

Blood Stream Infection in a Neonatal Intensive Care Unit (NICU) Level III, in AlHasa, Saudi Arabia

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Abstract

Introduction: Hospital-Acquired Infection (HAI) is a serious health problem affecting the patients in the Neonatal Intensive Care Units (NICUs) worldwide. Medical literature suggests that bloodstream infection (BSI) is considered as the most common kind of HAI. Hence this study focuses on BSI among the neonates at the NICU.

Aim: To determine the prevalence of BSI, and their association with the patients' gestational age and their birth weight, the causative agents, predominant agents found in the isolates, and antibiotic sensitivity. It likewise probes deeper on whether the infection was device-associated.

Methodology: A retrospective descriptive study was done among 99 patients with positive blood culture from the total unit admissions of 1209 from January-2017 to December-2018.

Result: The prevalence of BSI is 8.19%, with the extremely preterm and those with extremely low birth weight representing the most affected cases of 39.4% and 48.5%, respectively. Gram-negative organisms are the leading cause of BSI; coagulase-negative Staphylococcus is the predominant organism found in the isolates. Most of the neonates who developed BSI were device-related (intubation and central line insertion); survival rate among them was 53.5%.

Conclusion: Nosocomial infections, especially bloodstream infections, are a significant public health problem worldwide. The rate of BSI in the study is higher than the global rate but resembles the local rates. The risk factors inversely proportional to BSI are gestational age, and birth weight but directionally proportionate to invasive procedures, either because of intubation or catheter-related procedures. Finally, improving prenatal health care, implementing strict infection control standards, and choosing proper antibiotics are recommended to avoid BSI in neonatal intensive care units.

Keywords: NICU; BSI; Blood Stream Infection; Gestational Age; Hospital-Acquired Infection

Introduction

Hospital-Acquired Infection (HAI), a serious worldwide health concern commonly affecting patients in the Neonatal Intensive Care Units (NICU), is considered as one of the major leading causes of mortality, morbidity, and prolonged hospitalization [1]. The rate of mortality among neonates in the developing country is as high as 80 per 1000 live births [2]. Although the survival rate of smaller and sicker

infants increases with advanced neonatal care, nosocomial infection remains a serious problem [3]. This is because, increase in invasive procedures, which is part of monitoring and treatment regimen, result to the further rise of HAI's. Neonates especially preterms and those with low birth weight, are more susceptible to HAI's because of their low immunity and immature defenses mechanisms [4]. It is cited in numerous literature that the most common type of HAI is bloodstream infection (BSI), which is "an infectious disease defined by the presence of viable bacterial or fungal microorganisms in the bloodstream and confirmed in clinical laboratories by at least one positive blood culture [5-7]. This study, then, focuses on the prevalence of BSI and their association with the patients' gestational age and their birth weight, the causative agents, predominant agents found in the isolates, and antibiotic sensitivity. It likewise probes deeper on whether the infection was device-associated.

Materials and Methods

This study was done at the NICU Level III of Maternity and Children's Hospital, Al-Ahsa, Saudi Arabia, a central referral government hospital specialized in providing healthcare and therapeutic services for maternity and children in the whole Al-Ahsa area. The hospital's deliveries are around 12,000 per year. The targeted Level III NICU has 16 beds with 100% occupancy rate the whole year. The most common cases in the unit are prematurity, meconium aspiration syndrome, respiratory distress, perinatal asphyxia and persistent pulmonary hypertension of the newborn.

Out of 1209 neonates, 99 were selected as subjects based on the inclusion and exclusion criteria. The sample includes all admissions to NICU Level III from January-2017 to December-2018, with a positive blood culture for more than 48 hours during the study period. Exclusion criteria include the following: maternal history of ante- and intra-partum infection, positive blood culture on admission, presence of immunodeficiency disease, non-institutional delivery and who readmitted back to hospital after 3 days of discharge.

Neonates were sub-grouped into 4 based on gestational age as follows: extremely preterm (EPT) or those less than 28 weeks, very preterm (VPT) from 28 to 32 weeks, moderate to late preterm (PT) from 32 to 37 weeks, and term (T) between 37 and 41 weeks [8].

The neonates were also classified according to their birth weight as follows: extremely low birth-weight (ELBW) or those who are less than 1000g, very low birth-weight (VLBW) less than 1500g, low birth-weight (LBW) less than 2500g, normal birth-weight (NBW) between 2500g and 4000g and high birth-weight (HBW) more than 4500g [9]. A retrospective descriptive study was done by reviewing and recording data from the patients' records, infection control department case studies, and microbiology department records. Descriptive statistics were used to summarize the baseline characteristics. All statistical analyses, graphs, and tables were performed by using SPSS 25 (IBM).

Results and Discussion

Out of 1209 neonates admitted to NICU Level III from January-2017 to December-2018, there were 99 neonates (8.19%) who developed 135 bloodstream infections. Figure 1 shows the frequency and percentage of neonates according to gestational age. The mean was 30.01 weeks (standard deviation - SD \pm 4.350). The most affected age group is the extremely preterm, which represents 39.4%. In terms of birth weight, those classified under ELBW represents the most affected cases by 48.5%. The mean weight was 1448.61g (standard deviation - SD \pm 917.4) (Table 1). As with the isolates, 66.67% were gram-negative bacteria, 21.48% were gram-positive bacteria, and 11.85% were fungi. The microorganisms which were identified are shown in figure 2. Coagulase-negative *Staphylococci* (CoNS) is the dominant microorganism identified among the study subjects (29 cases) which represent 21.4% of the total infectious organisms, followed by *Serratia* spp, *Klebsiella* spp and *Candida* SPP (12.6%, 11.9% and 11.85%, respectively). The 99% of the neonates who developed BSI were intubated, 91.9% of them have central lines and 5.1% have undergone surgical procedures. The data shows that 53.5% of all infected patients

have survived while 46.5% have expired. Overall, the total deaths during the study duration was 267 patients, 46 of them were due to BSI, representing 17.2% of the total cases of HAIs. The 94.7% of those with *Staph Spp* were Methicillin-resistant *Staphylococcus aureus* (MRSA) and 17 (89.5%) out of 19 were sensitive to vancomycin. *Klebsiella spp*, like *Serratia Spp*, were resistant to ampicillin (86.7% and 85.7%, respectively). *Serratia spp* is sensitive to Tienam with 71.4%, and *Klebsiella spp* was susceptible to Tienam by 60%. There is a trend of cephalosporin resistance in both *Serratia spp* and *Klebsiella Spp*. In the cases of *Klebsiella spp* infections, 12 (80.0%) out of 15 were resistant to Cephalosporins up to the third generation, while 3 cases (20.0%) were sensitive. There are 9 (69.23%) cases of *Serratia* that were resistant to the third generation of Cephalosporins. There are no cases that were resistant to the fourth generation of Cephalosporins.

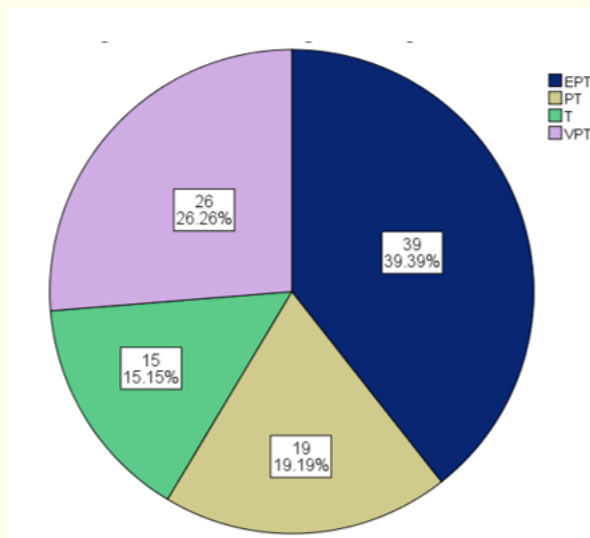


Figure 1: Frequency and percentage of neonates according to gestational age and BSI.

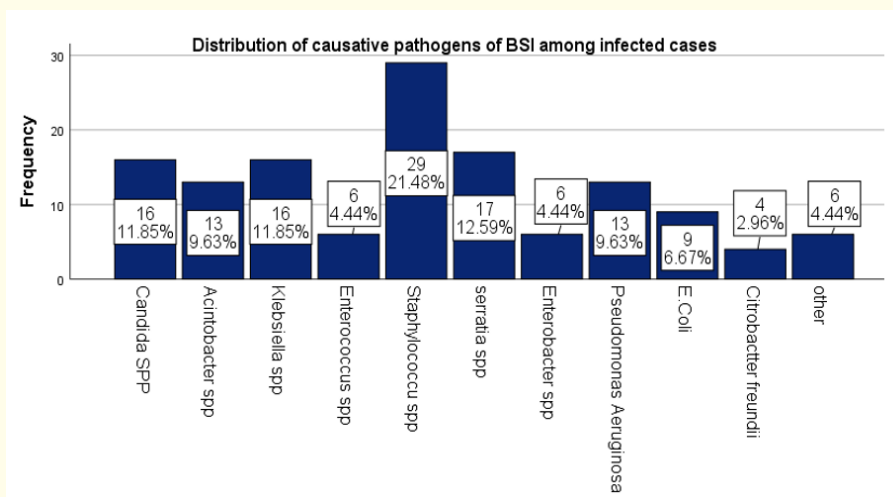


Figure 2

	Frequency	Percent
ELBW	48	48.5
HBW	1	1.0
LBW	12	12.1
NBW	14	14.1
VHBW	1	1.0
VLBW	23	23.2
Total	99	100.0

Table 1: Frequency and percentage of birth-weight of BSI cases.

Discussion

The current study shows the prevalence of bloodstream related infections (BSIs) in the investigated unit, which is 8.19%. Many studies had been done regarding BSI and reported a wide range of infection rates in different institutions. AA Mahfouz., *et al.* 2010 reported that the prevalence of BSI is 7.8%, which is slightly lower than this study's result [10]. The present research categorized the sample based on their birth weight and gestational age. It is suggested by this study that the lower the birth weight and gestational age, the higher the incidence of BSI. The same findings were reported by AK Al-Zahrani., *et al.* 2013 and Yilmaz., *et al.* 2010 [11,12]. This result may be attributed to the fact that immaturity of the immune system and defense mechanisms among neonates, especially among premature neonates, make them more vulnerable to infection [4]. Furthermore, the present study found that gram-negative bacteria are the predominant group causing BSIs while the most common organism isolated was the coagulase-negative *Staphylococcus* spp (CoNS). The increase in CoNS incidence may be related to it being a part of body's normal flora and improper sterilizing or techniques in disinfection [13]. It is important to note that *Candida's* high prevalence is related to an outbreak in the unit between November 14 and December 20, 2017 which affected 6 cases; 3 of whom were due to BSI. Similarly, a study done on the southwestern part of Saudi Arabia reported CoNS as the most frequently isolated organism from their NICU (23.4%), followed by *Klebsiella* spp (22.1%) [10]. Likewise, Dal-Bó Karla., *et al.* 2012, reported CoNS as the most common identified organisms [14]. In contrast, there were national and international studies that reported different values. One study found that 66% of the BSI isolates were gram-positive bacteria, 25% were gram-negative bacteria, and 9% were fungi [15]. It was reported in a study done in the NICU of King Abdulaziz Specialist Hospital, Taif, KSA, that the most common organism was *Klebsiella* spp, followed by *Enterobacter* spp species; while gram-positive cocci such as CoNS, were less frequent [11]. This study shows that the infection prevalence is highly device-associated especially those with central lines and on mechanical ventilation, which is compatible with other researches [5,10,17]. Regarding the survival rate, it is believed that the survival rate is linked with the gestational age and birth weight by a positive correlation relationship like what the current study and other studies have reported [10,15]. Antibiotic sensitivity was also studied in this research and the result shows that the common strain of *Staph* Spp was Methicillin-resistant *Staphylococcus aureus* (MRSA), which is sensitive to vancomycin. Similarly, in a study done during an outbreak at the NICU in a Tabuk hospital, 29 strains were identified to be coagulase-negative, and all of them were MRSA [18]. On the other hand, gram-negative organisms *Klebsiella* spp and *Serratia* spp were resistant to ampicillin and cephalosporins which is congruent to other studies [19-21]. The most common sensitive antibiotics for *Klebsiella* spp were amikacin and Tienam. Likewise, a study done in a hospital in Madinah, Saudi Arabia reported that 86.6% of the *Klebsiella* samples were sensitive to amikacin [22]. In general, when comparing *Klebsiella* spp and *Serratia* spp with *Staph* Spp, it is obvious that the gram-negative bacteria have higher percentages of multidrug resistance when compared to gram-positive, which is only MRSA. Consequently, the drugs of choice for BSI in Maternity and Children Hospital in Al-Ahsa are vancomycin and Tienam. Although Infection control strategies and standards are universal as recommended by the Centers for Disease Control and Prevention, it is difficult to make direct comparisons between the data because of inconsistencies in surveillance or study methods, infection detection methods, and the selected populations.

Conclusion

Nosocomial infections like bloodstream infections are a significant public health problem. The rate of BSIs in the study is higher than the global rate but resembles the local rates. The risk factors inversely proportional to BSI are gestational age and birth weight but directionally proportionate to invasive procedures, either through intubation or insertion of a catheter. The most common organism was coagulase negative staph, but the most common groups are gram-negative bacteria. The preferred antibiotics should be targeted, covering both gram-positive and negative microorganisms, mainly vancomycin and Tienam. Finally, improving prenatal health care, implementing strict infection control standards, and choosing proper antibiotics are recommended to avoid BSI in neonatal intensive care units.

Conflict of Interest

The authors declared that they do not have anything to disclose regarding financial conflict.

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