Research Article

Factors Associated with Neonatal Mortality among Preterm Infants at Intensive Care Unit of a Tertiary Hospital in Vietnam

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Abstract

Background: Neonatal mortality remains a major health problem in middle and low-income countries.

Objective: To identify factors associated with neonatal mortality in premature neonates at a tertiary hospital in Vietnam.

Methods: A cross-sectional study was performed on 324 preterm neonates admitted to the Bach Mai Hospital in 2023. Clinical and paraclinical characteristics were collected. Multivariate analysis was used to examine factors associated with neonatal mortality.

Results: The total premature neonatal mortality rate was 12.7%. Living area, Apgar-score at the 1st minute, congenital defect, undergoing mechanical ventilation and hypothermia were critical predictors for neonatal mortality in intensive care unit.

Conclusion: This study underlined the high rate of neonatal mortality in the intensive care unit of a tertiary hospital in Vietnam. Further interventions to improve the capacities of hospitals and health professionals should be warranted to reduce this burden.

Keywords: Hospital; Mortality; Neonatal; Premature

Introduction

Neonatal Mortality Rate (NMR) is one of the important indicators to measure the quality of maternal and newborn health care. Reducing NMR is a priority in the global health agenda. The Sustainable Development Goal (SDG) underlines in goal 3.2 that aims to "end preventable deaths of newborns and children under five years of age" and 'with all countries aiming to reduce their NMR to at least as low as 12 per 1,000 live births" [1]. Globally, about 15 million premature infants are born annually and about 1 million of these newborns died due to preterm birth complications [2]. Thanks to the efforts of countries and health systems, the NMR has decreased significantly over years. According to the United Nations Children's Fund (UNICEF), by the end of 2017, the NMR decreased by 51% from 37 deaths per 1000 live births in 1990 to 18 deaths per 1000 live births in 2017 [3,4]. In Southeast Asian countries, there are an estimated 200,000 neonatal deaths each year, with the rate of mortality ranging from 1 to 30 per 1000 live births [5]. Common causes of neonatal death include infection, low birth weight, premature birth or asphyxia. However, in each country, these causes vary according to the quality of health services or the responsiveness of the health system. Therefore, providing up-to-date evidence in each country is important in developing intervention programs to minimize NMR in those countries.

In Vietnam, according to the UNICEF, the NMR was 10.6 deaths per 1,000 live births in 2017, which was higher than the NMR in some countries in the region such as Singapore (1.1 deaths per 1,000 live births), Thailand (5.5 deaths per 1,000 live births), China (4.5 deaths per 1,000 live births) and especially Japan (only 0.9 deaths per 1,000 live births) [3]. Data from international organizations show that the neonatal mortality rate tended to decrease from 23.4 per 1000 live births in 2000 to 15.9 per 1000 live

births in 2019 [6]. However, this rate is still a long way from the SDG target (12 per 1000 live births), which requires up-to-date data on risk factors for neonatal mortality to develop appropriate intervention programs. This study was conducted to determine neonatal mortality patterns among preterm infants and factors related to neonatal mortality at a tertiary hospital in Vietnam.

Methodology

Study Design and Participants

A cross-sectional study was conducted at the Department of Pediatrics, Bach Mai Hospital from 1/2023 to 12/2023. There were 324 preterm infants (from 23 to 37 weeks of gestation) admitted to the Department of Pediatrics, Bach Mai Hospital then hospitalized in the intensive care unit within 28 days of birth. We excluded neonates who died before hospitalization and whose neonatal medical records had incomplete information. Ethical approval for this study was approved by the Institutional Review Board of Bach Mai Hospital.

Data Collection

Infants admitted to the hospital and treated in the intensive care unit were included in the study if they met the inclusion and exclusion criteria. The patient was monitored and treated by doctors at the Department of Pediatrics, Bach Mai Hospital. The clinical and laboratory information of the patient was recorded in the medical record. The information included:

General characteristics consisted of age, gender, hospital admission time, weight and regions (urban and rural). Mother's characteristics were also collected including age, illness and gestational age by week.

Clinical and paraclinical characteristics: included neonate's weight, neonate's first- and fifth-minute Apgar scores, hypothermia, postpartum cardiopulmonary arrest, respiratory failure, respiratory rate, oxygen saturation (SpO_2) and other associated birth defects. Low birth weight was defined as infants weighing less than 2500 g at birth. Neonatal mortality was defined according to ANZNN Data dictionaries [7]. Neonatal mortality in this study comprised deaths that occurred within 28 days of birth. We also collected information about mechanical ventilation (including invasive and noninvasive ventilation), cardiac ultrasound and treatments (catheterization, intravenous feeding, transfusion of blood and blood products, surfactant pumps or antibiotics).

Statistical Analysis

The SPSS 20.0 software (SPSS, USA) was used for data analysis. Descriptive statistics were performed. A chi-squared test was used to examine the differences in mortality across clinical groups. Multivariate Logistic regression was performed in measuring associations between clinical characteristics and neonate mortality. A P-value of less than 0.05 was considered statistically significant.

Results

During the study period, 324 premature infants were recruited. Among them, 41/324 (12.7%) premature newborns died. The majority of infants were from rural areas (53.4%). There were 235 premature infants (72.5%) delivered from pregnant women with illness. Fig. 1 showed that the most common disease in mothers were Hemolysis, Elevated Liver Enzymes and Low Platelets (HELLP) syndromes (18.3%), followed by Lupus (17.4%) and Amniotic fluid and placenta disease (13.2%).

Table 1 shows that the neonatal mortality rates were significantly high in infants from rural areas (17.3%) and low birth weight (16.5%) compared to those from urban areas (7.3%) and normal birth weight (4.0%) (p<0.01).

In Table 2, neonatal mortality rates were significantly high in infants having mothers with illness (14.7%), low Apgar score at the 1st minute (35.3%), having hypothermia (69.2%), having low oxygen saturation ($SpO_2 \leq 90\%$) (23.6%), undergoing mechanical ventilation (26.6%) and having birth defects (57.9%) (p<0.01).

Table 3 shows multivariate regression to determine associated factors with neonatal mortality. Overall, living area, Apgar-score at the 1st minute, having birth defects, undergoing mechanical ventilation and having hypothermia were associated with a higher risk of neonatal mortality (p<0.05).

Characteristics	Survivors	Neonatal Death	Total	p-value
	n (%)	n (%)	n (%)	
Regions				
Urban	140 (92.7%)	11 (7.3%)	151 (46.6%)	<0.01
Rural	143(82.7%)	30 (17.3%)	173 (53.4%)	
Weight				
< 2500 g	187 (83.5%)	37 (16.5%)	224 (69.1%)	<0.01
≥ 2500 g	96 (96.0%)	4 (4.0%)	100 (30.9%)	
Mother's age				
<35 years	163 (57.6%)	20 (48.8%)	183 (56.5%)	0.30
≥35 years	120 (42.4%)	21 (51.2 %)	141 (43.5%)	

Table 1: Neonatal mortality according to general characteristics.

Characteristics	Survivors	Neonatal Death	Total	p-value
	n (%)	n (%)	n (%)	
Mother's illness				
Yes	197 (85.3%)	34 (14.7%)	235 (72.5%)	<0.01
No	86 (92.5%)	7 (7.5%)	93 (28.7%)	
1st-minute Apgar score				
≤ 5	55 (64.7%)	30 (35.3%)	85 (26.2%)	<0.01
> 5	228 (95.4%)	11 (4.6%)	239 (73.8%)	
Hypothermia				
Yes	4 (30.8%)	9 (69.2%)	13 (4.0%)	<0.01
No	279 (89.7%)	32 (10.3%)	311 (96.0%)	
Oxygen saturation				
SpO_2 ≤ 90%	68 (76.4%)	21 (23.6%)	89 (27.5%)	<0.01
SpO_2 > 90%	215 (91.5%)	20 (8.5%)	235 (72.5%)	
Mechanical ventilation				
Yes	94 (73.4%)	34 (26.6%)	128 (39.5%)	<0.01
No	189 (96.4%)	7 (3.6%)	196 (60.5%)	
Birth defects				
Yes	8 (42.1%)	11 (57.9%)	19 (5.9%)	<0.01
No	275 (90.2%)	30 (9.8%)	305 (94.1%)	

Table 2: Neonatal mortality according to clinical characteristics.

Model	Standardized Coefficients		p-value	Collinearity Statistics	
	OR	SE		Tolerance	VIF
Weight (<2500g vs ≥ 2500 g-ref)	1.01	0.035	0.710	0.891	1.122
Area (Urban vs Rural - ref)	0.90	0.032	0.026	0.955	1.035
Apgar score (≤ 5 vs >5-ref)	1.22	0.042	<0.001	0.639	1.444
Birth defects (No vs Yes-ref)	0.79	0.067	<0.001	0.954	1.048
Maternal age (<35 years vs ≥35 years - ref)	1.04	0.032	0.427	0.978	1.020
Mechanical ventilation (Yes vs No-ref)	1.13	0.039	0.029	0.666	1.502
↓SpO_2 (Yes vs No-ref)	1.14	0.038	0.501	0.834	1.199
Mother's illness (Yes vs No-ref)	1.19	0.035	0.126	0.958	1.044
Hypothermia (No vs Yes-ref)	0.77	0.082	<0.001	0.921	1.086

Table 3: Multivariate regression to determine associated factors with neonatal mortality.

Discussion

Results of this study contribute part of the evidence on neonatal mortality in a developing country. This study showed that the neonatal mortality rate in the intensive care unit at a tertiary hospital in Vietnam remained high (12.7%). This result was significantly higher than the general neonatal mortality rate in Vietnam in 2019 (15.9 deaths per 1000 live births) [6]. This result can be explained by the fact that Bach Mai Hospital is the hospital at the highest level of the health system in Vietnam; thus, the cases of pediatric patients admitted to the emergency department and intensive care often had severe health conditions with a high risk of death. When compared with other studies, the neonatal mortality rate in our study was still at the same or lower level. Previous research in Ethiopia found a mortality rate of 21.3% [8]. Another study in Guinea showed a mortality rate of 23.7% or a study in Haiti showed a mortality rate of 14.5% [9,10]. When assessing factors related to neonatal mortality, the study found that the five most important predictors included living areas, Apgar-score at the 1st minute, having birth defects, undergoing mechanical ventilation and having hypothermia. Infants from rural areas had a higher risk of death than those from urban areas. This could be explained by the fact that these children often had serious medical conditions and were transferred from lower-level hospitals, which could not afford to treat these conditions. This also shows a gap in the capacity of the primary health care level in preventing neonatal mortality and the need for more capacity building and knowledge transfer programs to strengthen the capacity of the primary health care providers.

The results of our study show that the 1st-minute Apgar score was one of the high-risk factors for neonatal mortality. This result is similar to some other studies around the world. Research in Ethiopia showed that infants with first minute Apgar score classification of severe increased 2.1 times of risk of neonatal mortality compared to other infants [8]. Another research in Brazil found that the neonatal mortality rate was significantly higher among those with lower Apgar scores [11]. A systematic and multicenter study found that Apgar scores were a critical predictor for the abnormalities and risk of death in both preterm and full-term neonates [12]. According to a study by Hosein, et al., in Iran on 942 infants, if a five-minute Apgar score was less than 7 points, the risk of mechanical ventilation increased by 18.6 times, the risk of cerebral hemorrhage increased by 4.8 times and the risk of mortality increased by 20.2 times [13]. Premature infants are at high risk of hypothermia. A systematic review found that hypothermia was observed in 32-85% of hospital-born infants and 11%-92% of home-born infants [14]. This was also a risk factor for neonatal mortality in this study. This is consistent with previous studies. Hypothermia is thought to be an indirect cause of neonatal mortality and is often accompanied by other serious health conditions such as neonatal infection, preterm birth or asphyxia [14]. In this study, only 4.1% of infants had hypothermia, which was significantly lower than global estimates [14]. This indicates success in controlling hypothermia in the study hospital. However, the mortality rate in children with hypothermia remains high, indicating that this is still a major challenge for healthcare workers in hospitals. Our results are also in line with previous studies when found that undergoing mechanical ventilation and having birth defects were major risk factors for neonatal mortality. A US report from 2003-2017 showed that 20.6% of infant deaths were attributable to birth defects [15]. Another study in Malta showed that 36.7% of infant deaths were caused by birth defects [16]. In this study, 57.9% of infants with birth defects died, indicating that this is still a serious health problem. This situation is related to prenatal screening and antenatal care; thus, interventions that enhance these measures need to be addressed thoroughly.

The study has some limitations. This study was performed in only one hospital; therefore, the study results may not be reflective of other hospitals. The study was carried out for only one year; therefore, trends in improving neonatal mortality have not been assessed over time. This study used a cross-sectional study design; therefore, the results did not allow to draw of causal conclusions.

Conclusion

This study underlined the high rate of neonatal mortality in the intensive care unit of a tertiary hospital in Vietnam. Living area, Apgar-score at the 1st minute, having birth defects, undergoing mechanical ventilation and having hypothermia were critical predictors for neonatal mortality. Further interventions to improve the capacities of hospitals and health professionals should be warranted to reduce this burden.

Conflict of Interests

The authors(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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