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ORIGINAL ARTICLE

Central venous catheter-associated bloodstream infections in pediatric hematology–oncology patients and effectiveness of antimicrobial lock therapy



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KEYWORDS

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Background: Central line-associated bloodstream infection (CLABSI) is a serious complication in hematology–oncology patients. This study aimed to analyze the prevalence of CLABSI and the effectiveness of antimicrobial lock therapy (ALT) in pediatric patients.

Methods: BSIs of all pediatric hematology–oncology patients admitted to a children’s hospital between January 2009 and December 2013 were reviewed. The United States National Healthcare Safety Network and Infectious Diseases Society of America guidelines were used to define CLABSI and catheter-related BSI (CRBSI). The incidence, laboratory and microbiology characteristics, poor outcome, and effectiveness of ALT were analyzed.

Results: There were 246 cases of CLABSI in 146 patients (mean age, 10.0 years), including 66 (26.8%) cases of CRBSI. The incidence of CLABSI was 4.49/1000 catheter-days, and the

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infection was responsible for 32.9% of the complications these patients developed and 9.3% of contributable mortality. Patients with acute myeloid leukemia had the highest infection density (5.36/1000 patient-days). Enterobacteriaceae (40.2%) and coagulase-negative staphylococci (CoNS; 20.7%) were the predominant pathogens. In multivariate analysis, older age, male sex, elevated C-reactive protein, acute lymphoblastic leukemia, and candidemia were associated with poor outcome. The success rate of ALT was 58.6% (17/29) for the treatment of CoNS and 78.3% (29/37) for Enterobacteriaceae infections. Patients with candidemia ($n = 18$) had the highest mortality (33.4%) and catheter removal rate (66.7%). Chlorhexidine as the disinfectant decreased the 1-year CLABSI rate from 13.7/1000 to 8.4/1000 catheter-days ($p = 0.02$).

Conclusion: CoNS and Enterobacteriaceae are the predominant pathogens in CLABSI among pediatric hematology–oncology patients. ALT is effective and showed no significant side effect. New disinfection practice and infection control measures can decrease CLABSI.

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Introduction

In pediatric hematology–oncology patients, the central venous catheter, especially totally implantable venous access ports (Port-A), is important for the administration of antineoplastic chemotherapy, blood component therapy, and parenteral nutrition. It is also useful for blood sampling. The most common and serious complication is central line-associated bloodstream infection (CLABSI) or catheter-related BSI (CRBSI). The most commonly involved organisms are coagulase-negative staphylococci (CoNS), *Staphylococcus aureus*, *Enterococcus* spp., *Escherichia coli*, *Klebsiella* spp., other enteric Gram-negative bacteria, and *Candida* spp.,¹ with infection rates varying widely in different patient groups.

In adults, 5.6–8.0% of patients with Port-A catheter experience a related infection, with the incidence rate ranging from 0.15 to 0.39/1000 catheter-days.^{1–4} However, there is a lack of similar data in the pediatric group. An estimated 0.2 episodes/1000 catheter-days in children with sickle cell disease and 11 episodes/1000 catheter-days in infants with intestinal insufficiency have been reported.^{5,6}

The diagnosis of CRBSI is based on the culture of the removed catheter tips or on quantitative blood cultures drawn from the catheter and from peripheral veins. The incidence of CRBSI is difficult to evaluate because of the need to obtain blood samples in pairs in the pediatric group. Antimicrobial lock therapy (ALT), also called anti-infective lock therapy or antibiotic lock therapy involves instilling an antibiotic or antiseptic into the catheter lumen to permit high concentration at the site of infection, is a novel way of treating CLABSI while attempting to salvage the catheter.^{1,7} Performing ALT early to save the catheter or avoid unnecessary systemic treatment is valuable, especially in the pediatric group. The Infectious Diseases Society of America treatment guidelines for CRBSI recommend the routine use of adjunctive ALT for adults and children.⁸ This retrospective study analyzed the incidence, laboratory and microbiology characteristics, risk factors, and outcomes in CLABSI/CRBSI episodes, and the effectiveness of ALT in pediatric hematology–oncology patients.

Methods

Patients and setting

This study was conducted in a university-teaching pediatric hospital in Taipei, Taiwan, with 292 beds. Pediatric hematology–oncology in-patients, aged 0–18 years, with central venous catheter who had a BSI from January 2009 to December 2013 in the oncology department were enrolled. Patients with BSI with other identified infectious foci were excluded. The data retrieved from the medical records included sex, age at the infection day, hematological–oncological diseases, date of central venous catheter implantation and removal, white blood cell count, neutropenia (absolute neutrophil count $< 500/\text{mm}^3$), level of C-reactive protein (CRP), microbiology results of all clinical specimens, use of systemic antimicrobial therapy, and the duration and regimen of ALT for documented infections.

Disinfection methods

For central line entry-site care, topical skin disinfection with povidone–iodine swabs and dry gauze dressing were used weekly or whenever the dressing is soiled or loose. Since June 2012, 2% chlorhexidine (in 70% alcohol) was used as the disinfectant as recommended by the U.S. Centers for Disease Control and Prevention guideline.⁹

Patient management and follow up

In the hematology–oncology departments, the primary physicians were encouraged to obtain blood samples (at least 1 mL) for culture from the central line catheter and peripheral veins in pairs when the patients had clinical symptoms or signs of infection, fever $> 38.3^\circ\text{C}$, or unstable vital signs (e.g., hypotension, tachypnea, tachycardia/bradycardia, or consciousness change). Samples from other potential infection foci were also cultured to determine the origin of infection. Empirical antibiotics were administered after obtaining blood cultures and their doses were adjusted based on the culture results. When CRBSI or a

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