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Original Article

Neonatal Morbidity and Mortality in a Neonatal Unit in a Vietnamese Hospital

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ABSTRACT

Background: Despite the numerous advances in newborn care, neonatal mortality and morbidity remain high, especially in developing countries, which requires us to find a way to improve facility-based care. The present study investigates the pattern of diseases and mortalities among these neonates admitted to the Neonatal Intensive Care Unit of Hue Central Hospital, Hue city, Vietnam, and explores the factors associated with the mortality.

Methods: A cross-sectional study was carried out at the Neonatal Intensive Care Unit of Hue Central Hospital between January 2019 and December 2019. Factors including age, sex, gestational age (GA), weight, diagnosis, and causes of neonatal death were studied. Each case was analyzed regarding factors affecting neonatal mortality.

Results: A total of 724 neonates were enrolled in this study. Of them, 403 (55.7%) were male, and 321 (44.3%) were female. Early-onset neonatal sepsis was the most frequent problem (49.9%), sequentially followed by late-onset neonatal sepsis (35.5%), congenital anomalies (14%), hyaline membrane disease (12.6%), unconjugated hyperbilirubinemia (12.2%), and asphyxia (10.2%). Moreover, the mortality rate was reported as 13.2%. The factors associated with mortality included GA, birth weight, multiple anomalies, critical congenital heart defects, asphyxia, hyaline membrane disease, cerebellar hemorrhage, and early-onset neonatal sepsis.

Conclusion: Neonatal sepsis was the primary cause of morbidity in the neonatal care unit in Vietnam. Preterm birth, asphyxia, and multiple anomalies were the main risk factors associated with mortality. Early management of preterm births and neonatal diseases should be given priority for improving neonatal outcomes.

Keywords: Death, Gestational age, Infection, Neonate

Introduction

The neonatal period, defined as the first four weeks of life, accounts for significantly high morbidity and mortality (1). Between 1990 and 2017, the global neonatal mortality rate decreased from 36.6 deaths per 1,000 live births in 1990 to 18 deaths per 1,000 live births in 2017 (2). However, the decline in neonatal mortality has been slower than that among children aged 1 to 59 months, with 2.6% and 3.6%, respectively (3). Notably, neonatal mortality rates varied significantly between countries (4), high in South Asia and low in Europe and North America. Therefore, a newborn's chances of surviving and thriving largely depend on where they are born. Surviving and thriving of a newborn is essential to achieve Sustainable Development Goals target of reducing the neonatal mortality rate of 12 or less per 1,000 live births by 2030 (5).

In Viet Nam, the mortality of children aged 1 to 11 months decreased a third from 44.4% in 1990 to 14% in 2019 (6). However, despite remarkable improvements in maternal and neonatal care, the neonatal mortality rate has remained high. The neonatal mortality rate from 2010 to 2014 was 11.95%, which accounted for 70% of all deaths in children under 1-year and 50% of all deaths in children under 5-years (6).

The neonatal mortality rate is a key indicator

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for assessing the quality of newborn care in countries. The leading causes of neonatal deaths are prematurity, infection, birth asphyxia, and congenital anomalies (7, 8). These causes make up nearly 80% of the causes of infant deaths (9). Meanwhile, the aforementioned causes could be partly prevented. One of the possible explanations for the high neonatal mortality is the lack of collaboration between pediatricians and obstetricians at the hospital.

Improving primary neonatal care is the strategic priority in developing countries and Viet Nam. Each newborn baby is classified into different groups based on gestational age (GA) and birth weight. Additionally, patterns of neonatal morbidity and mortality seem to be different in these groups. As a result, determining the disease patterns and mortality patterns among neonates plays an essential role in enhancing the quality of the neonatal care unit. Therefore, the current study was conducted to investigate the morbidity and mortality pattern at the Neonatal Intensive Care Unit in Hue Central Hospital, Viet Nam, and explore the associated risk factors for mortality in the neonatal period.

Methods

Study Design

A descriptive cross-sectional study was performed in the Neonatal Intensive Care Unit in Hue Central Hospital from January 1st, 2019, and December 31th, 2019. This hospital is one of the main hospitals located in the middle part of Viet Nam. This hospital also provides neonatal intensive care services for critically ill neonates and those who need neonatal care. The Neonatal Intensive Care Unit has 20 nurses and six pediatricians. Besides, the unit has 30 critical care beds for newborns, 14 kangaroo mother care beds, and 16 mother side beds. The standard nursing procedures in the unit are phototherapy, umbilical transfusion, oxygen administration, nasogastric tube insertion, intravenous infusion, lumbar puncture, and continuous positive airway pressure ventilation.

Sampling Procedure

We included all newborn neonates (0-28 days of life) who were consecutively admitted to the Neonatal Intensive Care Unit in Hue Central Hospital during the study period. We excluded neonates if the disease was not clearly confirmed. Finally, we included 724 neonates admitted to the Neonatal Intensive Care Unit in Hue Central Hospital from January 1st, 2019, and December 31th, 2019.

Diagnostic Criteria

Diagnosis of the disease and the cause of death was made using the clinical information and the necessary laboratory reports by a specialist pediatrician and confirmed by a second specialist.

Two methods were used to calculate the gestational age at birth: fetal ultrasound and the New Ballard Score. If the difference of GA between the two methods was more than 2 weeks, GA was based on New Ballard Score; otherwise, GA was based on fetal ultrasound (10).

The newborn classification based upon the GA includes the following categories (New Ballard Score) (11-13): (1) Preterm infants: GA < 37 weeks (Extremely preterm infants: GA < 28 weeks; Very preterm infants: 28 -< 32 weeks; Moderate and late preterm infants: 32 -< 37 weeks). (2) Term infants: 37 -< 42 weeks. (3) Post-term infants: ≥ 42 weeks.

The newborn classification, which was based upon the nutritional status, used Fenton growth charts 2013 (14): (1) Small for GA: weight for GA < 10th percentile. (2) Appropriate for GA: weight for GA between 10th and 90th percentile. (3) Large for GA: weight for GA > 90th percentile.

Early-onset sepsis was defined as occurring in the first three days of life, whereas late-onset sepsis occurred after three days within the neonatal period (15).

Hyaline membrane disease was diagnosed by a combination of assessments, including premature, breathing efforts (these signs indicate the baby's need for oxygen), and x-rays of the lungs (16).

Unconjugated hyperbilirubinemia was defined when the conjugated bilirubin level was less than 15% of the total bilirubin (17).

Birth asphyxia was diagnosed according to The Guidelines of the American Academy of Paediatrics and the American College of Obstetrics and Gynaecology, including: (1) profound metabolic or mixed acidemia (pH < 7.00) in the umbilical artery blood sample, if obtained, (2) persistence of an Apgar score of 0–3 for longer than 5 min, (3) neonatal neurologic sequelae, and (5) multiple organ involvement (18).

Cerebellar hemorrhage was confirmed by an ultrasonologist.

Meconium aspiration syndrome was suspected when a neonate showed respiratory distress in the setting of meconium-containing amniotic fluid. The diagnosis was confirmed by a chest x-ray showing hyperinflation with variable areas of atelectasis and flattening of the diaphragm (19).

Transient tachypnea was suspected when there was respiratory distress shortly after birth and was confirmed by chest x-ray (20).

Congenital heart defects were confirmed by echocardiography.

Polycythemia was defined if the Hct from a peripheral venous blood sample was > 65 percent or the hemoglobin was > 22 g/dL.

Data Collection

Attending to the standard of this research, each patient had a medical recording sheet filled with information that met the research needs. The clinical symptoms and neonate classification was based on New Ballard Score, fetal ultrasound measurement in the first trimester, nutritional status, or birth weight. The necessary laboratory and imaging tests were conducted, including chest x-ray, echocardiography, etc.

Statistical Analysis

All data were analyzed using Statistical Package for Social Sciences (SPSS) version 16.0. The Chi-square test was used to compare the risk factors between the death and survival groups and explore the correlation between the two categorical variables in cross-tables. A P-value of less than 0.05 was considered statistically significant.

Results

A total of 724 neonates were enrolled in this study. Of them, 403 (55.7%) and 321 (44.3%) were male and female, respectively.

Pattern and Causes of Morbidity

Table 1 shows the classification of neonatal morbidity in our study. Neonatal sepsis was the most prevalent disease (84.4%) (Table 1), which was the most seen in early-onset sepsis (49.9%) (Table 2). The other major causes of morbidity were hyaline membrane disease (12.6%), unconjugated hyperbilirubinemia (12.2%), and asphyxia (10.2%) (Table 2). In addition, there were several rare disorders, such as multiple malformations and polycythemia, with 1.2% and 1.0% morbidity rates, respectively.

Early-onset neonatal sepsis (73.7%) and hyaline membrane disease (33.8%) were the most common disorders among the preterm group. Meanwhile, in the term group, unconjugated hyperbilirubinemia (15.5%), anemia (7,9%), and critical congenital cardiac defects (3.1%%) were the most frequent diseases (Table 2).

Table 1. Distribution of diseases in the neonatal period

Classification of neonatal diseases	Number of neonates (n)	Percentage (%)
Neonatal sepsis	618	85.4
Congenital anomalies	93	12.8
Respiratory diseases	110	15.2
Hemolytic disease	140	19.3
Neurological diseases	95	13.1
Metabolic diseases	22	3.0
Others	22	3.0

Table 2. Distribution of diseases according to gestational age

Diseases	All patients (n=724)	Preterm neonates (n=266)	Term neonates (n=458)	P-value
Early-onset neonatal sepsis	361 (49.9%)	196 (73.7%)	165 (36.0%)	<0.001
Late-onset neonatal sepsis	257 (35.5%)	87 (32.7%)	170 (37.1%)	0.2660
Hyaline membrane disease	91 (12.6%)	90 (33.8%)	1 (0.2%)	<0.001
Asphyxia	74 (10.2%)	32 (12.0%)	42 (9.2%)	0.2840
Other congenital anomalies	69 (9.5%)	19 (7.1%)	50 (10.9%)	0.1213
Unconjugated hyperbilirubinemia	88 (12.2%)	17 (6.4%)	71 (15.5%)	0.0005
Meconium aspiration syndrome	8 (1.1%)	0 (0.0%)	8 (1.7%)	0.0777
Cerebellar hemorrhage	21 (2.9%)	10 (3.8%)	11 (2.4%)	0.3950
Anemia	45 (6.2%)	9 (3.4%)	36 (7.9%)	0.0243
Transient tachypnea of the newborn	11 (1.5%)	7 (2.6%)	4 (0.9%)	0.1375
Hypoglycemia	22 (3.0%)	8 (3.3%)	14 (3.1%)	0.9427
Polycythemia	7 (1.0%)	3 (1.1%)	4 (0.9%)	0.8979
Multiple congenital anomalies	9 (1.2%)	2 (0.8%)	7 (1.5%)	0.6371
Hypoprothrombinemia	5 (0.7%)	2 (0.4%)	3 (1.1%)	0.5676
Critical congenital cardiac defects	15 (2.1%)	1 (0.4%)	14 (3.1%)	0.0300

Table 3. Distribution of primary cause of death among term and preterm newborns

Diseases	Death		P-value
	Term neonates (n=27)	Preterm neonates (n=56)	
Asphyxia	12 (44.4%)	17 (30.4%)	0.3137
Cerebellar hemorrhage	1 (3.7%)	5 (8.9%)	0.6853
Hyaline membrane syndrome	0 (0.0%)	38 (67.9%)	<0.0001
Early-onset neonatal sepsis	19 (70.4%)	44 (78.6%)	0.5927
Late-onset neonatal sepsis	3 (11.1%)	19 (33.9%)	0.0524
Multiple anomalies	6 (22.2%)	2 (3.6%)	0.0219
Critical congenital heart defects	9 (33.3%)	1 (1.8%)	0.0002
Meconium aspiration syndrome	3 (11.1%)	0 (0.0%)	0.0559

Neonatal Mortality

There were 83 (11.5%) newborn deaths during the study period. Of them, male neonates accounted for 53%, higher than the figure for females (47%). The male to female ratio was 1.1/1.

Table 3 shows the distribution of diseases among the deceased population between term neonates and preterm neonates.

The proportion of hyaline membrane syndrome was higher in preterm neonates, while critical congenital heart defects predominantly presented in term neonates. There was an association between GA, birth weight, and mortality, whereas nutritional status was not related to neonatal mortality rate (Table 4).

Table 5 shows the association between mortality and diseases in the neonatal period, including multiple anomalies, critical congenital heart defects, asphyxia, hyaline membrane disease, cerebellar hemorrhage, and early-onset neonatal sepsis.

Table 4. Association between neonatal classification and mortality

Neonatal classifications	Death (n=83)	Survival (n=641)	P-value
Gestational age			
< 28	25 (30.1%)	8 (1.2%)	<0.001
28 - < 32	20 (24.1%)	47 (7.3%)	
32 - < 37	11 (13.2%)	155 (24.2%)	
37 - 42	27 (32.5%)	431 (67.2%)	
Birth weight			
<1000	21 (25.3%)	8 (1.2%)	
1000 - < 1500	22 (26.5%)	45 (7.0%)	
1500 - < 2500	19 (22.9%)	161 (25.1%)	<0.001
≥ 4000	1 (1.2%)	426 (66.5%)	
2500 - < 4000	20 (24.1%)	1 (0.2%)	
Nutritional status			
Small for gestational age	14 (16.9%)	67 (10.5%)	
Appropriate for gestational age	65 (78.3%)	547 (85.3%)	0.2024
Large for gestational age	4 (4.8%)	27 (4.2%)	

Table 5. Association between mortality and diseases in neonatal age

Diseases	Death (n=83)	Survival (n=641)	P-value
Multiple anomalies	8 (9.6%)	3 (0.5%)	<0.001
Critical congenital heart defects	10 (12.0%)	5 (0.8%)	<0.001
Hyaline membrane disease	38 (45.8%)	54 (8.4%)	<0.001
Asphyxia	29 (34.9%)	45 (7.0%)	<0.001
Meconium aspiration syndrome	3 (3.6%)	9 (1.4%)	0.3043
Cerebellar hemorrhage	6 (7.2%	15 (2.3%)	0.0316
Early-onset neonatal sepsis	63 (75.9%)	298 (46.5%)	<0.001
Late-onset neonatal sepsis	22 (26.5%)	235 (36.7%)	0.0896

Discussion

In recent years, most studies in Vietnam have revealed the common causes of neonate mortality at the late stage, including diffuse alveolar hemorrhage, septic shock, and multiple organ failure. In our opinion, early detection plays an essential role in treatment, prognosis, and reduction in neonate mortality.

Our data showed the ubiquitous diseases in neonates, in which early-onset neonatal sepsis accounted for the highest proportion (49.9%), followed sequentially by late-onset neonatal sepsis (35.5%), congenital anomalies (14%), hyaline membrane syndrome (12.6%), unconjugated

hyperbilirubinemia (12.2%), asphyxia (10.2%), anemia (6.2%), and polycythemia (1.0%).

Another study conducted in Tehran, Iran, revealed that the mortality rate for early-onset neonatal sepsis and term infants sepsis were 52.3% and 47.7% respectively (21). Therefore, the neonatal infection could be classified into early-onset neonatal sepsis caused by maternal-fetal transmission and acquired neonatal sepsis after birth. Two neonatal disorders often present with similar clinical symptoms; however, these could be caused by different etiologies and be controlled by different treatments (22). Misdiagnosis in these disorders significantly contributes to neonatal deaths during their first week of life.

Early-onset neonatal sepsis transmission from mother to fetus in developed countries is approximately 5-7% of live births (23). Consequently, in these countries, plans to screen for bacteria responsible for causing neonatal disorders, especially group B streptococcus, would be conducted synchronously and widely at around 36 weeks of pregnancy (24).

Early-onset neonatal sepsis was the most outstanding cause in our study, with 49.9% in term and preterm infants. This result was in line with other surveys in Viet Nam (25-29).

Causes of neonatal deaths worldwide could be classified into five separate groups: preterm birth and its complications, birth asphyxia, neonatal infection, congenital anomalies, and others (9, 30-35). Premature birth is considered a risk factor for neonatal mortality, at least 50% of neonatal deaths are caused by preterm birth (36, 37). The classification systems for causes of neonatal deaths based on only one disease are not appropriate because so many etiologies could lead to fatalities in neonates at the same time (38). Therefore, in the present study, in order to tailor treatment strategies for the reducion of neonatal deaths, we emphasized the primary causes relating the infant deaths.

Our data showed that the mortality rate of hospitalized neonates in Hue Central Hospital in 2019 was 11.5%, lower than that in Nepal (17.6%) (39). And the neonatal fatality rate remained high and unchanged a few years ago in underdeveloped and developing countries like Viet Nam.

Regarding the association between mortality rate and diseases in newborns, the current study illustrated that multiple anomalies and critical congenital heart diseases were the first and second leading causes of death. Therefore, prenatal screening and testing, and terminating early pregnancy would play a vital role in reducing the neonatal mortality rate for these diseases.

In our study, birth asphyxia was the fourth leading cause of neonatal death. The World Health Organization (WHO) estimates that one million survivors of prenatal asphyxia will suffer from cerebral palsy and morbidity annually. Most neonatal deaths by asphyxiation occur in low-income nations, and the mortality rate associated with perinatal asphyxia in developing countries is 20 times higher than this rate in developed countries. According to WHO, perinatal asphyxia and birth trauma could occur simultaneously, so modern obstetric management could reduce the mortality rate for birth asphyxia and trauma (40).

Based on our findings, the mortality rate decreased with increasing GA. However, there was only one post-term neonate in our study; therefore, we could not evaluate post-term infants like other surveys. The possible explanation for this difference is that good pregnancy care management of obstetricians would reduce post-term pregnancies.

In addition, the data has also indicated the relationship between mortality rate and nutritional status. The death rate was highest for small-for-GA neonates; meanwhile, it was lowest for appropriate-for-GA neonates. This finding corresponds with the results of other studies (41).

Therefore, neonatal deaths mainly occur in the following groups: preterm infants, low birth weight infants, and small-for-GA neonates. This finding is similar to the previous studies (32, 36, 42). Although WHO argues low birth weight is the primary cause of neonatal death, most neonatologists agree that low birth weight is associated with neonatal deaths but not the primary cause. Additionally, premature birth and its complications are the leading cause of death among neonates.

Determining whether a factor is related to the risk of neonatal death or not plays a vital role in reducing the neonatal mortality rate. In addition, GA is the key index reflecting the maturity of a newborn infant, and birth weight may be a surrogate parameter if GA is unknown. Therefore, determining the relationship between GA and birth weight would change the attitude in clinical settings. Consequently, all neonates should be classified based on GA and birth weight before offering probable management.

Determination of the disease model based on GA has revealed that the percentage of premature babies having health issues was high and that all life-threatening diseases could occur in preterm

infants. As a result, physicians should carefully examine a preterm newborn, especially <32 weeks, to establish early diagnosis and manage these diseases.

Conclusion

Based on admitted patients to the Neonatal Intensive Care Unit in Hue Central Hospital hospital in 2019, the present study confirms that neonatal sepsis, congenital anomalies, hyaline membrane disease, and unconjugated hyperbilirubineamia asphyxia were the most ubiquitous indications for hospitalization. Moreover, the neonatal mortality rate in Viet Nam is still high, which is significantly associated with preterm birth, asphyxia, and multiple anomalies. Early management of preterm births and neonatal diseases should be given priority to decrease the neonatal death rate.

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Conflicts of interest

The authors declare no competing interests.

Authors' contributions

All authors contributed to data analysis, drafting or revising the article, agreed on the journal to which the article will be submitted, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work.

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