Investigating the effects of the neonatal factors and therapeutic modalities on neonatal mortality in neonatal intensive care unit of Shahid Motahhari Hospital, Urmia

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ABSTRACT

Background: A newborn is highly fragile whose death can be caused by embryonic, intrapartum, and postpartum factors. Identifying the causes of death is the first step to be taken in order to decrease the death rate. The present study was aimed at finding out how neonatal factors and therapeutic actions affect death of newborn babies.

Materials and Methods: The is a case-control study where the case group included 250 dead neonates who were hospitalized in the neonatal intensive care unit during 2007-2009. The control group also included 250 newborn neonates who were hospitalized in the same unit and were discharged alive and healthy after they were treated appropriately. Researcher-designed questionnaires including demographic characteristics of mothers and infants, causes of hospitalization, treatment and its complications, and causes of death were used to collect the required data. Chi-square test, odds ratio (OR), and logistic regression were applied to analyze how the variables were related. $P < 0.05$ were considered significant. Statistical analyses were carried out using software SPSS 16.0.

Results: The results of advanced logistic regression model showed that first-minute Apgar less than 6 (OR = 4.02), existence of birth asphyxia (OR = 6.16), hyaline membrane disease (OR = 4.08), and sepsis (OR = 6.42) increased the death rate of neonates hospitalized in the intensive care unit, and applying nasal continuous positive airway pressure and multiparity decreased the death rate of newborn babies. There was no significant correlation between variables such as low birth weight, consanguinity, blood group, pr eterm labor history, and baby's gender, and the death rate of neonates.

Conclusions: The results of the study show that factors such as low Apgar score, asphyxia, hyaline membrane disease, sepsis, prematurity and congenital anomalies, and method of delivery have a positive effect on the death of neonates. They also prove that suitable management and carrying out appropriate therapeutic actions and intensive care decrease the death rate of newborn babies.

Key words: Case-control study, intensive care unit, neonatal death, neonatal factors, therapeutic care

INTRODUCTION

Neonatal period (the first 28 days after birth), which is the period of various physiological adaptations to the extrauterine life, is a vulnerable time.

About 130 million babies are born annually. More than 10 million children die before the age of 5 years, 8 million of whom die before the age of 1 year and more than half of these deaths occur in the first 4 weeks after birth. About 98% of the neonatal deaths occur in developing countries.[1] According to the World Health Organization (WHO), the rate of deaths is 30 times more in the countries with the highest rate compared to the countries with the lowest rate.[2,3]

According to the reports of Ministry of Health and Medical Education, the index of neonatal death in Iran is 16-20 deaths out of 1000 survived births, which is higher than that in developed countries.[4] WHO has urged Iran to halve its neonatal death rate by 2015.[5]

Risk factors in studying neonatal death are categorized into three groups: Prenatal, intrapartum, and postnatal factors. All over the world, infection, preterm delivery, and birth asphyxia contribute to about 87% of neonatal deaths.[6]

In most societies, congenital malformations and premature birth are the main causes of neonatal death. In the USA,

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babies with low birth weight (LBW) and extremely LBW account for 6-7% and 1% of babies' death, respectively.[7] These causes, however, are the second and third reasons, respectively, which are responsible for one half of the neonatal deaths.[8]

Preterm delivery constitutes about 8-10% of all deliveries. Prematurity is responsible for about 60-80% of neonatal deaths all over the world in babies without congenital anomalies. In many cases, neonatal diseases are caused by respiratory problems, of which hyaline membrane disease (HMD) can be mentioned as the foremost. About 1.3% of all neonatal deaths are caused by HMD or its complications in premature newborns.[9,10]

Nayeri *et al.* have mentioned five main causes of neonatal death, including prematurity, internal bleeding, septicemia, respiratory distress syndrome, and congenital anomalies, while Gheibi *et al.* have reported prematurity (68%), HMDs (51%), asphyxia (13%), sepsis (13%), and congenital cardiac malformations (8%) as the most important causes of neonatal death.[2,5]

Method of delivery is one of the most important issues influencing neonatal death.[11,12] The baby's gender has also been considered as an important factor in his or her death.[13-18]

One of the most important issues in babies' death is suitable management and timely referral of newborn babies with high-risk levels and being hospitalized in neonatal intensive care unit (NICU). NICU is a critical section in a hospital, dealing with infections (e.g. septicemia, pneumonia, surgical infections, and other infections) that are difficult to control. In the USA, nosocomial infections in NICU have been reported to be 12.5-26.5%.[19-22]

Management, appropriate care, and supportive cares are the important factors in preventing babies' death. Rostami *et al.* have reported that the rescue chances of the babies who have received preventive nasal continuous positive airflow pressure (nCPAP) are three times higher than the other babies.[23]

Considering that an analytical and comprehensive study has not been done about the role of neonatal risk factors and the therapy given for hospitalized neonatal death in west Azerbaijan, the need is felt to conduct such a study in this center. The present article is an extract from the results of this research project.

MATERIALS AND METHODS

The study is case–control study, wherein the case group included 250 died babies who were hospitalized in the NICU during 2007-2009. The control group also included 250 newborn babies who were hospitalized in the same unit and were discharged alive and healthy after they were given appropriate treatment. Only the newborn babies from Shahid Motahhari Therapy-Training Center were selected in order to homogenize the sample and eliminate some threatening factors (factors involved in referral, death, etc.). Data collection was carried out through a researcher-designed questionnaire which was designed based on other studies and scholars' points of view. Inclusion criteria included the babies' complete profiles, and the criteria for exclusion included their incomplete profiles.

The questionnaire contained six sections (mother's and baby's demographic information, causes of hospitalization, during-treatment complications, therapeutic actions, and causes of death) for alive babies and five sections for dead ones. Chi-square test, odds ratio (OR), and logistic regression were applied to analyze how the variables were related. $P < 0.05$ was considered significant. Statistical analyses were carried out using software SPSS 16.0.

RESULTS

Based on single-variable analysis, neonatal risk factors affecting the newborn babies hospitalized in the NICU are as follows: 51.6% of case babies and 18.3% of control babies had first-minute Apgar score of less than 6, which proved to have a significant correlation with babies' death ($p < 0.001$). About 9.6% of babies of case group and 2.4% of babies in the control group had during-birth asphyxia which proved to have a significant correlation with neonatal death ($P = 0.001$) [Table 1].

In this study, one of the factors causing death of babies hospitalized in the NICU was HMD; 77.6% of case babies and 44.8% of control babies suffered from this disease ($P < 0.001$). Fourteen percent of case babies and 2% of control babies had sepsis which showed a significant relation with babies' death ($P < 0.001$). Moreover, 58.8% of case babies and 71.5% of control babies were born through Cesarean section which also proved to have a significant effect ($P < 0.001$) [Table 1].

Congenital anomalies have been recognized as one of the significant risk factors of death of babies hospitalized in the NICU. Eight percent of case babies and 2.8% of control babies were reported to have congenital anomalies ($P < 0.001$) [Table 1].

Regarding therapeutic actions, the results of the study also showed that having nCPAP played a significant role in decreasing death of babies hospitalized in the

Table 1: The distribution of independent variables by independent variables; *P* value based on Chi-square test

Variables	n (%)		P value	OR	95% CI for OR
	Cases	Controls			
Apgar			<0.001		
<6	129 (51.6)	45 (18.3)		Reference	
>6	121 (48.4)	201 (81.7)		4.02	(2.34, 6.44)
Birth asphyxia			0.001		
No	226 (90.4)	244 (97.6)		Reference	
Yes	24 (9.6)	6 (2.4)		6.16	(1.86, 20.39)
HMD			<0.001		
No	56 (22.4)	138 (55.2)		Reference	
Yes	194 (77.6)	112 (44.8)		4.08	(2.35, 7.07)
Sepsis			<0.001		
No	215 (86)	245 (98)		Reference	
Yes	35 (14)	5 (2)		6.42	(2.00, 20.59)
nCPAP			0.001		
No	214 (87.6)	189 (75.6)		Reference	
Yes	31 (12.4)	61 (24.4)		0.43	(0.22, 0.85)
Pregnancy count			<0.001		
0	133 (53.2)	3 (1.2)		Reference	
1-2	94 (37.6)	170 (63.8)		0.01	(0.002, 0.41)
3-4	17 (6.8)	64 (25.7)		0.004	(0.001, 0.21)
≥5	6 (2.4)	12 (4.8)		0.011	(0.002, 0.064)
Delivery			0/003		
C/S	147 (58.8)	178 (71.5)			
Vaginal	103 (41.2)	71 (28.5)			
Anomaly			0/001		
No	230 (92)	243 (97.2)			
Yes	20 (8)	7 (2.8)			

HMD: Hyaline membrane disease, nCPAP: Nasal continuous positive airflow pressure, OR: Odds ratio, CI: Confidence interval, C/S: Cesarean section

NICU (*P* < 0.001). There was also a significant relation between supportive cares and neonatal death (*P* < 0.001). Increased number of pregnancies also had a significant effect on neonatal death (*P* < 0.001) [Table 1].

Variables like LBW, baby's gender, blood group, history of preterm labor, and consanguinity had no significant role in the death of neonates hospitalized in the NICU.

In order to gauge the key effects of the mentioned factors, the adjusted OR calculated from advanced logistic regression model was measured through advance selection method. The results showed that the OR of neonatal death was 4.02 times greater for neonates with first-minute Apgar score of less than 6 compared to those with first-minute Apgar score of 6 and more, for asphyxia, the OR was 6.16, for HMD it was 4.08, and

for sepsis it was 6.42. Applying nCPAP and multiparity led to a decrease in the death of neonates hospitalized in the NICU [Table 1].

DISCUSSION

In the present study, the most important neonatal risk factors affecting neonatal death were found to be sepsis, birth asphyxia, HMD, first-minute Apgar score of less than 6, congenital anomalies, and delivery method.

In our study, the most common risk factor for neonatal deaths was sepsis which raised the risk of death by infection to 6.42 times more than the other causes. In the studies of Sereshtedari *et al.*,[24] Chowdhurg *et al.*,[25] Bauni *et al.*,[26] and Gheibi *et al.*,[2] sepsis and its complications were reported to be the first cause of death, but in the investigations of Nayeri *et al.*[5] and Amin *et al.*,[27] sepsis had higher ratings. This may be due to the factor that premature babies are prone to infection, but it should be more investigated because of the high number of deaths resulting from it.

This spread of sepsis has been reported to be in 1-10 cases out of 1000 live births, but 10-50% of deaths occur because of it.[2-3,5,28]

The second risk factor in the present study was at birth asphyxia, which is in line with Tariq and Kundi's study[29] which mentioned sepsis and neonatal asphyxia as the main causes of death, but in the studies carried out by Sereshtedari *et al.*,[24] it was the cause of the 16% deaths in 18 provinces of the country,[30] in Bangladesh approximately 26% of neonatal deaths are caused by asphyxia.[25]

The other serious clinical problem is respiratory difficulty, and in this study, it manifested as respiratory distress and HMD. In our study, it was the third risk factor of infant death. The study of Abdul in Malaysia[31] showed that this problem with sepsis is the most important cause of infants' death.

There is also a second leading cause of infant death in Tariq and Kundi's study,[29] and respiratory distress syndrome which were studied by Kumar *et al.* in India,[32] Jehan *et al.* in Pakistan,[28] Naghavi in 18 provinces of Iran,[30] Javanmardi *et al.* in Isfahan,[33] Amani *et al.* in Ardebil,[27] and in the studies of Nayeri *et al.* in Tehran and Sereshtedari *et al.*,[5,24] HMD was the top cause of infant mortality.

One of the causes of infant death, low Apgar score at birth, is increasingly mentioned in many studies to be a risk factor. Low Apgar score at birth could be correlated to factors such as neonatal infections, birth asphyxia, meconium aspiration,

respiratory distress syndrome, and other causes which may result in infant mortality.

In our study, nCPAP was applied in the control group two times more than in the case group, which resulted in a decrease of babies' death by 0.43. This finding correlates with the findings of the studies conducted by Fallahi *et al.,*[14] Lee *et al.,*[34] and Boskabadi *et al.*[35] In their study, Rostami *et al.* also reported that applying preventive nCPAP to newborn babies will increase their survival chances by three times.[23]

Another risk factor causing babies' death is congenital anomalies. In the present study, this factor occupied the fifth position as the risk factor for infant death. Congenital anomalies was found to be in the second position in the studies of Sharifi,[36] Hematyar and Yarjo,[37] Javanmardi *et al.* in Esfahan,[33] and Naghavi's study in 18 provinces.[30] It was mentioned as the second and first cause in the studies of Sareshtedati *et al.*[24] and Donna,[38] respectively. In Namaki *et al.*'s study,[3] congenital anomalies and infection were mentioned as the leading factors of infant death.

The rate of abnormalities in our study compared with other studies, which shows that it is a less important factor in the incidence of neonatal death. This may be due to high morbidity and mortality caused by other factors such as immaturity, lack of attention and careful examination at the time of birth, lack of screening for neonatal abnormalities, and not performing autopsy in dead neonates.

LBW is an important indirect factor causing neonatal death. Death rate in babies with LBW is about 40 times higher than in babies with normal weight.[39] Unlike these studies, no significant relationship was observed between LBW and neonatal death in a study.[40] This finding is in correlation with that of Nayeri *et al.*[5]

In the present study, normal vaginal delivery was higher in the case group than that in the control group. Statistical tests proved a significant relation between the method of delivery and neonatal death. This finding shows that cesarean section can be better when there is an emergency case or prematurity. Although emergency cesarean section is performed to save the lives of the mother and baby, the selection is not always uncomplicated. In a study, it has been reported that two-third of babies who died were born through cesarean section.[12,41,42]

In our study, despite the high level of infant mortality in males, there was no significant relation between gender and the cause of death. Different studies have proved higher rate of death in male babies.[13,17] This finding correlates with that of Nayeri *et al.*[5]

An important risk factor that was investigated in this study was the number of pregnancies. The results of this investigation showed that death rate decreased as the number of pregnancies increased. Statistical tests also proved a significant relationship between them. Number of births higher than 5, pregnancy number above 3, and high rate of birth were mentioned as effective factors causing babies' death in studies conducted by Shirvani and Khosravi,[42] Chaman *et al.*,[13] and Titaley *et al.*,[42] respectively.

Appropriately carrying out care and supportive cares can be effective factors in preventing babies' death. In our study, 51.6% of case babies and 2.3% of control babies had received supportive care from birth. Higher death rate in case babies can be due to bad physical conditions and other threatening factors.

The results of the study show that incorrect methods of transfer can increase the death rate. In this study, special attention was devoted to increasing the care standards in order to decrease the death rate.[28,43-45]

According to the results of the study that took into consideration factors such as age, occupation, consanguinity, blood group, preterm delivery background, and sex in two groups with equal distribution, it can be concluded that factors related to accompanying diseases and care during delivery play a significant role in neonatal death. Therefore, regarding the fourth goal of millennium development, decreasing babies' death to two-fourths by 2015 in countries with high rate of mortality, it seems to be better to spot pregnancies with high risk of babies' death through pre-delivery care and to transfer mothers who are likely to bear premature or sick babies to centers that have NICUs. In cases where it is impossible to specify whether a delivery is risky before birth, the subsequent hospitalization problems can be prevented by providing appropriate conditions of transfer and therapeutic actions in intensive care units.

CONCLUSION

The major risk factors in this study (sepsis, asphyxia during birth, HMD, congenital anomaly, and Apgar score less than 6 in the first minute of birth) are considered as the major complications of preterm labor and preterm infants. So, strict preventive programs should be undertaken for premature preterm labor and preterm infants; taking care of the infants in four stages (before conception, during

pregnancy, during delivery, and thereafter) can be highly effective as well.

ACKNOWLEDGMENTS

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