

## Comparison of the Umbilical Cord Bacterial Colonization in Newborn Infants Rooming in with Mothers and Neonates Admitted to Neonatal Intensive Care Unit

Mohammad Forozeshfard<sup>1</sup>, Raheb Ghorbani<sup>2</sup>, Mohammadreza Razavi<sup>3</sup>, Navid Danaei<sup>4</sup>,  
\*Shamsollah Nooripour<sup>4</sup>

<sup>1</sup> Cancer Research Center, Semnan University of Medical Sciences, Semnan, Iran.

<sup>2</sup> Social Determinants of Health Research Center, Semnan University of Medical Sciences, Semnan, Iran.

<sup>3</sup> Nursing Care Research Center, Semnan University of Medical Sciences, Semnan, Iran.

<sup>4</sup> Department of Pediatric, Amir al-Momenin Hospital, Semnan University of Medical Sciences, Semnan, Iran.

### Abstract

#### Background

Bacterial colonization during and shortly after birth are common in newborn infants. The aim of this study was to determine the umbilical cord bacterial colonization in newborn infants rooming in with mothers and neonates admitted to neonatal intensive care unit (NICU).

#### Materials and Methods

In a cross-sectional study, 180 newborn infants were studied in three groups including: newborn infants born via normal delivery and stayed with their mothers (n=60), newborn infants born by cesarean section and stayed with their mothers (n=60), and newborn infants admitted in NICU (n=60). Umbilical cord care was done as natural drying without use of any disinfectant or local antibiotic for all newborn infants. Bacterial culture was performed on the second day in three groups and in days of 5-7 only among the infants admitted in NICU.

#### Results

Among the subjects, 50% (n=90) were boy and 50% (n=90) were the first-time mothers. Normal gestational age (38 to 42 weeks) was seen in 67.2% (n=121) of subjects. Three groups had no significant differences in terms of gender (p=0.247), and first-time mothers (p=0.344), but had a significant difference in terms of gestational age (p=0.001). Staphylococcus aureus was the most common bacteria responsible for the colonization in the first culture (n=31, 17.22%), and second culture (n=17, 13.5%). Bacterial colonization was more common in newborn infants who were born by cesarean section and stayed with their mothers compared to the other groups (p<0.001).

#### Conclusion

According to the study, bacterial colonization was common in newborn infants who were born by cesarean section and stayed with their mothers and Staphylococcus aureus had an important role in this colonization. Future study is recommended to confirm our results.

**Key Words:** Cesarean section, Colonization, Delivery, Infants, Umbilical cord.

\*Please cite this article as: Forozeshfard M, Ghorbani R, Razavi M, Danaei N, Nooripour Sh. Comparison of the Umbilical Cord Bacterial Colonization in Newborn Infants Rooming in with Mothers and Neonates Admitted to Neonatal Intensive Care Unit. Int J Pediatr 2017; 5(11): 6009-6015. DOI: **10.22038/ijp.2017.25938.2208**

#### \*Corresponding Author:

Shamsollah Nouripour, Mostafa Khomeini Street, Semnan, Iran. Fax: +98 23 33654177

Email: are20935@gmail.com

Received date: Aug.10, 2017; Accepted date: Aug. 22, 2017

## 1- INTRODUCTION

Annually, one million newborn infant's death occur in the world due to infection caused by bacteria that are entered the body through umbilical cord (1). Necrotic tissues of umbilical cord are the best places for bacterial colonization which are established shortly after birth (2, 3). *Staphylococcus aureus*, Group B streptococcus (GBS) and *Escherichia coli* (*E. coli*) have been the predominant isolates from the colonized umbilicus in newborns (4-6). To the umbilical cord bacterial colonization a sequences of steps including the process of bacterial transmission, an invasion to primary host defense mechanisms such as skin, mucosal adhesion, and colonization with bacterial growth is required (7, 8). Umbilical cord colonization occurs with the growth of bacterial organisms including both normal skin flora and pathogenic bacterial, and can result in life-threatening conditions (9).

Today, advances in umbilical cord care have reduced exposure of umbilical cord to infection in developed and developing countries (10-12). Strategies including use of disinfection solutions and hygiene protocols, postnatal care, and reduction the number of caregivers to a person have been associated with reduced incidence of umbilical cord colonization, so that in studies, application of chlorhexidine and hygienic caring reduced the incidence of umbilical cord infection (10-13).

Potential risk factors for umbilical cord infection are low birth weight, childbirth prolongs, premature rupture of membranes, non-sterile delivery, umbilical cord catheterization, method of umbilical cord care, and home delivery (14, 15). The most common complication of umbilical cord infection is sepsis (6, 16). The incidence of newborn infant sepsis due to umbilical cord colonization has been estimated to occur in 1-4 cases per 1,000 live births in developing countries, depended on geographic location (12, 17).

Other complications of umbilical cord infection are inflammation of the umbilical artery, portal vein thrombosis, hepatic abscess, peritonitis, intestinal gangrene, necrosis and finally death (18, 19).

Given that dangerous complication of umbilical cord infection may be lead to death, the aim of this study was to determine and comparison of the umbilical cord bacterial colonization in newborn infants rooming in with mothers and neonates admitted to neonatal intensive care unit (NICU).

## 2- MATERIALS AND METHODS

### 2-1. Study design and population

In a cross-sectional study, 180 newborn infants born in female hospital of Amir- al-Mu'minin hospital in Semnan, Iran, during the October 2014 to March 2015 were recruited. Sample size was calculated using pilot data (10 newborn infants admitted to NICU, 10 newborn infants who stayed with mother in normal delivery and 10 newborn infants who stayed with their mothers in cesarean section). After counseling with a statistician and that it would not be possible to evaluate data for 2% of subjects, a total of 60 newborn infants per group were considered to detect difference in laboratory finding with 80% power and 95% confidence interval (CI). Therefore, 180 patients as convenience sampling were included to the study.

### 2-2. Methods

Newborn infants were investigated in three groups: newborn infants born by caesarean section, and vaginally who stayed with mothers at the birth time, and neonates who were admitted to NICU. In this study, umbilical cord care method was as umbilical cord natural drying without use of any disinfectant or local antibiotic for all newborn infants.

### 2-3. Measuring tools

A questionnaire was used for collecting data including type of delivery, first time mothers, gender, birth weight and gestational age.

#### 2-4. Laboratory measurements

Culture samples were collected by a laboratory technician who was unaware of the aim of the study from the newborn infants cord stump using a sterile swab. All samples were placed in a sterile tube and were immediately transferred to laboratory. In laboratory, samples were taken by swab and were immediately transferred to blood agar. After 24 hours, the grown colonies were separated, and identified by standard methods. Also, for newborn infants admitted to NICU, the second culture samples were collected from umbilical cord stump on days 5-7 after birth. Bacteriological examinations were performed on the all colonization.

#### 2-5. Inclusion and exclusion criteria

All newborn infants in NICU were treated by empirical antibiotic therapy with the same protocol, based on the treatment of premature neonatal sepsis bacteria (first week: Ampicillin and Cefotaxime, Amikacin). If newborn infants in NICU received other antibiotics due to sepsis that resistance to empirical antibiotic treatment or any other reason were excluded from the study.

#### 2-6. Ethical consideration

After the full explanation about the purpose of the study to one of the parents by the researchers, an informed consent was obtained before delivery. For selecting infants admitted to NICU, an informed consent from parents was obtained immediately after admission.

#### 2-7. Data Analyses

Data were analyzed by SPSS (version 20.0) and descriptive statistics were used to determine the frequency and distribution of data. Kolmogorov-Smirnov test was

used to determine the normality. Also; Chi-square test, t student test, one-way ANOVA in normal and Mann-Whitney and Kruskal Wallis test in non-normal data were used for data analysis. The level of statistical significance was set at  $P < 0.05$ .

### 3- RESULTS

All 180 infants were investigated and none of them were excluded from the study. Among them, 50% (n=90) were boy and 50% (n=90) were the first-time mothers. Normal gestational age (38 to 42 weeks) was seen in 67.2% (n=121) of subjects. The mean birth weight was  $3,750 \pm 250$  grams and  $3,680 \pm 330$  grams in newborns rooming in with their mothers at the birth time in normal vaginal delivery and in caesarean section, respectively. The mean birth weight was  $2,310 \pm 145$  grams in infants who were admitted to NICU that majority (85%, n= 51) of them were in abnormal range. Data analysis showed that three groups had no significant differences in terms of gender and first-time mothers, but had a significant difference in terms of gestational age and birth weight. **Table.1** shows the distribution of these variables.

In investigating of bacterial colonization on the second day of birth, umbilical cord bacterial colonization was significantly higher in the neonates born by cesarean section and rooming in with mothers compared to the other groups ( $P < 0.001$ ). *Staphylococcus aureus* was the most frequently isolated from the newborns umbilical cord. In 13 cases (42%) they were mixed with other bacteria, and in 18 cases (58%) they were the only isolates. After *Staphylococcus aureus*, *Escherichia coli* in the NICU neonates, and *Klebsiella pneumoniae* in the neonates rooming in with mothers were the most cause of umbilical cord colonization (**Table.2**). There was no significant difference between the groups in term of frequency of isolated bacteria from the newborns umbilical cord ( $P > 0.05$ ) (**Table.2**).

Assessment the distribution of umbilical cord culture results on the day of 5-7 in newborns admitted to NICU showed that 18.3% (n=11) of them were without growth, and *Staphylococcus aureus* (n=17, 13.5%), *Escherichia coli* (n=8, 13.5%), *Klebsiella pneumoniae* (n=11, 18.2%), *Staphylococcus epidermidis* (n=6, 10%), *Enterococci* (n=3, 5%), *Staphylococcus haemolyticus* (n=2, 3.5%), and

*Staphylococcus saprophyticus* (n=2, 3.5%), were the most frequently isolated from the umbilical cord, respectively.

Also, umbilical cord culture results in the second day and day of 5-7 had not significantly relationship with gender, first time mothers, gestational age and birth weight and these factors had not effect on the colonization rate (P>0.05).

**Table-1:** Distribution of gender, first-time mothers, gestational age and birth weight in three groups

Variables	Studied groups			P-value
	Admitted to NICU Number (%)	Stayed with mother and cesarean section delivery Number (%)	Stayed with mother and normal vaginal delivery Number (%)	
Gender				
Boy	31 (51.7)	25 (41.7)	34 (56.7)	0.247
girl	29 (48.3)	35 (58.3)	26 (43.3)	
First-time mothers				
Yes	34 (56.7)	26 (43.3)	30 (50)	0.344
No	26 (43.3)	34 (56.7)	30 (50)	
Gestational age (38-42 weeks)	6 (10)	57 (95)	58 (96.7)	0.001
Birth weight (2500 – 4000grams)	9 (15)	54 (90)	53 (88.3)	0.001

**Table-2:** Distribution of umbilical cord culture results on second day of birth in three groups

Culture Result	Studied groups			P-value*
	Admitted to NICU Number (%)	Stayed with mother and cesarean section delivery Number (%)	Stayed with mother and normal vaginal delivery Number (%)	
Without growth	42 (70)	21 (35)	34 (56.7)	0.001
<i>Staphylococcus aureus</i>	7 (11.8)	16 (26.8)	8 (13.5)	0.051
<i>Escherichia coli</i>	4 (6.7)	6 (10)	5 (8.5)	0.424
<i>Klebsiella pneumoniae</i>	3 (5)	9 (15)	7 (11.8)	0.134
<i>Staphylococcus epidermidis</i>	2 (3.5)	4 (6.7)	3 (5)	0.587
<i>Enterococci</i>	1(1.5)	2 (3.5)	1 (1.5)	0.89
<i>Staphylococcus haemolyticus</i>	1(1.5)	1 (1.5)	1 (1.5)	-
<i>Staphylococcus saprophyticus</i>	- (0)	1 (1.5)	1 (1.5)	0.811

\*Chi-square test.

#### 4- DISCUSSION

This study was conducted aimed to determine of the umbilical cord bacterial colonization in newborn infants rooming in with mothers and neonates admitted to neonatal intensive care unit. Our results indicated that newborns born by cesarean section are more susceptible to develop umbilical cord bacterial colonization compared to newborns born by vaginal delivery and neonates admitted to NICU. *Staphylococcus aureus* was the most common bacteria responsible for the colonization. Statistically, frequency of bacteria was similar between the groups.

Chamnanvanakij et al. investigated the umbilical cord bacterial colonization among 180 infants stayed at home. In their study, umbilical swab cultures was performed within 7 days post discharge, which all taken culture specimens were positive and *Klebsiella*, *Escherichia coli*, *Enterobacter* and *Staphylococcus* were the most frequent organisms, respectively. *Klebsiella* and *Escherichia coli* were isolated from the umbilical cord in 60% and 37.2% of the neonates (20).

In our study, majority of the neonates had not any umbilical cord bacterial colonization, which this difference may be due to umbilical cord care method. Natural drying of umbilical cord was the only used methods in our study, while in Chamnanvanakij et al., triple dye and alcohol were the other methods. Despite the many studies, there is still controversy over which umbilical cord care practice is the best (21). Several trials have shown that dry cord care increased colonization rates of bacteria, especially *Staphylococcus aureus* (21, 22).

In another study by Besharati et al., prevalence of bacterial colonization was investigated among 100 neonate in-patients NICU ward. Results of this study showed that *Staphylococcus epidermidis*, *Klebsiella pneumoniae* and *Escherichia coli*

were the main cause of microbial colonization and septicemia in the neonates (23). In our study, *Klebsiella pneumoniae* and *Escherichia coli* were the leading cause of colonization, too. Ying, et al., conducted a study aimed to determine the distribution of bacteria isolated in omphalitis. In their study, total of 69 strains of pathogens were isolated from samples, which *Staphylococcus aureus* (33.33%), *Escherichia coli* (64%), and *Klebsiella pneumoniae* (59%), were the predominant isolates recovered from the inflamed umbilicus in newborns (24). The results of this study are in line with our study. The most common isolated organisms in Taffazoli et al. study in Mashhad, Iran, were *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella Pneumoniae* in the umbilical stump (25).

In Oishi et al. study, also, despite the use of disinfectant in order to in the prevention of neonatal umbilical colonization, a significant number of participants colonized by *Staphylococcus aureus* (26).

*Staphylococcus epidermidis* is a skin and mucosal flora, which similar to *Staphylococcus aureus* are the most frequent causes of nosocomial infections on indwelling devices (27). Therefore, healthcare personnel have an important role in prevention of *Staphylococcus* colonization and standard precautions should be performed to avoid transfer and spread of bacteria. Association of bacterial colonization with low birth weight or early gestational age has been reported in several studies (28, 29).

We did not observe this relationship that further carefully designed studies are needed to demonstrate them. The most important limitation of this study was low sample size and lack of control on the hand hygiene of personals due to higher incidence of infection following contacts caregivers with mothers. Also, studies aimed to introduce the best strategies to

decreases the prevalence of *Staphylococcus aureus* were recommended.

#### 4-1. Limitations of the study

The most important limitation of our study was the lack of uniformity of samples in terms of gestational age and birth weight. Other limitation was the second culture which was done only in infant admitted in ICU. Also, other factors such as parent education and socio-economic status, and history of vaginal infection may be effective in umbilical cord colonization. So, we recommend another study with considering these factors.

#### 5- CONCLUSION

This study showed that umbilical cord bacterial colonization was more in infants who were born by cesarean section and stayed with their mothers. So, due to need of mothers for special care, number of caregivers and close contacts caregivers with mother especially in those with caesarian section, cares to prevent transmission of bacteria should be considered.

#### 6- CONFLICT OF INTEREST

There is no conflict of interest.

#### 7- ACKNOWLEDGMENT

The authors would like to express their gratitude to the staff of the NICU ward in Amir al-Mu'minin hospital for their cooperation. This study was supported in part by grant from the Semnan University of Medical Sciences.

#### 8- REFERENCES

1. Karumbi J, Mulaku M, Aluvaala J, English M, Opiyo N. Topical umbilical cord care for prevention of infection and neonatal mortality. *The Pediatric infectious disease journal* 2013;32:78.
2. Kai-Larsen Y, Gudmundsson GH, Agerberth B. A review of the innate immune defence of the human foetus and newborn,

with the emphasis on antimicrobial peptides. *Acta Paediatrica* 2014;103:1000-8.

3. Sangkomkamhang US, Lumbiganon P, Prasertcharoensook W, Laopaiboon M. Antenatal lower genital tract infection screening and treatment programs for preventing preterm delivery. *Cochrane database of systematic reviews issue*, 2015.
4. Chan GJ, Lee AC, Baqui AH, Tan J, Black RE. Prevalence of early-onset neonatal infection among newborns of mothers with bacterial infection or colonization: A systematic review and meta-analysis. *BMC infectious diseases* 2015;15:118.
5. Vergnano S, Heath PT. Fetal and neonatal infections. *Medicine* 2013;41:723-9.
6. Camacho-Gonzalez A, Spearman PW, Stoll BJ. Neonatal infectious diseases: Evaluation of neonatal sepsis. *Pediatric clinics of North America* 2013;60:367-89.
7. Duan Q, Zhou M, Zhu L, Zhu G. Flagella and bacterial pathogenicity. *Journal of basic microbiology* 2013;53:1-8.
8. Fletcher, Madilyn, and Dwayne C. Savage, eds. *Bacterial adhesion: mechanisms and physiological significance*. Springer Science and Business Media, 2013.
9. Julian S, Burnham C-AD, Sellenriek P, Shannon WD, Hamvas A, Tarr PI, et al. Impact of neonatal intensive care bed configuration on rates of late-onset bacterial sepsis and methicillin-resistant *staphylococcus aureus* colonization. *Infection Control and Hospital Epidemiology* 2015;36:1173-82.
10. Imdad A, Mullany LC, Baqui AH, El Arifeen S, Tielsch JM, Khatri SK, et al. The effect of umbilical cord cleansing with chlorhexidine on omphalitis and neonatal mortality in community settings in developing countries: A meta-analysis. *BMC Public Health* 2013;13(3): 1.
11. Saleh J-EA, Nemecek J, Jones C. Impact of hygienic caring of the umbilical cord in the prevention of neonatal tetanus. 2015.
12. Bhutta ZA, Darmstadt GL, Hasan BS, Haws RA. Community-based interventions for improving perinatal and neonatal health

outcomes in developing countries: A review of the evidence. *Pediatrics* 2005;115:519-617.

13. Mullany LC, Darmstadt GL, Tielsch JM. Role of antimicrobial applications to the umbilical cord in neonates to prevent bacterial colonization and infection: A review of the evidence. *The Pediatric infectious disease journal* 2003;22:996.

14. SAWARDEKAR KP. Changing spectrum of neonatal omphalitis. *The Pediatric infectious disease journal* 2004;23:22-6.

15. Davies E, Isaacs D, Levinsky R. Defective immune interferon production and natural killer activity associated with poor neutrophil mobility and delayed umbilical cord separation. *Clinical and experimental immunology* 1982;50:454.

16. Imdad A, Bautista RMM, Senen KAA, Uy MEV, Mantaring III JB, Bhutta ZA. Umbilical cord antiseptics for preventing sepsis and death among newborns. *The Cochrane Library* 2013.

17. Puopolo KM, Escobar GJ. Early-onset sepsis: A predictive model based on maternal risk factors. *Current opinion in pediatrics* 2013;25:161-6.

18. Ameh EA, Nmadu PT. Major complications of omphalitis in neonates and infants. *Pediatric surgery international* 2002;18:413-6.

19. Veloso FT, Cardoso V, Fraga J, Carvalho J, Dias LM. Spontaneous umbilical fistula in crohn's disease. *Journal of clinical gastroenterology* 1989;11:197-200.

20. Chamnanvanakij S, Decharachakul K, Rasamimaree P, Vanprapar N. A randomized study of 3 umbilical cord care regimens at home in thai neonates: Comparison of time to umbilical cord separation, parental satisfaction and bacterial colonization. *J Med Assoc Thai* 2005;88:967-71.

21. Broom MA, Smith SL. Late presentation of neonatal omphalitis following dry cord care. *Clinical pediatrics*. 2013;52(7):675-7.

22. Evens K, George J, Angst D, Schweig L. Does umbilical cord care in preterm infants influence cord bacterial colonization or detachment? *Journal of perinatology* 2004;24:100-4.

23. Besharati R, SADEGHIAN A, MAMORI GA, Lashkardoust H, GHOLAMI S. Sources of bacteria causing nosocomial infections at NICU of Ghaem hospital in Mashhad, Iran. *Journal of North Khorasan University of Medical Sciences*. 2013; 5 (1): 25-30.

24. Ying C. Study on 69 Pathogens and Drug-resistance of Neonatal Omphalitis. *Journal of Mathematical Medicine*. 2013; 2:015.

25. Taffazoli M, Farahani L, Mohammadzadeh A, Esmaeeli H, Ghazvini K. Dose topical application of breast milk affect on bacterial colonization in umbilical cord? *Koomesh* 2008;10:Pe29-Pe35, En5.

26. Oishi T, Iwata S, Nonoyama M, Tsuji A, Sunakawa K. Double-blind comparative study on the care of the neonatal umbilical cord using 80% ethanol with or without chlorhexidine. *Journal of Hospital Infection* 2004;58:34-7.

27. Otto M. Staphylococcus epidermidis—the 'accidental' pathogen. *Nature Reviews Microbiology*. 2009;7(8):555-67.

28. Mullany LC, Darmstadt GL, Katz J, Khatry SK, LeClerq SC, Adhikari RK, Tielsch JM. Risk factors for umbilical cord infection among newborns of southern Nepal. *American Journal of Epidemiology*. 2007;165(2):203-11.

29. Güvenç H, Aygün D, Yaşar F, Şoylu F, Güvenç M, Kocabay K. Omphalitis in term and preterm appropriate for gestational age and small for gestational age infants. *Journal of tropical pediatrics*. 1997;43(6):368-72.