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ORIGINAL RESEARCH

Pattern and Neonatal Outcome of the Neonatal Intensive Care Unit in Qassim, Saudi Arabia

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Purpose: Neonatal mortality is one of the main public health problems, especially in developing countries. Limited studies on neonatal mortality exist in Saudi Arabia, particularly in central Saudi Arabia. Therefore, this study aimed to determine the incidence, causes, and associated factors for mortality among neonates admitted to the neonatal intensive care unit (NICU) in a single center in Al-Qassim, Saudi Arabia.

Patients and Methods: This retrospective study included 988 neonates admitted to the NICU in Saudi Arabia, between January and December 2023. Data were obtained from the hospital records using a questionnaire composed of sociodemographic data, neonatal and maternal information, and neonatal outcomes. Logistic regression analyses were performed, and the adjusted odds ratio (AOR) and 95% confidence interval (CI) were calculated.

Results: Data from 970 neonates (46.6% female) were collected and included in the analysis. Of the 970 neonates, 291 (30.0%) were preterm births, and 317 (32.7%) were low-birth-weight (LBW) babies. Overall, 417 (43.0%) neonates were delivered via cesarean section. Prematurity (51.7%), hypothermia/hypoglycemia (17.6%), neonatal jaundice (11.4%), congenital malformations (5.4%), respiratory distress syndrome (3.9%) and neonatal sepsis/infection (3.1%) were the main diagnoses at admission. Nineteen (2.0%) neonates died during the time of admission to discharge in the NICU. Univariate analysis showed that preterm birth (OR = 4.12, 95% CI = 1.60–10.5) and LBW (OR = 5.9, 95% CI = 2.13–16.77) were associated with increased odds of neonatal mortality. Maternal age, number of children, duration of admission, mode of delivery, and sex of the neonate were not associated with neonatal mortality. In the multivariable logistic regression analysis, LBW (AOR 4.2, 95% CI = 1.24–14.39) was associated with neonatal mortality.

Conclusion: The current study showed that prematurity, neonatal jaundice, and congenital malformations were the main causes of admission to the NICU. Neonatal mortality is lower than in other regions and is associated with LBW.

Keywords: NICU, birth asphyxia, preterm, age, neonatal mortality, outcome

Introduction

The Sustainable Development Goals (SDG) Target 3.2 for neonatal and child health encourages all countries to end preventable deaths of newborns and children under five years of age by 2030.[1,2] According to the World Health Organization (WHO), the first month of life is the most vulnerable period for children; 2.4 million newborns died in 2020 (nearly half [47%] of all deaths for children under the five deaths occurred in the neonatal period (the first 28 days of life). Preterm birth, intrapartum-related complications (birth asphyxia), infections, and congenital anomalies are the leading causes of most neonatal deaths.[3] Despite the global reduction in child mortality by almost half between 2000 and 2019, progress remains slower in neonates in 65 (32%) of the 204 countries.[2] The WHO attributes neonatal death to conditions and diseases associated with a lack of quality care at or immediately after birth and in the first days of life.[3]

Neonatal mortality is a global health issue, especially in resource-limited settings, such as Sub-Saharan Africa, followed by Central and South Asia.[3] Admission to the neonatal intensive care unit (NICU) in developing countries is

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associated with poor outcomes.[4,5] Having neonates requiring care in the NICU places a heavy financial burden on families, both during birth hospitalization and after discharge,[6] especially for preterm infants.[7]

The practical steps for tackling neonatal issues (morbidity and mortality) and their negative impact on health on a global scale require a thorough understanding of the local context. First, frequency of admission to NICU, common causes, outcomes, and quality of provided care need to be assessed, and then, appropriate healthcare measurements need to be applied accordingly to improve the quality of care via prioritizing and planning health services and re-allocating resources. Although the literature shows an improvement in neonatal health in Saudi Arabia, there is room for improvement that necessitates a call for action.[8–11] In Saudi Arabia, 4.1% of term neonates were admitted to the NICU;[12] perinatal outcomes were associated with mode of delivery, maternal disease, the weight of the mother and neonate prematurity and weight, and birth asphyxia (65.2%) was the main cause of neonatal mortality.[8]

It is clear from the reviewed studies that the common causes of NICU admission are preterm birth, low birth weight (LBW)[8,13–15] and neonatal infection/sepsis.[16–18] Other countries reported findings similar to those of Saudi Arabia. A study in the United Arab Emirates showed that an LBW neonate was 30 times more likely to require treatment in the NICU. In the Al-Qassim region, about half of the pregnant mothers (47.1%) have complications during pregnancy, such as cesarean deliveries, gestational diabetes mellitus, anemia, LBW, and preterm birth.[19] The mode of delivery might influence neonatal health.[20]

Although neonatal morbidity and mortality have received more attention worldwide, including in Gulf countries, neonatal epidemiology is understudied in Saudi Arabia; in particular, there is a lack of comprehensive studies in the Al-Qassim region. Investigating the epidemiology (incidence, causes, associated factors, and microbial profile) of neonatal morbidity and mortality is crucial to generating data that might be useful for evidence-based intervention.

The current study aimed to determine the pattern of neonatal admission in the NICU and the prevalence and associated factors for mortality among neonates admitted to the NICU of King Saud Hospital, Unaizah, Al-Qassim, Saudi Arabia.

Materials and Methods

Study Design and Setting

A retrospective hospital-based study was conducted in 2023 at the NICU of King Saud Hospital, Unaizah, Saudi Arabia, after all ethical approval documents were obtained.

The Al-Qassim region has a population of 1,336,179 residents. It is 350 km from the capital of Saudi Arabia (Riyadh) and is located in the centre of Saudi Arabia. There are no standardized protocols for neonatal care across hospitals. However, there are specific protocols for some diseases, eg, neonates of a diabetic mother.

Data Collection

Two medical officers trained by the investigators reviewed medical files before data collection. Data were collected using a structured questionnaire (papers were used). The questionnaire was based on a thorough review of similar previous studies.[8,10,11,15,16]

The NICU of King Saud Hospital, Unaizah, Saudi Arabia, offers special care to neonates at risk or who are ill. The unit is supervised by neonatologists, pediatricians, and skilled nurses. In addition to other basic newborn and neonatal services, the NICU has the following facilities: incubators, supplemental oxygen administration, radiant warmers, phototherapy machines, umbilical transfusion, nasogastric tube insertion, intravenous infusion, urinary catheterization, lumbar puncture, necessary laboratory investigation, and continuous positive airway pressure ventilation. Using a questionnaire, data were obtained from neonates and the neonates' mothers' medical files/records of those who were admitted to the NICU. The questionnaire is composed of sociodemographic data and neonatal and maternal information. Neonatal information includes birth weight, length of hospital stays, sex, mode of delivery (vaginal or cesarean section),

APGAR score, and gestational age. In addition, it contains primary admission diagnosis, outcome (discharge well/discharge against medical advice or death), and cause of death.

Inclusion and Exclusion Criteria

We reviewed all files of the mothers with neonates aged 0–28 days admitted to the NICU of King Saud Hospital, Unaizah, Saudi Arabia. Exclusion criteria included not having complete data, neonates presenting only for a brief observation, and neonates referred to another NICU facility.

Sample Size Determination and Sampling Procedure

A consecutive sampling technique was followed. A sample of 970 files (including mothers' files) was calculated using Epi-Info software based on the difference in the proportions of the desired factors (LBW). We assumed NICU admissions had 45% and 30% proportions for LBW and non-LBW neonates, respectively. This sample size had 80% power, with a precision of 5%.

Operational Definitions

- Term birth is defined as the birth of a baby at ≥37 weeks gestational age.
- Preterm birth is defined if the gestational age is <37 weeks.
- Normal birth weight is defined as the weight of a baby immediately after delivery (≥2500 g).
- LBW is defined if the birth weight is <2500 grams.
- Hypothermia is defined as an admission temperature of < 36.5 °C.
- Inadequate antenatal care (ANC) is defined based on recent WHO recommendations for 2016 as less than eight ANC contacts, and adequate ANC is defined as eight ANC contacts or more.[21]
- Maternal body mass index is computed as the weight in kg divided by the square of the height in meters (kg/m^2).[22]
- Admission diagnosis is based on the NICU medical staff in charge of the NICU.
- The neonatal length of hospital stay in the NICU is calculated in days by subtracting the date of discharge from the date of admission.
- Neonatal mortality is defined as the probability of neonatal death within the first 28 days of life.

Ethics

This was a retrospective study that complies with the Declaration of Helsinki and was approved by the Ministry of Health represented by the Research Board at Qassim Regional Research Ethical Committee at General Director of Health Affairs, Al-Qassim region, Saudi Arabia (No.607/44/16884). All personal identifiers were excluded during data collection to maintain confidentiality and privacy. Patient data is reserved and confidential and used only for research purposes.

Statistics

Data was analysed using SPSS software version 22.0 (SPSS Inc., Chicago, IL, USA). Quantitative indices were checked for normality using the Shapiro–Wilk test. Quantitative and categorical variables were compared between the two groups using the *t*-test, non-parametric Mann–Whitney *U*-test, and chi-square test. Univariate and multivariate logistic regression analyses were performed with neonatal mortality as an independent variable (age, sex, and gestational age). The Hosmer–Lemeshow test was used to check the model adequacy fitness; it was found that the model fit the data adequately. Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were calculated. A two-sided *P*-value of <0.05 was considered statistically significant.

Results

Data from 970 neonates (46.6% female) were collected and included in the analysis. The median (interquartile range [IQR]) maternal age was 31.0 (27.0–36.0) years, and the number of children was 3 (1–4); the median (IQR) gestational age was 38.0 (36.0–39.0) weeks and 291 (30.0%) were preterm births; median (IQR) birth weight of the neonates was

2800 (2.3–3.2) gm and 317 (32.7%) were LBW babies and median (IQR) hospital stay was 3.0 (2–6) days and 398 neonates (41.0%) stayed <3 days. Overall, 553 (57.0%) neonates were delivered vaginally, whereas 417 (43.0%) were delivered via cesarean section (Table 1).

Prematurity (51.7%), hypothermia/hypoglycemia (17.6%), neonatal jaundice (11.4%), congenital malformations (5.4%), respiratory distress syndrome (3.9%) and neonatal sepsis/infection (3.1%) were the main diagnoses at admission (Figure 1).

Furthermore, 19 (2.0%) neonates died during the time of admission to discharge in the NICU. Of these 19 neonatal deaths, 5 (26.3%) neonates had congenital malformations, 13 (68.4%) died due to preterm birth and its complications, and 1 neonate had respiratory distress syndrome. The reported congenital abnormalities were congenital heart disease, musculoskeletal, Down syndrome, and digestive and urinary tract obstruction.

Factors Associated with Neonatal Mortality

Univariate analysis showed that increasing gestational age (OR = 0.73, 95% CI = 0.65–0.81) and increasing birthweight (OR = 0.16, 95% CI = 0.08–0.30) were associated with decreased odds of neonatal mortality; hence, preterm births (OR = 4.12, 95% CI = 1.60–10.5) and LBW (OR = 5.9, 95% CI = 2.13–16.77) were associated with increased odds of neonatal mortality. Maternal age, number of children, duration of admission, mode of delivery, and sex of the neonate

Table 1 Characteristics of Newborns Admitted to the NICU (N = 970)

Variables		**Median**	**Interquartile Range**
Maternal age, years		31.0	27.0–36.0
Number of children		3	1–4
Gestational age, weeks		38.0	36.0–39.0
Birth weight, kg		2.8	2.3–3.2
Admission temperature,^{0}C		37.0	37.0–27.0
Duration of admission, days		3.0	2–6
		Frequency	**Proportion**
Mode of delivery	Vaginal	553	57.0
	Cesarean	417	43.0
Preterm birth	Yes	291	30.0
	No	679	70.0
Low birth weight	Yes	317	32.7
	No	653	67.3
Gender	Female	452	46.6
	Male	518	53.4
Hypothermia	Yes	55	5.7
	No	915	94.3
Length of hospital stay <3 days	Yes	398	41.0
	No	572	59.0

Abbreviation: NICU, neonatal intensive care unit.

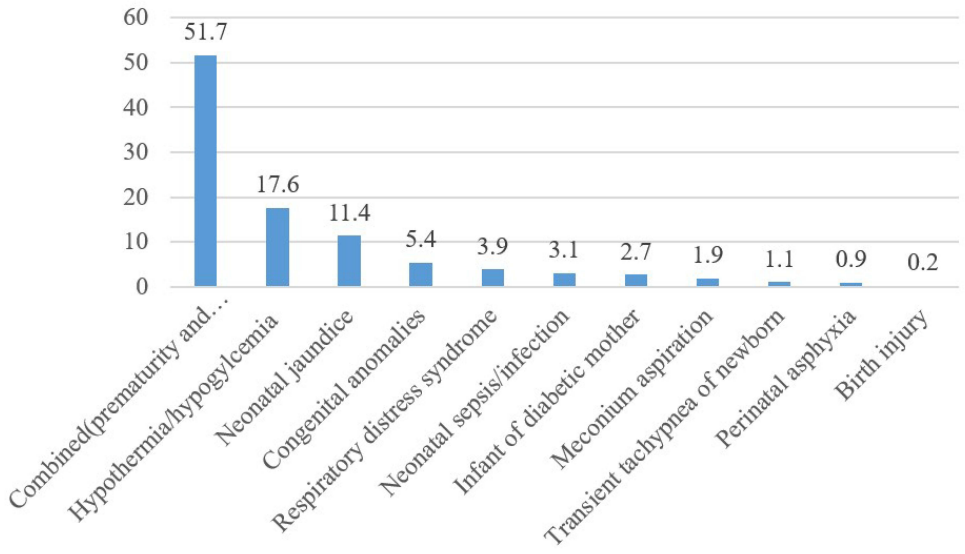

Figure 1 The main diagnosis upon admission to the neonatal intensive care unit in Qassim, Saudi Arabia.

were not associated with neonatal mortality (Table 2). In the multivariable logistic regression analysis, LBW (AOR 4.2, 95% CI = 1.24–14.39) was associated with neonatal mortality. Preterm birth (AOR 1.82, 95% CI = 0.59–5.61) was not associated with neonatal mortality (Table 3).

Table 2 Comparison Between Newborns Who Died and Survived in the Neonatal Intensive Care Unit

Variables		Died	Survived	Odds Ratio	95% Confidence Interval	P
Median (interquartile range)						
Maternal age, years		31.0 (27.0–36.0)	26.0 (8.0)	1.04	0.96–1.12	0.316
Number of children		3 (3)	3 (4)	1.01	0.79–1.27	0.938
Gestational age, weeks		37.0 (3.0)	35.3 (7)	0.73	0.65–0.81	<0.001
Birth weight, kg		2.6 (1.3)	1.8 (1.7)	0.16	0.08–0.30	<0.001
Duration of admission, days		4.0 (4.0)	2.0 (2.0)	1.01	0.95–1.06	0.720
Frequency (proportion)						
Mode of delivery	Vaginal	260 (61.3)	86 (72.3)	Reference		0.800
	Cesarean	164 (38.7)	23 (27.7)	0.95	0.68–1.33	
Preterm birth	No	165 (38.9)	71 (59.7)	Reference		<0.001
	Yes	259 (61.1)	48 (40.3)	4.12	1.60–10.5	
Low birth weight	No	175 (41.3)	77 (64.7)	Reference		0.001
	Yes	249 (58.7)	42 (35.3)	5.9	2.13–16.77	
Gender	Female	221 (52.1)	55 (46.2)	Reference		0.255
	Male	203 (47.9)	64 (53.8)	1.03	0.41–2.56	
Length of hospital stay <3 days	No	129 (30.4)	77 (64.7	Reference		0.708
	Yes	295 (69.6)	42 (35.3)	0.83	0.32–2.14	

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Table 3 Multivariate Analysis of the Factors Associated With Neonatal Mortality in the Neonatal Intensive Care Unit

		Odds ratio	95% Confidence Interval	P
Preterm birth	No			
	Yes	1.82	0.59–5.61	0.294
Low birth weight	No			
	Yes	4.2	1.24–14.39	0.021

Discussion

In the current study, prematurity, hypothermia/hypoglycemia, neonatal jaundice, and congenital malformations were the main causes of admission to the NICU. This is consistent with previous results from Jeddah, Saudi Arabia, which showed that respiratory complications, hypoglycemia, and jaundice were the common cause of admission among term neonates.[12] Moreover, respiratory failure of newborns (41.2%) and prematurity (33.3%) were the main indications for admission among neonates admitted to the NICU in Jordan.[23] In Yemen, among the 549 newborns admitted to NICU, the most common admission diagnoses were complications of prematurity (34.9%), perinatal asphyxia (34.4%), neonatal jaundice (18.8%) and neonatal sepsis (16.1%).[14]

In the current study, 2.0% of the admitted neonates died during the period of admission. This low neonatal mortality rate goes with the findings from Qatar, which showed that the overall neonatal mortality rate was 0.25%.[24] The mortality rate in the current study was lower than that reported in Jordan, where the overall mortality rate was 3.8%.[23] The mortality rate in our study was also lower than reported in Yemen, where among 549 newborns admitted to the NICU, neonatal death was 21.8%; preterm birth and LBW were the most common causes of death.[14] Prematurity was the main predisposing factor for mortality (AOR: 9.9, 95% CI: 3.5, 27.6). Admission to NICU in developing countries such as Sudan and Ethiopia is associated with poor outcomes.[4,5] In Eastern Sudan, a retrospective study included 543 neonates admitted to the NICU; of them, 46.4% were LBW, 43.5% were preterm babies and 27% were newborns admitted after caesarean delivery; the neonatal mortality before discharge was 21.9% (119/543) of live-born babies at the hospital; prematurity and its complications (48.7%), respiratory distress syndrome (33.6%), birth asphyxia (21.0%) and infection (9.0%) were the most common causes of neonatal mortality; preterm birth, LBW, low five-minute APGAR score and length of hospital stay <3 days were associated with neonatal mortality.[4] In Ethiopia, an institutionally based prospective cohort study among 513 neonates admitted to the NICU revealed an overall neonatal mortality rate of 25.8 deaths per 1,000 neonate days; most (83.5%) of the neonatal deaths occurred in the early phase of neonatal period (<7 days post-partum); being unemployed, not attending ANC, not initiating exclusive breastfeeding, neonatal admission due to respiratory distress syndrome and first-minute APGAR score classification of severe significantly increased the risk of neonatal mortality.[5] Globally, neonatal mortality is a major public health problem, particularly in low-income countries. Every day, approximately 7,000 neonates die in their first month of life worldwide, and the majority of these deaths occur in low-income countries. In Sub-Saharan Africa, there is a high burden of neonatal mortality, which accounts for an estimated 49.6% of all deaths of children under the age of five.[25] The difference between our results and those of other countries could be explained by the differences in socioeconomic and healthcare systems between the study region and those with higher mortality rates.

Our study indicated that LBW and preterm birth were associated with an increased risk of neonatal mortality, consistent with the findings of several previous studies.[26–28] In Oman, prematurity was the primary cause of neonatal mortality.[29] This observation highlighted the importance of detecting the potential determining factor, LBW, and optimizing its management. Moreover, LBW babies were susceptible to complications such as asphyxia, hypothermia, and sepsis. This could be explained by the fact that LBW babies are often preterm and lack sufficient surfactants, which causes breathing difficulties, problems with cardiopulmonary transition, and, ultimately, birth asphyxia. Additionally, small babies have limited brown fat tissue, which raises their risk of hypothermia and thus worsens hypoxia.[30]

Thus, proper neonatal care, including appropriate feeding, temperature maintenance, and hygienic cord cutting and covering, can substantially avert some of these effects and reduce mortality.[26,27]

Limitations

Nonetheless, this study has some limitations. The first is its retrospective nature, which could lead to bias (missing data and misclassification). Many variables were not assessed, such as maternal health conditions, antenatal care (ANC) utilization, and socio-economic factors.

Conclusion

The current study showed that prematurity, neonatal jaundice and congenital malformations were the main causes of admission to the NICU. Neonatal mortality in Al-Qassim, Saudi Arabia, is lower compared to other regions in the world, and mortality is associated with LBW. Preventive measures are needed towards reducing LBW.

Informed Consent

The informed consent was waived by the ethical committee for the following reasons, because of the nature of the study, which used existing data from the participants' medical records.

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Disclosure

The authors report no conflicts of interest in this work.

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