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Incidence of risk factors for bloodstream infections in patients with major burns receiving intensive care: A retrospective single-center cohort study

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ABSTRACT

Objectives: The objective was primarily to identify risk factors for bloodstream infections (BSI) caused by different pathogens.
Methods: A retrospective single-center cohort study was performed on 472 burn patients with an abbreviated burn severity index (ABSI) ≥ 3, a total burn surface area (TBSA) ≥ 10%, and an ICU stay of at least 24 h. Risk factors for different BSI pathogens were analyzed by competing risks regression model of Fine and Gray.
Results: A total of 114 burn patients developed 171 episodes of BSIs caused by gram-negative bacteria (n=78;46%), gram-positive bacteria (n=69;40%), and fungi (n=24;14%) median after 14 days (range, 1–164), 16 days (range, 1–170), and 16 days (range, 0–89), respectively. A total of 24/114 patients (21%) had fatal outcomes. Isolation of the most common bloodstream isolates *Enterococcus* sp. (n=26), followed by *Candida* sp. and *Pseudomonas* sp. (n=22 for both) was

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significantly associated with increased TBSA ($p \leq 0.006$) and ABSI ($p < 0.0001$) and need for fasciotomy ($p < 0.01$). The death risk of patients with MDR gram-negative bacteremia was significantly increased by a hazard ratio of 12.6 (95% CI:4.8–32.8; $p < 0.0001$).
Conclusions: A greater TBSA and ABSI were associated with a significantly higher incidence of BSIs caused by *Pseudomonas* sp., *Enterococcus* sp. and *Candida* sp.

1. Background

Burns represent severe injuries. However, in recent years, survival rates in burn patients have increased as a direct consequence of honed surgical techniques and improved intensive care [1–4]. With the improved survival, the time spent in the intensive care unit (ICU) is prolonged, and, consequently, the risk of infectious complications and sepsis as a leading cause of late death among patients with severe thermal injury has increased [3,5]. Previously, Patel et al. demonstrated a four-fold increase in mortality among burn patients suffering from bloodstream infections (BSI) [6]. A greater total burn surface area (TBSA) and the early usage of broad-spectrum antibiotics were found to further increase the risk for invasive fungal infections and nosocomial infections due to multidrug resistant (MDR) bacteria in burn patients requiring intensive care [1,5,7–9]. Infections caused by MDR bacteria and fungi represent a growing threat [8,10]. It has been previously suggested that MDR bacteria and *Candida* sp. often cause late BSI in patients with severe thermal injury [10]. These organisms have a tremendous impact on the potential therapy success in burn patients, and it is widely known that local and/or systemic infections with MDR bacteria represent a serious therapeutic challenge [11,12].

To identify organisms that cause BSI, we conducted a single-center retrospective cohort study over an 11-year period at the ICU for burn trauma of the General Hospital of Vienna, Austria. The objective was primarily to identify risk factors for BSI caused by different pathogens. Furthermore, we sought to demonstrate changes in the BSI pathogen profile during the ICU hospitalization period and determine mortality rates for different BSI pathogens.

2. Methods

2.1. Study population

A retrospective single-center cohort study was implemented in patients suffering from burn injury who were admitted to the 6-bed burn ICU of the General Hospital of Vienna, Austria between May 2003 and August 2014. Approval from the local ethics committee (EC No. 1652/2014) was obtained.

3. Study design and data collection

Inclusion criteria were severe burn injury, an abbreviated burn severity index (ABSI) [13] ≥ 3, a TBSA $\geq 10\%$, a stay at the ICU of at least 24 h, survival of at least 72 h, and a patient age ≥ 12 years.

Bacteremia/fungemia was defined as the presence of at least one positive blood culture for bacteria *spp.* and/or fungus during ICU stay. The procedure for taking blood cultures did not change over time. If there was any suspicion of infection (e.g. fever, increase of inflammatory parameters, clinical signs for pneumonia, acute abdomen, urinary tract infection or local wound infection), at least two to three aerobic and anaerobic blood cultures were drawn for microbiological analyses. In any case blood cultures were taken from the central venous catheter (CVC), the peripheral vein and/or the arterial line. If the CVC was removed for any reason the CVC-tip was sent to microbiological analysis. In the present study, we did not analyze if there was a match between pathogens isolated from blood cultures taken from the CVC and pathogens isolated from the CVC-tip. In the case of *coagulase-negative Staphylococcus* sp. (*CoNS*), *Propionibacterium* sp., or *Corynebacterium* sp. bacteremia was considered only when two or more subsequent blood cultures showed the same bacterial species with identical antibiogram [8]. Bacteria resistant to at least 3 classes of standard antibiotics (broad-spectrum beta-lactam antibiotics, including 3rd generation cephalosporins, quinolones, aminoglycosides, or carbapenem for gram-negative organisms, vancomycin for enterococci, or methicillin for *Staphylococcus aureus*) were classified as MDR.

Clinical data were recorded and analyzed according to age, gender, third-degree burn, inhalation trauma, number of surgical procedures, fasciotomy/escharotomy, TBSA, ABSI, patient transfer (no/national/international transfer), gastrointestinal complications, kidney failure, days spent in the ICU, and days until bacteremia/fungemia. Time to event was calculated from ICU admission to the occurrence of bacteremia/fungemia, death, or ICU discharge. The observation period was limited to the ICU stay. BSI infections and mortalities that occurred after ICU discharge were not included in the current investigation.

3.1. Microbiological BSI diagnostics

Blood culture samples each consisted of an aerobic and anaerobic bottle. Usually 1–3 samples were collected per blood draw. The blood culture bottles were incubated at 36.5–37 °C for up to 7 days in the semi-automated continuous-monitoring blood culture system BacT/ALERT 3D (BioMérieux, Marcy l'Etoile, France). Gram stain and subcultures on solid media were performed from positive blood cultures. Isolates were then identified by standard microbiological methods, Vitek II (BioMerieux, Marcy l'Etoile, France), or matrix-assisted laser desorption ionization-time of flight mass spectrometry

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