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ORIGINAL ARTICLE

Increased frequency of peripheral venipunctures raises the risk of central-line associated bloodstream infection in neonates with peripherally inserted central venous catheters

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Background/Purpose: Central-line associated bloodstream infection (CLA-BSI), which is mostly caused by coagulase-negative staphylococcus, is an important morbidity in neonatal intensive care units. Our study is aimed to identify the risk factors of CLA-BSI in neonates with peripherally inserted central venous catheters (PICCs).
Methods: A retrospective cohort study of neonatal intensive care unit patients with a PICC insertion between January 1, 2011 and December 31, 2012 was conducted. We performed univariate and multivariate analyses with a logistic regression model to investigate the risk factors and the association between increased frequency of peripheral venipunctures during PICC use and the risk of CLA-BSI while adjusting for other variables.
Results: There were 123 neonates included in our study. Thirteen CLA-BSIs were recorded within the follow-up period. The incidence of PICC-associated CLA-BSI was 4.99 per 1000 catheter-days. There was no statistically significant association between the risk of CLA-BSI and gestational age, birth weight, chronological age, or other comorbidities. However, the odds of CLS-BSI increased to 12 times if the patient received six or more venipunctures within the period without concurrent antibiotic use [odds ratio (OR), 11.94; $p < 0.001$]. The OR of CLA-BSIs increased by 16% per venipuncture during PICC use (OR, 1.14; $p = 0.003$).

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Conclusion: During PICC use, increased frequency of venipunctures, especially when there was no concurrent antibiotic use, substantially raises the risk of CLA-BSI. By decreasing unnecessary venipunctures during PICC use, PICC-associated CLA-BSI and further morbidities and mortalities can be prevented.
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Introduction

Hospital-acquired infections (HAIs), which usually result in the majority of the mortality and morbidities in the intensive care unit (ICU) setting, have been a serious problem for the health care of premature infants. In a survey conducted in the United States, HAIs occurred in about one-tenth of the patients in neonatal intensive care units (NICUs).[1,2] More than 50% of HAIs were bloodstream infections, especially central-line associated bloodstream infection (CLA-BSI).[1–3] The attributable mortality rate of CLA-BSIs in the ICUs ranged from 4% to 20%,[4] although the rate may be a little lower in the NICU,[5] but the consequent morbidities and prolonged duration of ICU admission still accounted for considerable medical costs.[4,6]

Although older children in the pediatric ICU may have other types of central lines, for example, double lumen catheter for renal replacement therapy or catheters for extracorporeal life support, peripherally inserted central catheter (PICC) accounts for the majority of central lines in the NICU because its placement is easier and it has fewer complications than a traditional central venous catheter.[7–10]

Many studies has tried to find the possible pathogenesis and the risk factors of CLA-BSI, but no consensus has been achieved.[11–17] Whereas some researchers argued whether low bodyweight (either at birth or at the time of catheter insertion) and the use of total parenteral nutrition contributed to CLA-BSI,[9,11,15,17] recent studies favored the prolonged duration of PICC use as the most important risk factor of acquiring CLA-BSIs.[13,18]

By contrast, about 70–90% of PICC-associated CLA-BSIs were caused by coagulase-negative staphylococci (CoNS).[11–13,19] Previous researchers considered that intraluminal colonization and increased frequency of hub manipulation might be the main pathogenesis of CLA-BSIs.[12,20] However, these studies had controversial findings to make a definite explanation, and their conclusion could not be applied completely to CLA-BSI in patients with PICCs. As a result, we designed this study to investigate the risk factors of PICC-associated CLA-BSIs.

Methods

Setting and patients

We conducted a retrospective cohort study of patients in the NICU at the National Taiwan University Hospital (NTUH), a tertiary-care facility in northern Taiwan. The NICU is a 25-bed ward admitting about 800–900 patients per year. Most patients in the NICU were born at the NTUH and admitted to the NICU soon after birth. The others were transferred to the NTUH from local obstetric clinics or other hospitals for more advanced medical care, for example, surgery for congenital heart disease.

In the NTUH NICU, a PICC would be inserted to deliver parenteral nutrition when a patient was not anticipated to have adequate oral intake at about 1 week after birth. PICCs were inserted by a skillful and experienced team, including pediatric residents and neonatologists, according to the standard protocol with sterile methods.

In this study, we included all the patients who received at least one PICC placement in the NTUH NICU between January 1, 2011 and December 31, 2012. The patients whose PICC insertion was performed at other hospitals prior to being transferred to NTUH were excluded because we could not confirm the medical records during the PICC use, and the setting and the catheter care routine were different outside the NTUH.

Data collection

The list of patients who had bloodstream infection that occurred in the NICU was obtained from the database of the central laboratory of NTUH. CLA-BSI was identified according to the surveillance definition of Centers for Disease Control and Prevention's National Healthcare Safety Network for CLA-BSI.[21,22]

The microorganism of CLA-BSI was cultured with standard laboratory methods at the central microbiology laboratory of NTUH, and the antibiotic susceptibility profiles were obtained from laboratory reports.

We reviewed all the medical charts of the eligible patients and conducted a thorough survey to record the data on sex, date of birth, gestational age at birth, birth bodyweight, and comorbidities during NICU admission. Data including the date of PICC insertion and removal, the site of PICC insertion, the date of antibiotic use and discontinuation, and the frequency of peripheral venipunctures patients received during PICC use were extracted from detailed medical records. Gestational age was categorized as $<$32 weeks or $\geq$32 weeks. Birth weight was categorized as $<$1500 g or $\geq$1500 g.[1,23] Chronological age was grouped as $\leq$7 days or $>$7 days. The PICC duration was divided into three groups — $\leq$10 days, 11–20 days, and $>$20 days — in univariate analysis, and the frequency of peripheral venipunctures was grouped as $<$6 times and $\geq$6 times.

Definition

In our study, a CLA-BSI was defined as a primary bloodstream infection in a patient that had a central line within the 48-hour period prior to the development of the

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