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ORIGINAL ARTICLE

Changing of bloodstream infections in a medical center neonatal intensive care unit

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Abstract *Background/Purpose:* Bloodstream infections (BSIs) are associated with high mortality and morbidity in neonatal intensive care units (NICUs). The epidemiology of these infections may change after the application of new infection control policies. The aims of this study are to reveal the changing epidemiology of BSIs in our NICU and inspect the effects of infection control efforts.

Methods: We reviewed and analyzed the clinical characteristics of culture-proven BSIs in our NICU from 2008 to 2013 and compared them with our two previously reported data (1992–2001 and 2002–2007).

Results: The mortality rate decreased from 16.3% in 1992–2001 to 5.6% in 2008–2013. In the recent study period, Gram-positive infections became predominant (58.0%). Coagulase-negative staphylococci remained the most commonly isolated organisms (26.0%). Group B *Streptococcus* (GBS) BSIs had the highest mortality rate (30.0%). Most GBS-infected infants' mother did not perform prenatal GBS screening. There was a decrease in the total fungal infection rate after fluconazole prophylaxis for very-low-birth-weight (VLBW) neonates, but the infections of fluconazole-resistant *Malassezia pachydermatis* increased. The incidence of central line-associated BSI increased to 10.6% in 2011. After restricting the catheter duration to <21 days, the incidence decreased to 4.2% in 2013.

Conclusion: Through the years, the overall mortality rate of BSIs in our NICU decreased. Maternal GBS screening is an important issue for avoiding early onset GBS mortality. Fungal

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infection rate decreased after antifungal prophylaxis policy for VLBW infants, but we should be aware of resistant strains. Restriction of the catheter duration may decrease the incidence of catheter-related BSI.

Introduction

Neonatal infection is a major cause of mortality and morbidity in newborns. Estimates suggest that >1.4 million neonatal deaths worldwide annually are due to invasive infections.[1] A systemic analysis of child mortality for 2010 with time trends since 2000 indicated that bloodstream infections (BSIs) are responsible for 13% of all neonatal mortality, and 42% of deaths in the 1st week of life.[2] Therefore, prevention and management of BSIs are very important to improve the outcomes of neonatal intensive care unit (NICU) patients. The epidemiology of BSIs in each NICU is different. Even in the same NICU, it will change over time. A BSI incidence rate of 3.01% with a density of 3.29 infections/1000 admission days in our NICU during 1992–2001 had been reported previously.[3] However, the incidence density changed to 2.78 infections/1000 admission days during 2002–2007 (unpublished report). In another northern Taiwan hospital, the reported incidence of BSI was 9.31% with an incidence density of 10.98 infections/1000 admission days during 1999–2001,[4] whereas the incidence rate was 4.06% in another hospital during 2001–2006.[5]

To decrease the burden of infections, several major infection control policies and procedures have been applied during the recent few years in our NICU, including maternal group B *Streptococcus* (GBS) screening plus intrapartum antibiotic prophylaxis, prophylactic fluconazole administration in very-low-birth-weight (VLBW) infants, restriction of peripherally inserted central catheter (PICC) duration to no longer than 21 days, etc. The aims of this study are to reveal the changing epidemiology of BSIs in our NICU and focus on the effects of the aforementioned infection control efforts.

Methods

Institute and ethics statement

This study was conducted in the NICU of a tertiary-level teaching hospital in northern Taiwan. The NICU has a total capacity of 23–33 beds, 348–896 hospitalized patients/year. This study and its protocol were approved by the Ethics Committee of MacKay Memorial Hospital, Taipei, Taiwan (Institutional Review Board number 14MMHIS 136).

Data collection and comparison

We collected the data from culture-proven BSI patients in NICU between January 2008 and December 2013, and compared these data with previously published (1992–2001)[3] and orally reported data (2002–2007). The data collected included patients' sex, gestational age, birth weight, symptoms/signs and the age of onset, pathogens, perinatal risk factors, underlying and associated conditions, maternal GBS screening, use of PICC, outcomes, etc.

Definition

BSI was defined according to the surveillance guidelines published by the Taiwan Centers of Disease Control, which required a positive blood culture result with at least one of the following signs or symptoms: fever (anal body temperature $> 38^{\circ}C$), hypothermia (anal temperature $< 36^{\circ}C$), apnea, and bradycardia; and that the signs or symptoms and positive laboratory results were not related to a previous infection at another site. Patients were excluded if the blood culture results were caused by contamination, such as that caused by commensal organisms (e.g., a Gram-positive bacillus in a patient with a negative result in the second set of blood culture drawn before antibiotic agents were administered or in a patient who recovered without use of antibiotics or without clinical symptoms of infection).

For comparison with previous data, we defined patients with BSIs within the first 7 days of life as the early onset group and those afterward as the late-onset group,[6] although some investigators divided them at or before 72 hours of life.

Premature rupture of membranes was defined as rupture of membranes >24 hours prior to delivery. Maternal fever and chorioamnionitis were based on maternal hospital records. Prematurity was defined as gestational age <37 weeks. LBW infants were those with birth weight <2500 g, and VLBW babies were those with birth weight <1500 g. Other perinatal risk factors recorded included Apgar score <7 at 5 minutes of life, delay of initial crying, meconium aspiration syndrome, fetal distress, maternal eclampsia, hydramnios, cesarean section due to placenta previa, placenta abruption, etc.

BSI-related mortality was defined as death with positive blood culture and diagnosis of sepsis or septic shock in the same episode. If the death could be explained by other reason, it was not considered in this category.

A PICC-associated central line-associated BSI (CLA-BSI) was defined as a primary BSI in a patient admitted to the NICU for > 48 hours before the onset of infection and met the National Healthcare Safety Network (NHSN) criteria for CLA-BSI.[7]

Statistical analysis

Data were analyzed by Chi-square or Fisher's exact test for categorical variables, as appropriate. Univariate analyses

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