td>
<td>42</td>
<td>30</td>
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<td>Median ABSI</td>
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