

Colonization with hospital flora and its associated risk factors in neonates hospitalized in neonatal ward of a teaching center in Isfahan, Iran

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Background: Due to the high incidence and prevalence of infection in neonatal ward, especially Neonatal Intensive Care Units (NICUs) reported by different studies and the important role of colonization with hospital germs in the development of nosocomial infections, we intended to evaluate the risk of colonization with hospital germs in neonates and its associated risk factors. **Materials and Methods:** This cross-sectional, descriptive-analytical study was conducted in 2016 in a Teaching Center in Iran. In total, 51 neonates were selected based on the inclusion criteria, and after recording their information in a checklist, samples were taken by swab from outer ear, axilla, and groin for culture. Neonates with negative culture from mentioned regions were enrolled in the study. The swab samples again were taken and sent for culture from mentioned regions in at least 3 days after hospitalization. Culture results from first and second sampling were collected and analyzed statistically. **Results:** This study was conducted on 51 neonates. The mean gestational age among the neonates ranged from 35.25 (Week) \pm 2.98. 22 girls (43.1%) and 29 boys (56.9%), most of them were born by cesarean. Based on the results of logistic regression, a significant association was found between the occurrence of colonization of hospital flora and the place hospitalization of the newborns (odds ratio (OR): 4.750; 95% confidence interval (CI): 1.26–17.85). **Conclusion:** This study revealed that the only risk factors of colonization with hospital flora in neonates are the type of delivery and place of hospitalization. Based on findings of the study, it is recommended to focus on efforts in increasing the rate of natural birth as well as improving conditions of infection control in NICUs to reduce the number of incidences of colonization with hospital flora in neonates.

Key words: Colonization, hospital flora, isolation of different microorganisms

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INTRODUCTION

Colonization may be caused by a direct contact with the exogenous microorganisms colonized in objects and body surface of other people.^[1] Soon after birth, the neonate acquires normal flora that colonizes skin and mucous membranes. At this stage, the immune system of the host is not fully developed and some normal microorganisms may become opportunistic pathogens, specifically in preterm neonates.^[2]

Typically, the act of being born involves moving from a sterile environment (womb) to a nonsterile one.

Therefore, normal flora is produced through direct contact with mother during or after delivery, other people, objects, and environment. In the early hours and days after birth, *Staphylococcus epidermidis* colonizes on the skin.^[1,2]

In addition, the alpha streptococci colonize the throat, and a combination of mostly aerobic Gram-negative organisms, along with a combination of anaerobic organisms colonize the gastrointestinal tract. Feeding method severely affects the establishment of flora on the gastrointestinal tract. The possibility of the neonatal gastrointestinal tract colonization with anaerobic bacteria or *Bacteroides fragilis* in the first 4–6 days after

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birth is greater among the neonates fed directly from the breast than those fed with infant formula.^[1]

Despite late-onset colonization in the Neonatal Intensive Care Unit (NICU) neonates (probably due to the exposure to antimicrobial agents), they were colonized with hospital flora, and thus there is a higher chance of colonization with antimicrobial-resistant microorganisms, with a domination of Gram-negative bacteria, except *Escherichia coli*.^[1]

Since the NICU neonates account for the highest prevalence of nosocomial infections and present with clinical markers and signs, that are often nonspecific, there is a significant interest in using methods, based on the culture of colonizing microorganisms, for prediction of pathogenic infections. According to some researchers, neonatal surface-colonizing microorganisms cause aggressive diseases.^[1]

The general mortality rate is 14.7%, and mortality from nosocomial infection is 24.1%.^[3] The possibility of infection is by 37.7% greater in male neonates.^[4] The general incidence of nosocomial infection is by 50.7% greater in neonates.^[3]

A broad spectrum of factors, including delivery method, place of hospitalization (neonatal ward or NICU), aggressive procedures and devices, feeding type and method, and consumption of antimicrobial agents, affect the establishment of normal flora in neonates.

The establishment of normal flora is influenced by internal and external factors. The internal factors, or host-related factors, may lead the prorogation and colonization of organisms to a specific area involved in disease (e.g., malignancy or dermatitis). The external factors include the use of aggressive devices and procedures or those kinds of procedures that disrupt the body's natural defense system (e.g., intravenous (IV) catheters, surgery, or antibacterial or steroid agents).

With regard to the studies reporting a high incidence and prevalence of infection in (NICUs) and lesser in neonatal ward as well as the significance of this problem and important role of colonization with hospital germs in nosocomial infections, we intended to evaluate the risk of colonization with hospital germs and its associated risk factors in neonates.

MATERIALS AND METHODS

Study design and participants

This cross-sectional study was performed in a teaching hospital in Isfahan, Iran, in 2016. The statistical population consisted of all admitted neonates in neonatal ward and NICU.

Neonates hospitalized in the neonatal ward or NICU immediately after birth with no signs of infection and the results of culturing samples from the axillary, groin, and outer ear areas also showed negative on infection were included in the study. Permission from all parents was obtained through consents. All neonates deceased for any reason or hospitalized for <48 h or showing positive results from culturing samples from axillary, groin, or outer ear areas were excluded from the study.

Convenience random sampling method was employed. The sample size consisted of 51 neonates.

Procedure and variable assessment

After recording the characteristics of patients in checklist, the samples were taken. Swab samples were first taken from outer ear, axilla region, and groin. Then, samples were sent to laboratory for culturing. Neonates with negative culture were enrolled in the study. The swab samples were retaken in the mentioned region from the neonates when they were released from the hospital or at least 3 days after admission. The samples were sent for culturing to laboratory. It was essential to record all practices in neonates checklist including the type of nutrition (IV, powdered milk, and breastfeeding), mechanical ventilation, and invasive procedures (placement of catheters, endoscopy, colonoscopy, bronchoscopy, and biopsy).

Sterile gloves and masks need to be used during sampling. Sampling was performed in outer ear, axilla region, and groin. For sampling, swabs were used which are made up of sterile cotton fiber and impregnated with normal saline or sodium phosphate buffer. Swabs were rubbed in the mentioned region and immediately transferred to laboratory for culturing. The first phase of sampling was performed in the delivery room. The second sampling phase was performed in the last place of hospitalization. Among the neonates hospitalized few days after the birth, the first sampling phase was performed at the place of hospitalization.

Statistical analyses

Quantitative and categorical data were presented as mean \pm standard deviation and frequency (percentage), respectively. Chi-square test (or Fisher's exact test) was used for evaluating the association of categorical data, and independent *t*-test was used for comparing the quantitative data between groups. Logistic regression was used for evaluating the association of potential risk factor of colonization and results were presented as odds ratio (OR) and 95% confidence interval for OR (95%CI for OR). IBM Statistical Package for the Social Sciences software version 20 (SPSS Inc., Chicago, IL, USA) was used

for analyzing data. $P < 0.05$ was considered statistically significant.

RESULTS

This study was conducted on 51 neonates. The mean gestational age among the neonates ranged from 35.25 (Week) ± 2.98 . In fact, 52% of the neonates were born at 36 weeks of gestation, mean \pm SD birth weight of 2349 (g) \pm 744.597. There were a total of 51 neonates, 22 girls (43.1%) and 29 boys (56.9%), most of them were born by cesarean. In fact, 36 of 51 births (70.6%) involved cesarean section and 15 (29.4%) were vaginal delivery. As for nutrition, thirty neonates (58.8%) were breastfed and only four cases (7.8%) were formula fed. It is noteworthy that 16 cases (31.4%) were both breastfed and formula fed. The most common systemic diseases observed among neonates were preterm and jaundice with incidences of 21.5% (11 preterm neonates) and 13.8% (7 neonates with jaundice, respectively). It should be pointed out that there were 9 neonates (17.6%) affected by no systemic disease. Among the invasive procedures performed on 51 neonates, blood sampling and venipuncture were simultaneously administered on 36 neonates (70.6%), blood sampling on 12 neonates (23.5%), and venipuncture on two neonates (3.9%). The mean duration of hospitalization was 11 (day) ± 8.039 . All neonates in this study breathed normally.

Table 1 displays the distribution of flora colonization across categories of study variables. There was no significant differences was found in terms of colonization incidence across categories of following variables: gender, type of nutrition, type of systemic disease, and type of invasive procedure ($P > 0.05$).

However, there was a significant association between colonization and location of hospitalization ($P = 0.017$) so that the highest incidence of nosocomial flora colonization was in neonates who were hospitalized in NICU (59.4%).

Based on the results of logistic regression, a significant association was found between the occurrence of colonization of hospital flora and the place of hospitalization of the newborns OR: 4.75(95% CI for OR): 1.26–17.85. Hence, the risk of colonization of hospital flora in neonates admitted to the NICU was 4.75 times more than neonates admitted to the neonatal department.

There was no significant difference between positive and negative colonized neonates with nosocomial flora in terms of mean pregnancy duration ($P = 0.774$), birth weight ($P = 0.967$), and duration of hospitalization ($P = 0.109$) [Table 2].

Table 1: Distribution of flora colonization across categories of study variables

	Nosocomial Flora Colonization		Total	P
	No	Yes		
Gender				
Girl	7	15	22	0.842
	41.20%	44.10%	43.10%	
Boy	10	19	29	0.569
	58.80%	55.90%	56.90%	
Delivery method				
Natural	8	7	15	0.049
	47.10%	20.60%	29.40%	
Caesarean Section	9	27	36	0.706
	52.90%	79.40%	70.60%	
Type of nutrition				
Breast	9	22	31	0.559
	52.90%	64.70%	60.80%	
Milk Powder	1	3	4	0.780
	5.90%	8.80%	7.80%	
Breast feeding Together with formula	7	9	16	0.314
	41.20%	26.50%	31.40%	
Type of disease				
Healthy	6	3	9	0.722
	35.40%	8.80%	17.60%	
Preterm	3	9	12	0.235
	17.60%	26.50%	23.50%	
Jaundice	3	4	7	0.137
	17.60%	11.80%	13.70%	
Other diseases	5	18	23	0.451
	29.40%	52.90%	45.10%	
Type of invasive procedure				
Blood Sampling	5	7	12	0.484
	29.40%	20.60%	23.50%	
Blood Sampling and Venipuncture OR Blood Sampling and Venipuncture with Other Way OR Other Way	12	27	39	0.765
	70.60%	79.40%	76.50%	
Location of hospitalization				
Neonatal Ward	13	13	26	0.017
	76.50%	40.60%	53.10%	
NICU	4	19	23	0.594
	23.50%	59.40%	46.90%	

Table 2: Comparison the difference between mean of the variables in positive and negative colonized neonates with nosocomial flora

Nosocomial flora colonization	n	Mean \pm SD	P
Pregnancy duration (week)			
Yes	34	35.16 \pm 3.15	0.774
No	16	35.43 \pm 2.68	
Birth weight (g)			
Yes	33	2352.12 \pm 784.54	0.967
No	17	2342.65 \pm 683.28	
Hospitalization duration (day)			
Yes	32	12.94 \pm 8.97	0.109
No	17	8.71 \pm 5.07	

SD = Standard deviation

Regarding the type of delivery method, although the frequency of flora colonization in cesarean section is more than vaginal delivery ($P = 0.049$), 79.4% (27 infants) of positive nosocomial flora colonization were born with cesarean section, it is not possible to show a significant association between the delivery method and the occurrence of colonization (OR: 3.43; 95% CI: 0.969–12.14).

DISCUSSION

Nosocomial infections, particularly in NICUs, are recognized as one of the most important causes of morbidity and mortality in hospitalized neonates.^[5] In this study, we evaluated the effects of risk factors on risk of colonization with hospital germs in neonates. These factors include the gestational age, the birth weight, gender, type of delivery, diet, aggressive procedure, length of pregnancy, systemic disease, increasing the length hospitalization, and place of hospitalization.

Kamath *et al.* studied about the risk factors of neonatal nosocomial infections, and they concluded that prematurity, low birth weight, and longer hospital stay were associated with increased neonatal nosocomial infections.^[6] Heshmati *et al.* found that bacteria were initiated by ingesting food and other environmental factors in newborns. Furthermore, this study has revealed that long-term hospitalization can increase the bacterial colonization in neonates. They also concluded that there is an increasing rate of colonization of bacteria in immature and low weight neonate.^[7]

While we found that there is no significant difference between the incidence of colonization with hospital flora and low birth weight and increased duration of hospital stay.

Gaynes *et al.* conducted that neonates admitted in NICU with acute medical problems for weeks to months or very low birth weight neonates which had been under aggressive procedures were encountered more nosocomial infection.^[8] Similarly, our findings emphasize that place of hospitalization – NICU versus ward – is one of the risk factors of colonization with hospital flora.

In another study conducted by Harrie *et al.*, they believed that the immunomodulatory effects of breast milk and dietary components such as probiotics and nucleotides added to the preterm formula in preterm neonates are complex because of the multiple risk factors for infections in these neonates.^[9]

Furthermore, some authors have found that fecal microflora of breastfed and formula fed neonates are essentially the same; others have demonstrated that *Bifidobacteria* are the predominant flora in the faces of breastfed neonates.^[10,11]

However, according to the results of our study, there was no significant association between the incidences of colonization with hospital flora and diet.

Furthermore, increasing the length hospitalization cannot be regarded as a risk factor of colonization with hospital flora. However, some other researchers disagree with this matter such as Różańska *et al.* detected that the length of hospitalization is one of the important and effective risk factors of colonization.^[12] In this study in addition to place of hospitalization, we found that in the delivery method, the frequency of flora colonization in cesarean section was higher than vaginal delivery. However, there was no statistically significant association as mentioned in the result section. On the other hand, a significant association can be found between the delivery method and the flora colonization by increasing the number of cases. Therefore, the type of delivery method can be considered as a risk factor.

In this regard, some of earlier researches and literatures have reported that anaerobic *Streptococcus* species are the first cause of infection. It seems that specific species constitute the normal flora of vaginal and oral cavity. While being born, the skin of neonates with cesarean surgery was found sterile during delivery, but neonates born through birth canal were found to be colonized with the normal flora.^[7]

CONCLUSION

This study revealed that the only risk factors of colonization with hospital flora in neonates are the type of delivery and place of hospitalization.

Based on findings of the study, it is recommended to focus on efforts in increasing the rate of natural birth as well as improving conditions of infection control in NICUs to reduce the number of incidences of colonization with hospital flora in neonates.

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Conflicts of interest

There are no conflicts of interest.

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