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 worldwide issue, especially with neonates in intensive care units (NICUs). Among all types of HAI, as per several works of literature, bloodstream infection (BSI) considers the most common kind. Hence this study is focusing on BSI in the NICU population.

Aim: To determine the prevalence of BSI, the causative agents, sensitivity to antibiotics, also reveals the gestational age, birth weight, and mortality rate. And if any invasive procedures were done.

Methodology: A retrospective descriptive study was used. Ninety-nine out of the total unit admission (1209) patients with positive blood culture who were admitted from January-2017 to December-2018 were selected.

Result: The prevalence of BSI is 8.19%. Extremely preterm represents the highest group of BSI by 37.8%. Gram-negative organisms are the leading cause of BSI; Coagulase-negative Staphylococcus is the predominant organism. Most of the neonates who developed BSI were intubated and had a central line. The survival rate among them was 53.5%.

Conclusion: BSI remains a significant challenge among the NICUs population because of intrinsic and extrinsic factors in addition to the building of antibiotic resistance. So, the severe intervention has to be taken in order to minimize the magnitude of BSI as well as all types of HAI. These study findings believed to assist in treating the problem and improving health care practices in NICUs.

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

Abbreviations

BSI: Blood Stream Infection; NICU: Neonatal Intensive Care Unit; HAI: Hospital-Acquired Infection

**Introduction**

Hospital-Acquired Infection (HAI) is a serious worldwide issue, especially among neonates in intensive care units (NICU). HAI considers 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 40 - 50 per 1000 live births [2]. Although the survival rate of smaller and sicker infants increased with advanced neonatal care, nosocomial infection remains a serious problem [3]. This advancement in neonatal care is accompanied by increasing invasive procedures which participate with raising HAI incidents [4]. Neonates especially preterm, and low birth weight is more susceptible to HAI because of low immunity, and immature defenses mechanisms [4,5]. It is mentioned in many works of literature that the most common type of HAI is bloodstream infection (BSI) [1,6]. Which “is infectious disease defined by the presence of viable bacterial or fungal microorganisms in the bloodstream (later demonstrated by the positivity of one or more blood cultures)” [7]. Hence, this study is focusing in the prevalence of BSI, the causative agents and their sensitivity to antibiotics, the gestational age, birth weight, and mortality rate of the targeted sample as well as the invasive procedures which had been done to them in order to minimize the risk of having BSI and reduce the incidence of this problem by improving the health care practices.

**Materials and Methods**

This study had been performed in NICU level III of Al-Ahsa Maternity and children hospital, Saudi Arabia, which is a central referral hospital in the whole Al-Ahsa area. The hospital’s deliveries are around 12000 per year. The targeted unit NICU III is occupied with 16 beds and the occupancy rate is 100% 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. 99 Out of 1209 neonates selected as subjects based on inclusion and exclusion criteria. The sample includes all admission to NICU III with positive blood culture for more than 48 hours during the period of 2017 to 2018. And the patients who had a maternal history of infection (Anti-intrapartum), positive blood culture on admission, presence of immunodeficiency disease, outsider admission, born before arrival and discharge and re-admission for more than three days were excluded. Neonates are sub-grouped based on gestational age; which is divided into Extreme preterm (EPT) 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. The weight of Neonates classified into Extremely low birth-weight (ELBW) 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 used 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, 99 neonates (8.19%) developed 135 bloodstream infections. Figure 1 shows the distribution of neonates based on gestational age [8]. The mean was 30.01 weeks (standard deviation - SD ± 4.350). The most commonly affected age group is Extreme preterm, which represents 39.4%. ELBW represents the most affected cases by 48.5%. The mean weight was 1448.61g (standard deviation - SD ± 4.350). The most commonly affected age group is Extremely low birth-weight (ELBW) 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 used 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).

had resistance to Cephalosporins up to the third generation, while 3 cases (20.0%) were sensitive. There are 9 (69.23%) cases of *Serratia* with resistance to the third generation of Cephalosporins. There are no cases with resistance to the fourth generation of Cephalosporins.

Figure 1: Distribution of gestational-age of BSI cases.

Figure 2: Distribution of causative pathogens of BSI among infected cases.
**Discussion**

The current study shows the prevalence of bloodstream related infection (BSI) 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. 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. In general, it is clear from the data that the lower the birth weight and gestational age, the higher the incidence of BSI, which is concurrent with A.K. Al-Zahrani and Yilmaz., et.al. This result may attribute to the fact that immaturity of the immune system and defense mechanisms among neonates, especially premature, make them more vulnerable to infection [5]. Furthermore, the present study found that gram-negative bacteria are the predominant group of BSI. Whereas, the most common organism is the coagulase-negative *Staphylococcus* spp (CoNS). The increase in CoNS incidence may be related to being a part of body normal flora and improper sterilizing or disinfectant techniques [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, which affected 6 cases, 3 of them were BSI. Similarly, a study done on the southwestern of Saudi Arabia reported CoNS as the most frequently isolated organisms from their NICU (23.4%), followed by *Klebsiella* spp (22.1%) [10]. Likewise, Dal-Bö Karla., et al. 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]. On NICU of King Abdulaziz Specialist Hospital, Taif, KSA, it was reported that the most common organism were *Klebsiella* spp, followed by *Enterobacter* spp species. Whereas gram-positive cocci as CoNS were less frequent [11]. This study shows that the infection prevalence is highly associated with central lines and 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 as the current study and other studies reported [10,15]. Antibiotic sensitivity also studied in this research. 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 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 had resistance to Ampicillin and Cephalosporin which resemble other studies [19,20]. The most common sensitive antibiotics for *Klebsiella* spp were Amikacin and Tienam. Likewise, in a study done in Madinah hospital, Saudi Arabia, 86.6% of the *Klebsiella* samples were sensitive to Amikacin [21]. 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 are only MRSA. As a result, the drugs of choice to BSI, where the study conducted are Vancomycin and Tienam. Although Infection control strategies are universal as recommended by the center of disease control, 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. By the end of this study, it had been found that a prospective design would be better to control the variables and study all antibiotics sensitivity to the targeted sample.

**Table 1:** Distribution of birth-weight of BSI cases.

<table>
<thead>
<tr>
<th>Birth Weight</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELBW</td>
<td>48</td>
<td>48.5</td>
</tr>
<tr>
<td>HBW</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>LBW</td>
<td>12</td>
<td>12.1</td>
</tr>
<tr>
<td>NBW</td>
<td>14</td>
<td>14.1</td>
</tr>
<tr>
<td>VHBW</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>VLBW</td>
<td>23</td>
<td>23.2</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Conclusion

Nosocomial infections are a significant public health problem, especially the bloodstream related one. The rate of BSI in the study is higher than the global rate but resembles the local rates. The risk factors inversely proportional to the BSI are gestational age and birth weight but directionally proportionate to invasive procedures, either intubation or catheter-related. 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, 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.

Bibliography

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