

Evaluating the Incidence and Risk Factors of Nosocomial Infection in Neonates Hospitalized in the Neonatal Intensive Care Unit of Fatemieh Hospital in Hamadan, Iran, 2012 - 2013

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Background: Nosocomial infection is one of the most important causes of neonatal mortality, especially in premature neonates hospitalized in Neonatal Intensive Care Units (NICUs).

Objectives: This study aimed to evaluate the incidence, main infection sites, prevalent microorganisms and risk factors related to nosocomial infection in NICU of Fatemieh Hospital in Hamadan, Iran, during 2012 - 2013.

Patients and Methods: This cross-sectional retrospective study was performed during an 18- month period (2012 - 2013) in which we evaluated the nosocomial infection in 1000 neonates hospitalized in NICU of Fatemieh Hospital in Hamadan, Iran, who survived more than 72 hours and were not transferred to other wards, till their discharge from the hospital or death, based on the National Nosocomial Infection Surveillance criteria. Data were analyzed using SPSS software.

Results: The incidence of nosocomial infection was 5.7 per 100 patients and 7.1 infections per 1000 days of hospitalization. Blood stream infection (45.6%) was known as the most prevalent site of nosocomial infection and staph coagulase negative (56.1%) as the most prevalent organism causing the disease. Independent factors related to nosocomial infection included lower gestational age, long-term mechanical ventilation, using parenteral nutrition, delay in initiation of oral feeding and setting venous catheters. No significant difference was observed in prognoses of the disease between the two groups, but the duration of hospitalization was longer in the group of patients having nosocomial infection.

Conclusions: The results of this study show that the incidence of nosocomial infection in neonates is high and decreasing the risk factors such as prematurity, mechanical ventilation and reducing invasive procedures can decrease the infection and improve rapid recovery in these neonates.

Keywords: Neonates; Nosocomial Infection; Risk Factors; Neonatal Intensive Care Units

1. Background

Recent achievements of medical science in taking care of neonates, especially premature neonates caused an impressive improvement in this group of neonates who most often require intensive care and long-term hospitalization. Because of premature immune system, severity of underlying disease and requirement of invasive procedures, premature neonates are disposed to nosocomial infection, which is one of the most important causes of mortality in neonates. The rate of incidence is reported 7% - 26% for different Neonatal Intensive Care Units (NICUs) (1). Blood stream infection is the most prevalent cause of nosocomial infection and low-gestational age and birth weight are the most important factors related to most of the nosocomial infections (2, 3). Moreover, the most prevalent pathogenic microorganisms causing infection are Gram-positive and Gram-negative bacteria (4).

2. Objectives

Evaluating nosocomial infection is one of the main

bases of evaluating the quality of services given to hospitalized neonates at NICUs. As nosocomial infection is multifactorial and affected by the condition of each ward, the present study aimed to evaluate the incidence rate, pathogenic organisms, infection sites and risk factors related to nosocomial infection in NICU of Fatemieh Hospital in Hamadan, Iran, during 2012 - 2013.

3. Patients and Methods

This cross-sectional retrospective study was performed on 1000 neonates hospitalized at NICU of Hamadan's Fatemieh Hospital, a level 3 medical teaching center, between October 2012 and March 2013. This NICU consists of 15 inpatient beds, 3 neonatologists, 3 pediatricians, 2 pediatric residents and 32 nurses and has an average annual rate of 800 admissions of neonates.

In this study, neonates being hospitalized for more than 72 hours were evaluated from birth time till discharge and their information including sex, pregnancy, birth date,

weight, setting venous catheters or chest tube, mechanical ventilation, laboratory findings, antibiotic therapy, parenteral nutrition, count and sites of infections and pathogens causing the infections was gathered using their medical records and completing a predesigned form.

The definition of nosocomial infection was based on a definition of Centers for Disease Control and Prevention-Nosocomial Infections Surveillance System (CDC-NNIS), which defined nosocomial infection as the existence of blood or other sterile fluid culture of the body after 72 hours from the admission along with clinical symptoms. According to this definition, clinical symptoms include fever, respiratory distress (that was not present previously), need to increase ventilator support, intolerance of feeding, poor neonatal reflexes, and skin lesions suspicious to pseudomonas, signs of disseminated intravascular coagulation (DIC). Almost all the patient admitted to NICU had respiratory distress or other problems that sepsis work-up should be done for them at the admission time include blood culture. If any symptoms that explained above presented after 72 hours, new cultures were obtained and if the result was positive included nosocomial infection and other data were gathered. The brain heart infusion agar (BHI) was used as environment for blood cultures. It is clear that the first blood culture of these patients (that obtained at admission time) was negative. For differentiating between contamination and true positive cultures of coagulase negative staphylococcus (CONS), two blood culture specimens were obtained from two sites at the same time and if both of them were positive, the result was recorded as true infection. Neonates having transferred to other hospitals sooner than 72 hours were eliminated from the study. SPSS software

(windows version 13.0) was used for statistical analysis. Moreover, a t-test was used to compare the variables and chi-square test to determine the correlation between risk factors and nosocomial infection. P values less than 0.05 were considered as statistically significant.

4. Results

From a total of 1000 hospitalized neonates entered the study, 57 cases had nosocomial infection. The incidence of infection was 5.1 per 100 hospitalized patients and 7.1 per 1000 days of hospitalization. Moreover, 56.1% of the studied neonates were male, 70.3% preterm and 61.5% were Low Birth Weight (LBW). The mean age of pregnancy was 34.5 ± 3.2 weeks and the mean birth weight was 2243 ± 8.5 g (Table 1). The most prevalent infection site was blood stream infection with 45.6% and conjunctivitis with 40.3%. No cases of meningitis have been reported. The mean duration of hospitalization in patients with nosocomial infection was 8.09 ± 5.39 days and overall mortality was 7.6%.

Gram-positive bacteria (59.6%) were the most prevalent pathogenic cause of nosocomial infection in our research. Staph coagulase negative with 56.1% and *Escherichia coli* with 21% were the most prevalent organisms. The distribution of pathogens in major infection sites is demonstrated in Table 2.

Independent factors related to nosocomial infection included lower gestational age, long-term mechanical ventilation, using parenteral nutrition, delay in initiation of oral feeding and setting central venous catheters. No significant difference was observed in prognoses of the disease between the two groups; however, the duration of hospitalization was longer in the group having nosocomial infection (Table 3).

Table 1. Comparison of Mean and Standard Deviation in Population With and Without Nosocomial Infection

Characteristics	Nosocomial Infection		P Value
	Yes (N = 57)	No (N = 943)	
Gestational age, wk	34.0 ± 3.9	34.6 ± 3.2	0.001
Birth weight, kg	2.00 ± 881	2.25 ± 809	0.242
Time of starting oral feeding, d	4.17 ± 5.63	3.13 ± 2.80	0.000
Duration of mechanical ventilation, d	1.42 ± 3.31	0.626 ± 2.20	0.000
Duration of antibiotic therapy, d	10.96 ± 7.7	712 ± 4.44	0.000
Length of hospital stay, d	12.1 ± 8.5	7.8 ± 5.0	0.000

Table 2. Distribution of Pathogens in Major Infection Sites ^a

	BSI	Conjunct	GI	UTI	Skin Inf	Total ^b
G+						
CONS	18	12	0	0	2	32 (56.1)
<i>S. aureus</i>	2	0	0	0	0	2 (3.5)
G-						
<i>E. Coli</i>	3	5	3	1	0	12 (21)
Klebsiella	3	5	0	0	0	8 (14.1)
Enterobacter	0	1	2	0	0	2 (3.5)
Total	26	23	5	1	2	57 (100)

^a Abbreviations: BSI, blood stream infection; Conjunct, conjunctivitis; CONS, coagulase negative staphylococcus; GI, gastrointestinal infection; Inf, infection; UTI, urinary tract infection.

^b Data are presented as No. (%).

Table 3. Characteristics of Study Population With or Without Nosocomial Infection

Characteristics	Nosocomial Infection		OR (95% CI)	P Value
	Yes (N = 57)	No (N = 943)		
Gender			1 (0.57 - 10.71)	0.995
Male	32	529		
Female	25	414		
Gestational age groups			0.82 (0.44 - 1.5)	0.521
≥ 37	19	278		
< 37	38	665		
Birth weight groups			1.26 (0.72 - 2.21)	0.481
> 2500	18	347		
< 2500	39	596		
Chest tube insertion			2.56 (0.73 - 8.86)	0.124
Yes	3	20		
No	54	923		
Venus catheterization			3.83 (1.76 - 8.30)	0.001
Yes	9	44		
No	48	899		
Total parenteral nutrition			1.44 (0.83 - 2.49)	0.187
Yes	23	301		
No	34	642		
Short outcome			1.71 (0.77 - 4.1)	0.171
Survive	50	873		
Expire	7	69		

5. Discussion

In our research, the incidence of infection is 5.7 per 100 hospitalized patients and 7.2 per 1000 days of hospitalization, which is acceptable comparing to the results of most of the studies in which the incidence rates were reported 6-50 per 100 hospitalized patients and 5 - 62 per 1000 days of hospitalization (3, 5-7).

The difference in statistics of various centers may be due to the difference in weight of hospitalized neonates, different treatment conditions, duration of hospitalization, different methods for the diagnosis of infections and duration of using antibiotics. As an example, the duration of hospitalization in our study was less than Garland et al. (8) and similar to Drews et al. (9) and van der Zwet et al. (10).

Like most of the studies, blood stream infection was the most prevalent site of nosocomial infection with 45.6% in our research (1, 8, 11, 12) and conjunctivitis with 40.3% was the second cause of infection in hospitalized neonates, which is different compared to the results of other studies (3, 5, 11), but is similar to Mireya et al. (13) in which conjunctivitis is reported as the second cause of nosocomial infection. In our study, the pneumonia was not recorded because the study was retrospective and culture of tracheal secretions was not performed routinely for patients.

Moreover, in our study, Gram-positive bacteria were the most prevalent pathogens of nosocomial infection with 59.6%, which is similar to the result of most of the studies (3, 7, 9, 11, 13, 14); however, in studies of Nambiar et al. (15) and Zaidi et al. (16) Gram-negative bacteria were

reported as the most prevalent pathogens, which can be due to increased resistance of Gram-negative bacteria to antibiotics.

Staph coagulase negative was the most prevalent isolated bacteria in our study, which is similar to the results of most of the studies (3, 11, 13). The reason of this high prevalence, as shown in Krediet et al. (17) study, is the overuse of invasive devices in NICU. And because of high incidence of staph coagulase negative isolated from the site and this may be due to frequent handling by hospital staff and insufficient hand washing.

In our study, low-gestational age, long-term mechanical ventilation, setting a central vein catheter, delay in initiation of oral feeding and long-term parenteral nutrition were accompanied by an increased risk of having nosocomial infection. Fourteen percent of the neonates having the weight of less than 1000 g, 6.4% of neonates being 1001 - 1500, 5.1% of neonates being 1501-2500 and 4.9% of neonates being more than 2500 g were infected. Prematurity and low-birth weight were assumed as notable risk factors of nosocomial infection in most of the researches (3, 11, 13, 18, 19).

In case of other risk factors, long-term mechanical ventilation in Joseph, Stoll, Gupta (14, 19, 20) studies and setting the venous catheter in Joseph (14), Babazono (21) studies and long-term parenteral nutrition in Tiskumara (7), Joseph (14) studies are known as risk factors, which are similar to the results of our study. Differences in risk factors in different studies are due to the quality of care

showing that the chance of infection will be reduced by improving the quality of services.

The overall death rate in hospitalized neonates was 7.6%, which was not higher in the group infected with nosocomial infection. However, the duration of hospitalization was noticeably longer in the group having nosocomial infection, which along with Jeong (3), Joseph (14), Uwaezuoke (22) studies show that nosocomial infection causes an increase in duration of hospitalization, but is different with the result of Brito et al. (11) study, which considers nosocomial infection as the cause of increase in neonatal deaths. In a study performed in Tabriz children hospital (2010 - 2011), the neonatal ward and NICU had the highest rate of nosocomial infection along with other pediatric wards. The most common organisms were Gram- negatives; however, in our study Gram-positive bacteria were predominant (23). It may be due to the difference between populations of two studies.

The incidence of nosocomial infection is high in neonates hospitalized in NICU especially in premature neonates, which causes increase in duration of hospitalization and treatment costs. Nosocomial infection is prevented by decreasing risk factors such as, prematurity, mechanical ventilation and reducing invasive devices.

This study is retrospective and it is a limitation of our research, for better results we will need to plan a prospective study focusing on preventing nosocomial infection in NICUs.

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Authors' Contributions

Study design and acquisition of data: Behnaz Basiri. Analysis and interpretation of data: Mohammad Kazem Sabzehei and Abbas Moradi. Drafting of the manuscript: Mohammad Kazem Sabzehei. Critical revision of the manuscript: Behnaz Basiri. Administrative, technical and material support and study supervision: Behnaz Basiri and Maryam Shokouhi.

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