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ORIGINAL STUDY

Mortality Rate Risk Factors in Neonatal ICUs in El Giza Governorate

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Abstract

Objective: **This study aimed to determine the incidence of neonatal mortality percentage in Neonatal ICUs in Giza Governorate hospitals for early prediction of the disease.**

Background: **Neonatal mortality rates, defined as death of a live born newborn within the first 28 days, vary greatly between countries, even within high-income countries.**

Patients and methods: **A retrospective study was conducted on 155 Egyptian neonates aged from 1 day up to 4 weeks to evaluate the risk factors of the mortality rates in the Neonatal ICU of Giza Governorate hospitals during the period from August 2021 to December 2021.**

Results: **Approximately 6.5% of the studied neonates experienced complications such as sepsis, chronic heart disease or hypoxic ischemic encephalopathy, and another 20.6% of the studied neonates were on mechanical ventilation. Survival rates were reported to be 84.5% of the studied neonates; moreover, the incidence of neonatal mortality among the studied sample was 15.5%. The most common cause of death was sepsis followed by chronic heart disease and sepsis with prematurity (50, 20.8, and 8.3%, respectively).**

Conclusion: **Prematurity, sepsis, respiratory distress syndrome, low birth weight, mechanical ventilation, and positive history of maternal illness and infection are considered as significant predictors of neonatal mortality.**

Keywords: Mortality rate, Pneumonia, Prematurity, Respiratory distress, Sepsis

1. Introduction

The rates of neonatal death are a standard metric for assessing a country's health status. The number of newborns who die before reaching 28 days of age per 1000 live births in a particular year is known as the neonatal mortality rate (NMR). Neonatal mortality, which accounts for 65% of infant mortality, is highest in the first 24 h of life [1,2].

Respiratory distress syndrome (RDS), sepsis, asphyxia, congenital anomalies, and disseminated intravascular coagulation are the most common causes of neonatal death, followed by prematurity, congenital anomalies, prenatal asphyxia and infection, neonatal infections, preterm delivery, and low birth weight (LBW), with infections such as sepsis being the most common cause of neonatal death. Between 2006 and 2010, the majority of infants had a birth weight of less than 2500 g, and the majority of neonatal deaths happened within the first 24 h of birth. According to maternal and newborn variables, this pattern appears to be different in different parts of Iran and even in different hospitals, and if we want to take effective actions to reduce neonatal mortality, the first step is to determine the causes of neonatal mortality [3].

Understanding the causes of death in Neonatal ICUs (NICUs) and the modifiable factors linked to death offers the potential to lower newborn mortality rates. To reduce the problems with these plans, it is vital to identify the causes of death in each country or part of a country [4].

The neonatal period covers birth up to but not including 28 days. The numerator of the NMR,

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therefore, is the number of deaths among children under 28 days of age during a given time period. The denominator of the NMR, like that of the infant mortality rate, is the number of live births reported during the same time period. The NMR is usually expressed per 1000 live births. In 2003, the NMR in the United States was 4.7 per 1000 live births [5].

The number of deaths during the first 28 completed days of life per 1000 live births in a given year or period is defined as the NMR [6]. NMR represents the number of neonatal deaths within 28 days of delivery per 1000 live births. Therefore, this study aimed to determine the incidence of neonatal mortality percentage in NICUs in Giza Governorate hospitals for early prediction of the disease.

2. Patients and methods

After taking the approval from the ethical committee, this retrospective study was conducted on 155 Egyptian neonates aged from 1 day up to 4 weeks. The file records were evaluated to assess mortality rate risk factors at the NICUs in Giza Governorate hospitals (five public centers) during the period from August 2021 to December 2021.

The least sample size needed for this study was calculated according to the mortality rate in 24 995 neonates admitted to NICUs in Iran, which was estimated to be 11.4% (95% CI: 9.10–14.20), at a power 80% and a confidence level 95%. The least estimated sample size was calculated to be 155 neonates [7].

We defined the in-hospital NMR as the proportion of admitted ill neonates who died during a certain time period [8]. Specific mortality rates were defined as the number of neonates who died from a particular pathology divided by the number of neonates admitted for that pathology over a given period [8]. Data were collected from the hospital record, and included both maternal and neonatal variables.

2.1. Statistical analysis

The data were collected and entered to the computer using STATA Statistical Program, USA, for statistical analysis. Depending on the situation, data were input as numerical or categorical. Two different statistical methods were used. In case of descriptive statistics, quantitative data were expressed as mean and SD for normally distributed variables, and qualitative data were described as number (frequency) and percentage. The Mann–Whitney *U* test, a nonparametric test of significance, was used to compare two groups with quantitative variables that are not regularly distributed. Because the margin of error accepted was set to 5% and the level of significance used was 95%, a *P* value of 0.05 was deemed statistically significant. Correlation analysis was used to compare the correlation between two continuous variables, and the results were represented by the correlation coefficient (*r*) [9].

3. Results

We reported a significant difference in sex, where male neonates in the studied group represented 66.5% and female neonates represented 33.5%, with a mean age of 2.6 ± 1.16 weeks. The mean duration of incubator use was 8.9 ± 4.59 days. Regarding the mode of delivery, 73.5% were delivered by cesarean section and 26.5% were delivered by normal vaginal delivery.

Maternal demographic data revealed about 52.3% of the mothers were aged 20–30 years, 21.3% of the mothers were from rural areas, 67.7% of the mothers had moderate education, 74.5% of the parents had negative consanguinity, and ~3.9% of had a history of other sick siblings.

Regarding NMR risk factors among studied group, there were no significant differences regarding sex, mode of delivery, and neonatal jaundice ($P = 0.051$, 0.32, and 0.95, respectively). There were highly significant differences regarding sepsis and mechanical ventilation ($P<0.001$) (Table 1).

The five public centers studied at the NICUs in Giza were as follows: 38.7% of the studied neonates taken from Beau Lac Public Hospital, 19.4% from Om Al-Atebaa Hospital and Imbaba General Hospital, 12.9% from October Hospital, and 9.7% from Zayed Puplic Hospital.

Regarding NMR risk factors among studied group according to the outcome, there was a significant difference regarding transient tachypnea of the newborn and meconium aspiration syndrome ($P = 0.003$ and 0.07, respectively). Moreover, there was a highly significant difference in terms of weight ($P<0.001$) (Table 2).

Finally, 6.5% of the studied neonates had complications, 20.6% were on mechanical ventilation, and 84.5% of the studied neonates survived. The incidence of neonatal mortality among studied sample was 15.5%. The most common cause of death was sepsis followed by chronic heart disease and sepsis with prematurity (50, 20.8, and 8.3%, respectively) (Table 3).

Regarding the maternal neonate mortality risk factors among the studied group when comparing

Table 1. Complication, outcome, and cause of death among studied neonates (N = 155).

Variables	*n* (%)
Child birth complications	
Positive	10 (6.5)
Negative	145 (93.5)
Use of ventilation	
MV	32 (20.6)
CPAP	14 (9.0)
Nasal O_2	36 (23.2)
None	73 (47.1)
Outcome	
Survived	131 (84.5)
Died	24 (15.5)
Cause of death (*N* = 24)	
Sepsis	12 (50)
CHD	5 (20.8)
Sepsis and prematurity	2 (8.3)
Pneumothorax	1 (4.2)
Sepsis and pneumothorax	1 (4.2)
CNS infection	1 (4.2)
Sever HIE	1 (4.2)
COVID-19	1 (4.2)

CHD, chronic heart disease; COVID-19, Coronavirus Disease 2019; CNS, central nervous system; CPAP, continuous positive airway pressure; HIE, hypoxic ischemic encephalopathy; MV, mechanical ventilation.

died and survive patients, there were significant difference regarding infection ($P = 0.02$) and there was a highly significant difference regarding history of maternal illness ($P = 0.001$).

4. Discussion

Deaths that occur at birth and up to 28 days after birth are included in NMR, which is a crucial metric for evaluating the state of a community's health. The three categories of neonatal mortality are very early mortality, which is defined as death within 24 h of delivery; early mortality, which is defined as death between 1 and 7 days after birth; and late mortality [10,11].

The highest rate of newborn mortality is seen very early (4.27 per 1000 live births in 2008). One of the government's growth and development goals is to lower NMR, which typically makes up 67% of the overall infant mortality rate. NICUs have a high rate of infant mortality; thus, periodic evaluation of these units' procedures and suitable adjustments to the procedures can reduce the mortality rate [12].

Our study demonstrated that the percentage of neonatal mortality was 15.5%. Philip [13] stated that for the last 6 years, deaths of extremely low birth weight (ELBW; 1000 g) accounted for 5% of the total, whereas deaths that occurred more than 28 days later (referred to as 'postponed' deaths) made up 47% of all deaths and 65% of those for ELBW infants occurred within 24 h of birth. When the birth weight was 500–1499 g, 1500–2499 g, or less than 2500 g, congenital abnormalities were responsible for 7, 54, and 66% of deaths, respectively. The majority of deaths in infants with birth weights under 1000 g

Table 2. Neonatal mortality risk factors among the studied group (N = 155).

Variables	Survivors (*N* = 131) [*n* (%)]	Nonsurvivors (*N* = 24) [*n* (%)]	Test of significance	*P* value
Sex				
Male	86 (55.5)	16 (10.3)	χ^2	0.051
Female	45 (29)	8 (5.2)	2.95	
Mode of delivery				
NVD	33 (21.3)	8 (5.2)	χ^2	0.32
CS	98 (63.2)	16 (10.3)	1.12	
Prematurity				
Yes	22 (14.2)	11 (7.1)	χ^2	0.001
No	109 (70.3)	13 (8.4)	8.7	
Respiratory distress syndrome				
Yes	36 (23.2)	6 (3.9)	χ^2	0.005
No	95 (61.3)	18 (11.6)	6.88	
Neonatal jaundice				
Yes	55 (35.5)	0	χ^2	0.95
No	76 (49)	24 (15.5)	12.10	
Sepsis				
Yes	23 (14.8)	14 (9)	FXT	<0.001
No	108 (69.7)	10 (6.5)	0.398	
Pneumonia				
Yes	31 (20)	3 (1.9)	FXT	0.003
No	100 (64.5)	21 (13.5)	3.96	
Mechanical ventilation				
Yes	13 (8.4)	19 (12.3)	χ^2	<0.001
No	118 (76.1)	5 (3.2)	21.66	

CS, cesarean section; NVD, normal vaginal delivery.

Table 3. Neonatal mortality risk factors among the studied group (N = 155).

Variables [*n* (%)]	Survivors (*N* = 131) [*n* (%)]	Nonsurvivors (*N* = 24)	Test of significance	*P* value
TTN				
Yes	7 (4.5)	0	χ^2	0.003
No	124 (80)	24 (15.5)	7.88	
Meconium aspiration syndrome				
Yes	2 (1.3)	1 (0.6)	FXT	0.07
No	129 (83.2)	23 (14.8)	2.98	
Intrauterine growth restriction (IUGR)				
Yes	18 (11.6)	2 (8.3)	FXT	0.58
No	113 (72.9)	22 (14.2)	0.80	
Congenital anomalies				
Yes	9 (5.8)	2 (8.3)	FXT	0.078
No	122 (78.7)	22 (14.2)	4.44	
IDM				
Yes	4 (2.6)	2 (8.3)	FXT	0.84
No	127 (81.9)	22 (14.2)	0.061	
Weight				
AGA				
Yes	105 (67.7)	20 (12.9)		
No	26 (16.8)	4 (2.6)		
SGA				
Yes	18 (11.6)	4 (2.6)	FXT	<0.001
No	113 (72.9)	20 (12.9)	50.03	
LGA				
Yes	8 (5.2)	0		
No	123 (79.4)	24 (15.5)		
Hospitalization duration				
Mean ± SD	7.9 ± 7.40	14.5 ± 8.54	*U*	0.82
Range	2−22	10−22	0.076	

AGA, appropriate for gestational age; IDM, infant of diabetic mother; LGA, large for gestational age; SGA, small for gestational age; TTN, transient tachypnea of the newborn; *U*, Mann−Whitney *U* test.

(61%) were likely avoidable and were caused by congenital abnormalities, hydrops, and inborn metabolic problems. Extreme preterm (500−750 g), severe abnormalities, and pulmonary hypoplasia each caused 12% of the mortality in ELBW newborns. Other studies have documented that NMR varied from 23 to 37% according to Mah et al. [14] and Hoseini et al. [15], respectively.

However, the studies by Mirzarahimi et al. [16] and Sharma et al. [17], assessing deaths in NICUs, documented higher mortality rates (56.7 and 58.8%, respectively.) Higher rates in preterm and LBW mortality were found.

In this study, male neonates represented 66.5% and female neonates represented 33.5%. Overall, 73.5% were delivered by cesarean section. The mean age was 5.6 ± 5.96 days, and the mean stay in an incubator was 8.9 ± 4.59 days.

According to Herbst et al. [18], the risk of neonatal death and the risk of an Apgar score below 5 min postnatally were both lower after cesarean delivery (OR: 0.4; 95% CI: 0.2−0.7, and OR: 0.4; 95% CI: 0.3−0.7, respectively), whereas the risk of infant respiratory distress syndrome (IRDS) was increased (OR: 2.1; 95% CI: 1.4−3.2). A diagnosis of IRDS was not associated with mortality (OR: 0.8; 95% CI: 0.5−1.5). Intraventricular hemorrhage (IVH) was not associated with mode of delivery (OR: 1.2; 95% CI: 0.5−2.8).

In the present study, we reported that ~21.3% of the mothers were from rural areas, 67.7% of the mothers had moderate education, 74.5% of the parents had negative consanguinity, 6.5% of the studied neonates had complications, 47.1% do not need ventilator, and 84.5% of the studied neonates survived. The most common cause of death was sepsis followed by chronic heart disease and sepsis with prematurity (50, 20.8, and 8.3%, respectively) (Tables 2 and 3).

Chowdhury et al. [19] found that birth asphyxia (44.9%), prematurity/low birth weight (15.1%), sepsis/meningitis (12.3%), RDS (6.9%), and pneumonia (5.5%) were the top five causes of neonatal deaths. These five causes accounted for 85% of the cases. The other causes included hypothermia, birth injury, sudden infant death, and congenital anomalies. Approximately 7% of the cases were classified as undetermined, as there was no agreement between any of the physicians on the cause assigned. In 1.9% of the cases, the physicians were unable to assign any cause.

According to Fehlmann et al. [20] and Islam et al. [21], neonatal infection (37.85%), preterm (31.26%), birth asphyxia (16%), and congenital abnormalities (10.54%) were identified to be the main causes of neonatal deaths. Overall, 35% of the deaths took place within the first 24 h of life, with the majority (74.2%) occurring within the first week. Neonates with birth weights under 2500 g and gestational ages under 37 weeks had a greater mortality rate. Among the mothers, it was more prevalent in housewives, lone parents, and pregnancies.

Sepsis came in second, with 46% of infant deaths being caused by RD. Another study's findings revealed hyaline membranes disease (HMD) (52.2%), sepsis (14%), and smaller GA had a significant association with NMR, and other study's results revealed sepsis (40%), respiratory distress (26%), and smaller GA had a significant association with NMR; both LBW and smaller gestational age (GA) had a significant association with NMR.

Regarding NMR factors among the studied group while comparing died and survive patients, there were statistically significant differences regarding prematurity, RDS, and pneumonia. There were highly statistically differences regarding sepsis and mechanical ventilation. Regarding NMR factors among studied group while comparing died and survived patients, there were significant differences regarding tachypnea of the newborn, and there were highly significant differences regarding weight.

Regarding maternal neonate mortality risk factors among studied group when comparing died and survive patients, there were significant differences regarding infection and there were highly significant difference regarding history of maternal illness.

In comparison, another study by Parkash and colleagues reported that neonatal complications were found to be significantly more common in the preeclampsia with severe features group, including LBW (35.1 vs. 74.3%), birth asphyxia (4.4 vs. 18.2%), admission to NICU (7.0 vs. 30.9%), and neonatal resuscitation (15.8 vs. 42.7%). Only in situations of severe preeclampsia and HELLP syndrome (three cases, 1.4%) did stillbirths occur. Preeclampsia with severe symptoms and the HELLP syndrome were associated with a greater risk of intrapartum death, but this difference was not statistically significant (2.6 vs. 6.4%) [22].

Finally, our results demonstrate that prematurity, sepsis, RDS, LBW, mechanical ventilation, positive history of maternal illness, and infection can be considered as significant predictors (risk factors) of neonate mortality.

Morales et al. [23] reported the following risk factors: congenital heart disease, perinatal depression, assisted ventilation, oliguria/anuria, exposure to various medications such as blood pressure medications (pressor/inotropic support), antenatal corticosteroids, low GA, LBW, low Apgar scores at 1 and 5 min, male sex, small for gestational age, low cord pH, intubation at birth, mechanical ventilation, umbilical artery/venous catheters, lower mean arterial pressures, and intubation at birth.

4.1. Conclusion

The percentage of NMR in Giza Governorate Hospitals was 15.5%. Prematurity, sepsis, RDS, LBW, mechanical ventilation, positive history of maternal illness, and infection are considered as significant predictors (risk factors) of neonatal mortality.

Ethical approval

We obtained the ethical approval of the study from the ethical committee of Faculty Medicine, Menoufia University.

Consent statement

A written informed consent was taken from the patients after explaining the aim of the study.

Conflict of interest

There are no conflicts of interest.

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