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# Burn-associated bloodstream infections in pediatric burn patients: Time distribution of etiologic agents

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ABSTRACT

*Background:* Infections are the leading cause of morbidity and mortality in patients with burns in burn units. Bloodstream infections (BSIs) in patients with burns may result from burn wound infection, use of invasive devices such as central venous catheters, and translocation of the gastrointestinal flora.

*Objective:* In this study, we investigated the distribution and antimicrobial drug resistance of causative pathogens in children with burns and the durational changes of microorganisms in the distribution of BSIs in children.

*Methods:* This study was conducted at the Pediatric Burn Unit (PBU) of Dr. Behçet Uz Children Research and Training Hospital during the period of November 2008–April 2015. The study subjects were all the patients admitted to the PBU, in whom microorganisms were isolated at least from one of the cultures, including blood and catheter cultures.

*Results:* Gram-positive bacteria were the most common causative agents of BSI in patients with burns (66.4%), followed by gram-negative bacteria (22.1%) and fungi (11.5%). The median duration of development of BSIs caused by gram-positive bacteria from the time of burn was 5 days (ranging from 2 to 54 days of burn), which was significantly shorter than that of BSIs caused by gram-negative bacteria (12 days) and fungal pathogens (13 days).

*Conclusion:* The etiologic agents of BSIs in children may differ from those in adults. Gram-negative drug-resistant bacteria such as multidrug-resistant *Pseudomonas aeruginosa* and *Acinetobacter baumannii* were important agents of BSI in patients with burns, especially in the long term; however, gram-positive bacteria should also be considered while deciding the antimicrobial therapy, especially in the early periods of burn.



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## 1. Introduction

Infections are the leading cause of morbidity and mortality in patients with burns [1]. The treatment and prevention of infections in patients with burns have always been a difficult challenge, even in developed countries. The skin forms a physical barrier, providing primary protection against microorganisms. Loss of or damage to skin integrity might enable pathogens to infiltrate the body, resulting in invasive infections [2].

Etiology of thermal injury and the number of microorganisms colonizing burn wounds might influence the risk of infections. The pathogens responsible for wound infections are reported to be primarily gram-positive bacteria including methicillin-resistant *Staphylococcus aureus* (MRSA) and gram-negative bacteria such as *Pseudomonas aeruginosa, Acinetobacter baumannii–calcoaceticus* complex, and *Klebsiella* species [3]. Bloodstream infections (BSIs) in patients with burns are important and frequent type of infections due to accumulation of several factors, including the presence of invasive indwelling devices, associated burn wound colonization, and translocation of the gastrointestinal microbial flora. *S. aureus*, *P. aeruginosa*, *K. pneumoniae*, and *Acinetobacter baumannii-calcoaceticus complex* are the organisms most commonly associated with bacteremia in patients with burns [3]. However, studies that mainly focus on BSIs in children with burns are limited in the English literature.

In the present study, we aimed to evaluate the distribution and antimicrobial drug resistance of microorganisms in children with burns and the durational changes of microorganisms in the distribution of BSIs in children.

## 2. Materials and methods

### 2.1. Study subjects and methods

This study included children who were hospitalized in the Pediatric Burn Unit (PBU) of Dr. Behçet Uz Children Research and Training Hospital, Izmir, Turkey, during the period of November 2008–April 2015. This hospital is a 400-bed pediatric teaching hospital with 2015 annual outpatient visits of more than 565,000 patients and approximately 21,000 hospitalizations per year. The PBU of our hospital is a 12-bed unit with annual admission of 245 patients corrresponding to 3845 patient days per year. In clinical settings, the subclavian vein was the preferred site for central venous catheterization, and the catheter was removed as soon as possible. The prophylactic antibacterial agents included sulbactam–ampicillin, and no antifungal prophylaxis was performed in the PBU.

Blood and other site cultures were obtained from the patients when they had fever. The study included all the patients admitted to the PBU, in whom microorganisms were isolated from at least one of the cultures, including blood and catheter cultures. The demographic characteristics of the patients were recorded using medical and computerized microbiology laboratory records.

### 2.2. Definitions

The blood culture results during the PBU hospitalization period were included in the study, while other culture results were excluded from the study. In the blood cultures, patients who had at least two isolations of coagulase-negative staphylococci (CoNS) in a period of 24 h of sampling were included. For multiple isolations of the same causative microorganism, the initial time of isolation was accepted. A blood culture was considered to be contaminated if one or more of the following organisms were identified in only one of a series of blood culture specimens: CoNS, *Propionibacterium acnes*, *Micrococcus* species, *viridans streptococci*, *Corynebacterium* species, or *Bacillus* species. The date of the microorganism culture was calculated from the date of the burn and isolations after the 60th day of the burn were excluded. Carbapenem resistance was evaluated for *P. aeruginosa* and *A. baumannii* and resistance to methicillin and vancomycin antibiotics was evaluated for *Staphylococcus* species and *Enterococcus* species. The presence of extended-spectrum beta-lactamase (ESBL) in *Klebsiella pneumoniae* isolates was also investigated. The duration of isolation of the microorganisms was divided into four groups: first week, second week, third week, and longer than third week.

### 2.3. Microbiological analysis

Each blood culture bottle was placed in the BacT/ALERT 9240 automated system (bioMeérieux, Marcy l'Etoile, France) and incubated for 7 days or until they were found to be positive [4].

A sample of blood from positive blood cultures was inoculated onto chocolate, eosin methylene blue lactose sucrose, and blood agar plates and incubated at 37 °C, 5% $CO_2$, for 48 h, according to the national laboratory guidelines. The microorganisms were identified with VITEK-2 compact system (bioMeérieux), and antibiotic susceptibility tests (including MIC levels, ESBL presence, and carbapenem resistance) were also performed with the same system for each isolate according to the manufacturer's instructions and the Clinical and Laboratory Standards Institute's criteria [5]. Identification and antibiotic susceptibility tests of gram-positive bacteria were performed using the automated VITEK-2 system with gram-positive identification card AST-P592, a supplementary Etest (bioMeérieux, Durham, NC, USA), and a disk diffusion test according to the manufacturer's instructions [6]. Vancomycin-resistant *Enterococcus spp.* (VRE) and MRSA were also identified using the automated VITEK-2 system [6]. This system was also used for the identification and antibiotic susceptibility tests of gram-negative bacteria with gram-negative identification card AST-N325, AST-N326, and AST-N327 [7]. The yeast identification was performed using API 20C AUX (bioMeérieux) [8].

This study was approved by the Local Ethical Committee of Dr. Behçet Uz Children's Training and Research Hospital.

### 2.4. Statistical analysis

Statistical analysis was performed using SPSS, version 15.0 (IBM SPSS, Chicago, IL). Quantitative data are expressed as mean ± standard deviation or median with interquartile