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Utility of Sequential Organ Failure Assessment score in predicting bacteremia in critically ill burn patients

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ABSTRACT

Background: We evaluated whether qSOFA ≥2 and an increase in SOFA (ΔSOFA) ≥2 can help predict bacteremia in a critically ill burn population.
Methods: Patients age ≥15 and TBSA ≥15% admitted between 2009 and 2015 were included. All blood cultures were recorded, and positive and negative blood culture days were defined based on the culture results. SOFA and qSOFA scores were compared between positive and negative blood culture days.
Results: There were 50 patients in our study with a mean age of 47yrs and mean TBSA burn of 37%. Bacteremic patients had larger TBSA and full thickness burns, higher revised Baux score, and longer hospital LOS, without a difference in mortality, compared to non-bacteremic patients. There was no difference in qSOFA and SOFA scores between positive and negative blood culture days. A ΔSOFA ≥5 was highly specific for positive blood culture days.
Conclusions: SOFA and qSOFA have limited ability to predict bacteremia in critically ill burn patients.
Summary: This study evaluates the utility of SOFA and quick SOFA scores in predicting bacteremia in a critically ill burn population. We found no difference in SOFA and qSOFA scores between positive and negative blood culture days. This suggests that these scoring systems may not be useful for predicting bacteremia in patients with burn injuries.

1. Introduction

Sepsis is a major cause of morbidity and mortality among burn patients, and the diagnosis of sepsis remains elusive despite all the advances in burn care over past few decades. Current definition of Systemic Inflammatory Response Syndrome (SIRS) was developed in 1992 by the American College of Chest Physicians (ACCP) and the Society of Critical Care Medicine (SCCM),[1] and it has since been widely used to diagnose infection and sepsis. However, patients with burn injuries experience chronic inflammation and constant exposure to organisms resulting in a hypermetabolic state that often persists for months after the initial injury. This hypermetabolic response leads to increased baseline temperature and heart rate, thus making SIRS a poor tool to help identify infections and sepsis.[2]

The American Burn Association (ABA) developed the ABA Sepsis Criteria (ASC) in 2007 with a goal to create a definition that is better able to distinguish between changes as a result of infection from changes secondary to the injury itself. This criterion had different cut-offs for temperature, tachycardia, and tachypnea, and also took into consideration thrombocytopenia, insulin resistance, and feeding intolerance.[2] Two subsequent studies have found ASC to be a poor predictor of bacteremia, even when coupled with a documentation of sepsis.[3,4]

The Sepsis-3 criteria, introduced in 2016 by the SCCM, defined sepsis as a life-threatening organ dysfunction caused by a dysregulated host response to infection, where organ dysfunction was

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defined by at increase in Sequential Organ Failure Assessment (SOFA) score of 2 points or more. For out-of-hospital and emergency department (ED) settings, a quick SOFA (qSOFA) score was developed to help identify patients at risk of poor outcomes.[5] A qSOFA score of ≥2, and an increase in SOFA score of ≥2, have both been shown to correlate with an increased risk of mortality in ED and intensive care setting, respectively.[6,7]

Designed as prognostic tools, the utility of SOFA and qSOFA to help identify infections and sepsis in unclear, especially in patients with burn injury. Therefore, the objective of our study was to evaluate whether a qSOFA score of ≥2 and an increase in SOFA score of ≥2, can help predict bacteremia in a critically ill burn population.

2. Methods

This was a retrospective study performed at an ABA-verified regional burn center serving adult and pediatric civilian populations. Patients age 15 years or older and a total body surface area (TBSA) burn of 15% or greater who were admitted to the burn intensive care unit between 2009 and 2015 were included. Patients who were admitted more than 72 h after injury, had hospital length of stay (LOS) of less than 72 h, died or made comfort care within 72 h, or had no blood cultures drawn during hospitalization were excluded.

A review of electronic medical record was performed to obtain demographic data, type and extent of burn injury, hospital LOS, ventilator days, and inpatient mortality. Injury Severity Score (ISS), Modified Baux and Acute Physiology and Chronic Health Evaluation (APACHE) II scores were calculated on the day of admission. All blood cultures obtained during hospitalization were recorded, along with other cultures (respiratory, urine, and wound) that were obtained at the same time. Laboratory and clinical data needed to calculate qSOFA and SOFA scores was obtained for the day of and one day prior to culture. When unavailable on the day of culture, laboratory data for platelet count and creatinine level was used from the preceding 3 days, and laboratory data for bilirubin level was used from the preceding 7 days. Medication administration record (MAR) was reviewed to determine whether patients were on systemic antibiotics at the time blood cultures were drawn.

We do not routinely obtain blood cultures at our institution, and there is no set protocol for obtaining them. The decision to obtain a blood culture is largely made by the attending physician and is based on the signs and symptoms of a systemic infection, such as high fever (usually >39.5 °C), hypothermia, tachycardia, hypotension, or worsening leukocytosis. Presence of fever alone does not automatically trigger a blood culture.

All blood culture results were reviewed for the presence or absence of bacteremia. Blood cultures that grew pathogens not containing common skin contaminants (i.e., diphtheroids, *Bacillus* species, *Proprionibacterium* species, coagulase-negative Staphylococci, or micrococci) were defined as positive, and those without growth were defined as negative. All blood cultures obtained from different sites on a single day were group together and considered as one blood culture day. A culture day was considered positive if any of the blood cultures obtained on that day resulted positive, whereas a culture day was considered negative when all blood cultures obtained on that day were negative.

Demographic, injury, and outcome variables were compared between patients with at least one episode of bacteremia during hospitalization and patients without bacteremia. Bivariate analysis was also performed by blood culture days, and SOFA and qSOFA scores were compared between blood culture positive and negative days. A difference in SOFA score (Δ SOFA) was calculated between total SOFA score on the day of culture and one day prior. To limit the influence of concurrent respiratory, urine, or wound infections on qSOFA and SOFA scores, we excluded blood culture days when one or more respiratory, urine, or wound cultures were positive.

Statistical analysis was performed using IBM SPSS© version 24 (IBM, Armonk, NY). Categorical variables were analyzed using Chi-square test or Fischer exact test as appropriate, while continuous variables were compared using Student's *t*-test or Mann-Whitney *U* test as appropriate. All means are reported as mean ± standard deviation and medians are reported as median (25th-75th percentile). This study was conducted under a protocol approved by the local Institutional Review Board.

3. Results

3.1. Patient population

There was a total of 50 patients in our study with a mean age of 46.9 ± 18.0 years. Majority (72%) of them were male, and flame/flash burn was the most common (84%) mechanism of injury. Inhalation injury was present in 17 (34%) patients. Mean TBSA burn was 37.4 ± 19.5% with mean full thickness burn of 22.0 ± 21.1%. Mean APACHE II score was 21.9 ± 9.3, mean revised Baux score was 90.0 ± 24.7, and median ISS was 18 (9, 25). Mean hospital LOS was 41.2 ± 26.7 days and median days on the ventilator was 8 (0, 19) days. Mortality was 16% (8 patients). Sepsis and multi-organ failure was the cause of death for 5 (63%) patients.

3.2. Comparison between bacteremic and non-bacteremic patients

Twenty-four patients (48%) had at least one episode of bacteremia during hospitalization. Comparing these bacteremic patients to non-bacteremic patients, there was no difference in age, gender, mechanism of burn injury, presence of inhalation injury, mean APACHE II score, and mortality between the two groups. The bacteremic group had higher mean TBSA burn, mean full thickness burn, median ISS, and mean revised Baux scores. Bacteremic patients also had a greater mean hospital LOS and median ventilator days (Table 1).

3.3. Blood culture analysis

Blood cultures were obtained on 199 days for the 50 patients

Table 1
Comparison between bacteremic and non-bacteremic patients.

	Bacteremic (n = 24)	Non-Bacteremic (n = 26)	*p*
Mean age (yrs)	47.3 ± 20.1	46.4 ± 16.1	0.855
Sex			0.211
Male	15 (63%)	21 (81%)	
Female	9 (37%)	5 (19%)	
Mechanism			0.150
Flame/flash	23 (96%)	19 (73%)	
Scald	1 (4%)	3 (12%)	
Chemical	0 (0%)	1 (4%)	
Mixed electrical and flame	0 (0%)	3 (11%)	
Inhalation injury	11 (46%)	6 (23%)	0.090
Mean TBSA burn (%)	44.4 ± 21.8	31.0 ± 14.	**0.016**
Mean full thickness burn (%)	30.1 ± 22.9	13.1 ± 14.7	**0.004**
Median ISS	25.0 (9.0, 36.8)	16.5 (7.0, 25.0)	**0.016**
Mean APACHE II score	24.0 ± 9.1	19.9 ± 9.3	0.122
Mean revised Baux score	99.4 ± 25.6	81.3 ± 20.6	**0.008**
Mean hospital LOS (days)	52.5 ± 30.4	30.9 ± 17.7	**0.004**
Median ventilator days (days)	15.5 (4.0, 29.3)	1.5 (0, 14.3)	**0.002**
Mortality	4 (17%)	4 (15%)	0.902

TBSA – Total Burn Surface Area, ISS – Injury Severity Score, APACHE - Acute Physiology and Chronic Health Evaluation, LOS – Length of Stay.
Bold signifies the $P < 0.05$ is considered statistically significant.

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