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Original Article

The epidemiology, antibiograms and predictors of mortality among critically-ill patients with central line-associated bloodstream infections

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Abstract *Background/purpose:* For high risk of central line-associated bloodstream infections (CLABSIs) in patients of intensive care units (ICUs) and scarcely epidemiology and therapeutic recommendations in Asia, we aimed to evaluate the annual change in epidemiology, antibiogram, and risk factors for 14-day mortality.
Methods: A retrospective study of ICUs patients with CLABSIs at a medical center in Taiwan (2010—2016), where central line care bundle implemented since 2014, by reviewing clinical data, pathogens, and the antibiogram.
Results: Gram-negative bacteria (59.3%) were main microorganisms of CLABSIs, and 9.0% of all GNB were MDROs. *Acinetobacter* spp., *Enterobacter* spp., and *Stenotrophomonas maltophilia* were the most frequently isolated. In multivariate analysis, malignancy, inadequate empirical antimicrobial therapy, inadequate definite antimicrobial therapy, and infection by fungi or multidrug-resistant organisms (MDROs) were associated with 14-day mortality (all $p < 0.05$). The CLABSI incidence rate decreased from 5.54 to 2.18 per 1000 catheter-day (from 2014 to 2015) with improved compliance to care bundle. Carbapenem and aminoglycoside were

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suitable empirical drugs in the hospital setting when GNB is predominant for CLABSI. Significant decreasing susceptibility of ampicillin/sulbactam in *Enterobacter* spp. (36.7%−0.0%), and ampicillin/sulbactam (12.5%−0.0%), ceftazidime (100.0%−52.9%), and tigecycline (87.5% −35.3%) in *Serratia marcescens*.

Conclusion: We identified Gram-negative bacteria as leading pathogens of CLABSIs in a Taiwan medical center, and good compliance to care bundle is associated with reduced CLABSI incidence rate. Malignancy, infection by MDROs or fungi, inadequate empirical or definite antimicrobial therapy are significant factors for 14-day mortality.

Introduction

Central line-associated bloodstream infection (CLABSI) is the leading cause of healthcare-associated infection (HAI) worldwide and is responsible for significant mortality, extended duration of hospital stays, and excess health cost expenditures.[1−4] CLABSI is also the major problem for intensive care units (ICUs) due to the widespread use of central line in critically-ill patients. However, the data of evolution and changing epidemiology within a population of CLABSIs were rare in Asian countries,[5,6] made it difficult to recommend empirical therapy for pathogens coverage according to specific circumferences. The increasing rate of multidrug resistant Gram-negative pathogens in HAIs may also have impact on CLABSI outcome.[4,7,8] Despite the various global surveillance studies, e.g. Study for Monitoring Antimicrobial Resistance Trends (SMART) has monitored the *in vitro* susceptibility patterns of clinical Gram-negative bacilli to antimicrobial agents collected worldwide from intra-abdominal infections since 2002 and urinary tract infections since 2009,[9−11] there was limited information about the related epidemiology of CLABSIs.

In this study, we analyzed the episodes of CLABSIs over the 2010−2016 period in a Taiwan medical center, among patients admitted to adult ICUs with central lines placed in order to investigate the incidence rates, bacteriological profile, antimicrobial susceptibility pattern, and risk factors associated with 14-day mortality in this setting.

Methods

Study design and data collection

We performed a retrospective cross-sectional study for CLABSI in ICU cases over a 7-year period (from January 2010 to December 2016) at Kaohsiung Medical University Hospital, a medical center in Taiwan. This study was approved by the Institutional Review Board of the Kaohsiung Medical University Hospital. The hospital provided 117 adult ICU beds (30 medical ICU beds, 20 cardiac care unit beds, 13 neurologic ICU beds, 25 surgical ICU beds, 10 cardiac surgical ICU beds, 14 neurosurgical ICU beds, and 5 burn center beds), and all with a nurse-to-patient ratio of 1:2.

A CLABSI interventional bundle was implemented since October 2011 according to the recommendation of CDC guidelines[12] in two ICUs since October 2011 and in all ICUs since January 2014. A multidisciplinary central-line bundle is defined as a combination of education, interventions such as selection of appropriate insertion site, application of hand hygiene, cleaning of the skin with alcohol followed by 2% chlorhexidine, full barrier precaution during the insertion of a central line, and the maintenance included hand hygiene, proper dressing changes, aseptic technique for accessing and changing needleless connectors, and a daily review of catheter necessity.[13] The items of a checklist during surveillance for ensuring the precision and accuracy of measurement includes hand hygiene, appropriate skin disinfection, maximal sterile barrier, catheter insertion site evaluation, proper dressing coverage, closed system of the catheter, and aseptic technique before using connectors.

All participants aged ≥18 years admitted to ICUs and had one or more central line catheterization were enrolled. By reviewing the medical records of those patients with CLABSIs, both of an infectious-disease specialist and another infection control practitioner excluded all secondary bloodstream infections, and recorded baseline demographics, main diagnosis on ICU admission, underlying diseases, catheter insertion site, causative microorganisms, the length of ICU stay, 14-day hospital mortality and in-hospital mortality. A new episode was defined by a different pathogen isolated from subsequent blood cultures, given that a patient could develop more than one CLABSI episode. Empirical antimicrobial therapy was defined as prescription of at least a new antibiotic within 48 h when a CLABSI episode was concerned and had corresponding blood sampling. Furthermore, the annual *in vitro* susceptibility of microorganisms isolated from episodes of healthcare-associated infection (HAI) were collected. Appropriate antimicrobial therapy was considered when the pathogen was susceptible to any one of the agents administered during the CLABSI episode by *in vitro* testing or previously published data.[14,15]

Definition of terms

CLABSI was defined based on the Centers for Disease Control and Prevention (CDC)/National Healthcare Safety Network (NHSN) definition in 2008.[12] A patient with a central venous catheter who has a recognized pathogen isolated from one or more blood cultures after 48 h of catheterization; or with the same skin commensals cultured