Original Research Article

Study of the neonatal mortality and morbidity patterns in the NICU over a five-year period at a rural tertiary care teaching hospital in South-West Bihar

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Abstract

Introduction: Neonatal mortality, defined as death within the first 28 days of life, is a core indicator for neonatal health and wellbeing and is becoming a prominent component of overall under-five mortality. It is therefore receiving particular attention from health authorities. Zw3**Aims and objectives:** 1. To determine the patterns of morbidity and mortality in the NICU in the last 5 years. 2. To know the outcomes of neonatal admissions in the NICU in the last 5 years. **Methodology:** This was a retrospective record-based study conducted in the NICU of a tertiary care teaching hospital situated in rural South Bihar, India. Medical records of a total of 1222 neonates belonging to the Rohtas district and admitted in the NICU of Narayan Medical College & Hospital, Sasaram between December 2015 and December 2019 were reviewed. The data on admission, sex, gestational age, birthweight, indications for admission, primary diagnosis and associated medical conditions, duration of hospitalization, complications encountered, investigations during hospitalization, and outcome were extracted and analysed. **Result:** 64.2% were term babies and 58.3% had normal birth weight. The data analysis for the morbidity showed that neonatal hyperbilirubinemia (NNH) (26.68%) was the most common cause of admission to NICU, followed by early-onset sepsis (EOS) (18.49%), perinatal hypoxia-ischemia (birth asphyxia) (16.61%), prematurity (admitted for preterm care, no complications on admission) (11.29%), respiratory distress syndrome (RDS) (8.30%), meconium aspiration syndrome (MAS) (6.98%) and late-onset sepsis (LOS) (5.85%), in that order. The overall mortality rate was 11.29% (138 out of 1222 total admissions). The major causes of mortality were perinatal hypoxia-ischemia (24.63%), prematurity (22.46%), EOS (15.22%), RDS (13.77%), LOS (10.87%) and MAS (10.14%). Prematurity (22.46%), LOS (21.13%), RDS (18.81%), birth asphyxia (16.74%), MAS (16.47%) and necrotizing enterocolitis (NEC) (11.11%) were the most lethal in terms of case fatality rates. **Conclusion:** This study identified neonatal hyperbilirubinemia (NNH), early-onset sepsis (EOS), perinatal hypoxia-ischemia (birth asphyxia), prematurity, respiratory distress syndrome (RDS), meconium aspiration syndrome (MAS) and late-onset sepsis (LOS) as the major causes of neonatal morbidity in the NICU of our institute in rural South Bihar. With a mortality rate of about 11%, the major causes of neonatal deaths were perinatal hypoxia-ischemia, prematurity, EOS, RDS, LOS and MAS. Prematurity, LOS, RDS, birth asphyxia, MAS and NEC were the most lethal diseases in terms of case fatality rates.

Key Words: NICU, MAS and NEC.

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Introduction

Neonatal mortality, defined as death within the first 28 days of life, is a core indicator for neonatal health and well being and is becoming a prominent component of overall under-five mortality. It is therefore receiving particular attention from health authorities[1].

The first month is the most crucial period for child survival. Globally, an estimated 2.5 million newborns die in the first month of life, approximately 7000 every day. Currently, an estimated 18 neonatal deaths per 1000 live births occur during the neonatal period accounting for 46% of under-five deaths[2].In India, 26 million babies are born every year, and 1.2 million die in the first four weeks of life, accounting for a quarter

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of global neonatal deaths. India thus faces the biggest newborn health challenge of any country in the world. Neonatal deaths constitute two-thirds of infant deaths in India; 45% of the deaths occur within the first two days of life. The common causes of neonatal mortality in India are asphyxia, prematurity and low birth weight, sepsis, congenital anomalies, and a variety of surgical problems[3]. The neonatal mortality rate (NMR) varies widely among the different states of India, ranging from 11 per 1000 live births in Kerala to 48 per 1000 live births in Uttar Pradesh. The neonatal mortality rate in Bihar (42 per 1000 live birth) is more than the national average of 22 due to poor health infrastructure and lack of access to quality healthcare. Preterm birth is one of the major clinical problems in obstetrics and neonatology, as it is associated with increased perinatal mortality and morbidity[4]. Demographic, maternal and neonatal factors like premature birth and low birth weight, asphyxia and birth trauma, complications during delivery, low household income, high birth order, gender, residence and mother's education play important roles in neonatal morbidity and mortality[5].Neonatal death reflects the loss of thousands of potential citizens each year. This, apart from being a grievous economic and social loss, is a source of immeasurable grief to thousands of parents. Hence, this is a field full of challenging enigmas to pediatricians[6].Neonatal mortality statistics serve as sensitive indicators of the availability, utilization, and effectiveness of maternal and child health services in the community. NMR is variable from place to place and is also different from hospital to hospital and between hospital-born and home-born babies. Data derived from hospital records do not truly represent NMR and its various causes in the community at large but have the advantage of being more reliable in term of causes of death, and they reflect the quality of obstetric and child care services available[7].While high infant mortality rates were recognized by the medical community at least as early as the 1860s, modern neonatal intensive care is a relatively recent advance. The neonatal intensive care units (NICUs) have a role in developing countries like India; although neonatal intensive care is among the more expensive services that any health care systems can provide. The cost of establishing an NICU runs into millions of rupees in India in which equipment costs comprise two-thirds of the establishment cost and ancillary personnel salary comprises the largest proportion of the running costs. Rational use of NICU services is the demand of time[8].Most newborn deaths are preventable by improving the quality of antenatal care, including care during delivery and at birth. Simple interventions like skilled birth attendance and access to emergency obstetric care can reduce NMR. With the above background, this study was conducted in the NICU of a tertiary medical centre (a medical college and hospital) of south Bihar with following aims and objectives.

Aims & Objectives

1. To determine the patterns of morbidity and mortality in the NICU in the last 5 years.
2. To know the outcomes of neonatal admissions in NICU in the last 5 years.

Methodology

This was a retrospective record-based study conducted in the NICU of a tertiary care teaching hospital situated in rural South Bihar. Medical records of a total of 1222 neonates belonging to the Rohtas district and admitted in the NICU of Narayan Medical College & Hospital, Sasaram between December 2015 and December 2019 were reviewed. The data on admission, sex, gestational age, weight for gestation, indications for admission, duration of hospitalization, complications encountered, investigations during hospitalization, and outcome were extracted. Referring place were noted for those referred from other hospitals or clinics. Place of birth, whether institutional or home delivery, was recorded. Antenatal history regarding high-risk pregnancy and maternal risk factors was asked. Natal history included place, duration, and mode of delivery. In the postnatal history, following points were noted: whether the baby was breathing spontaneously or cried immediately after birth (vigorous) or not (non-vigorous), resuscitation if required, and its modes and medication if any were enquired.Gestational age was assessed according to the New Ballard scoring and last menstrual period (LMP) and categorized as preterm (<37 weeks completed), term (37-42 weeks), and post-term (>42 weeks completed). Birth weight was recorded within 1 h of admission and categorized as- appropriate for date, small for date, or large for date with respect to their gestational age.General examination findings were recorded for all the babies with special reference to meconium staining, cyanosis, icterus, hypothermia, icterus, sclerema, dehydration, and any congenital malformation. Similarly, detailed systemic examination findings were also be recorded. Final outcome whether the baby was discharged, died, absconded or left against medical advice (LAMA) and the duration of hospital stay were recorded. All the cases were divided into four groups - 0–24 h, 1–3 days, 3–7 days, and 7–28 days.The following inclusion and exclusion criteria were used for selection of study subjects.

Inclusion criteria

All the neonates who were admitted to the NICU in the study period and belonged to the Rohtas district.

Exclusion Criteria

Babies admitted to the NICU but not belonging to the Rohtas district. The calculation of the survival was done after subtracting them from the total admission, as their outcome was not known.

Statistical analysis

The birth weight and the gestational age were expressed in mean ± SD. All the data was analysed by using the Open Epi statistical software, version 2.3.1. The mean, standard deviation, odds ratio and the relative risk were calculated by using appropriate statistical methods. P-value of < 0.05 was considered to be statistically significant for any given measures.

Results

The data analysis showed that there were 1222 neonates admitted to the NICU during Dec 2015 to Dec 2019. The average length of stay (ALS) of the neonates admitted to the NICU was 6.4 days. The average age on admission of the neonates was 5.24 days. The age wise distribution of admitted neonates revealed that about a four-fifth (81.13%) of the neonates were in the age group of 0-7 days (early neonatal period). About one-fifth (18.87%) of the neonates admitted were in the late neonatal period (>7 to 28 days) (Table 1). Majority of neonates were males (61%). The ratio of males (61%) and female (39%) neonates was 1.56:1 (Figure 1). It was observed that the mean gestational age of the neonates admitted to the NICU was 33.24 weeks. The minimum and maximum gestational age of the neonates was 26.2 and 42.4 weeks respectively. Majority (64.2%) of the neonates were born at full term of gestation. The study showed that the average weight on admission of the neonates was 2388.4 grams. The minimum and maximum weight of the admitted neonate was 954 and 4125 grams respectively. Majority (61.2%) of the neonates were of normal weight (2500-3500 grams).Most (88%) of the neonates were born in health institutions. The study also showed that about three fourths (74%) of the neonates belonged to joint families whereas about one fourth (26%) belonged to nuclear type of families. The distribution of neonates according to dwelling place revealed that more than four fifths (83%) of the neonates admitted to NICU belonged to families living in rural dwelling areas whereas less than a fifth (17%) belonged to families residing in urban areas.

Table 1. Distribution of the study subjects according to the age of neonates on admission

Age of the neonates	No.	Percentage (%)
0-7 days	991	81.10
8-14 days	127	10.39
15-21 days	73	5.97
22-28 days	31	2.54
Total	**1222**	**100**

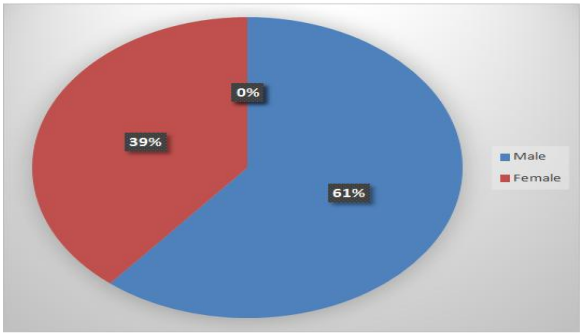

Fig 1: Distribution of the study subjects according to gender

Table 2: Socio-demographic characteristics of the study subjects

Variables		No	%
Gestational age at birth	Preterm (<37 weeks)	426	34.86
	Term (37 weeks – 42 weeks)	785	64.24
	Post-term (>42 weeks)	11	0.9

Weight on admission	High weight (>4000 g)	21	1.7
	Normal weight (2500-4000 g)	712	58.3
	Low weight (1500-2499 g)	402	32.9
	Very low weight (1000-1499 g)	82	6.7
	Extremely low weight (<1000 g)	5	0.4
Place of delivery	Health institution	1099	89.93
	Home	123	10.07
Type of family	Joint family	877	71.77
	Nuclear family	345	28.23
Dwelling Place	Rural	835	68.33
	Urban	387	31.67
Grand Total		**1222**	**100**

Table 3: Pattern of morbidity among neonates admitted to the NICU

Disease	Frequency (N)	Percentage (%)
Neonatal hyperbilirubinemia (NNH)	327	26.79
Early-onset sepsis (EOS)	226	18.49
Perinatal hypoxia-ischemia (Birth asphyxia)	203	16.60
Preterm (for preterm care, no other complications at admission)	138	11.32
Respiratory Distress Syndrome (RDS)	101	8.30
Meconium Aspiration Syndrome (MAS)	85	6.98
Late-onset sepsis (LOS)	71	5.85
Transient tachypnea of newborn (TTN)	25	2.07
Polycythemia	14	1.13
Hypothermia	11	0.94
Apnea	9	0.75
Necrotizing enterocolitis (NEC)	9	0.75
Grand Total	1222	100

Data analysis for morbidity showed that neonatal hyperbilirubinemia (NNH) (26.68%) was the most common cause of admission to NICU, followed by early-onset sepsis (EOS) (18.49%), perinatal hypoxia-ischemia (birth asphyxia) (16.61%), prematurity (admitted for preterm care, no complications on admission) (11.29%), respiratory distress syndrome (RDS) (8.30%), meconium aspiration syndrome (MAS) (6.98%) and late-onset sepsis (LOS) (5.85%), in that order. Early and late-onset sepsis together accounted for about a quarter of all NICU admissions. Data analysis for the outcome of all the admitted newborns revealed that out of 1222 neonates admitted, most (1081) were discharged with advice (88.46%), whereas a total of 138 of the admitted newborns expired with a mortality rate of 11.30%. Three babies were discharged/left against medical advice (LAMA).The disease-specific mortality rates among the neonates admitted to NICU were studied and it was found that prematurity (22.46%), late-onset sepsis (LOS) (21.13%), respiratory distress syndrome (RDS) (18.81%), perinatal hypoxia-ischemia (birth asphyxia) (16.74%), and meconium aspiration syndrome (MAS) (16.47%) were the top five major contributors to the mortality, in that order.

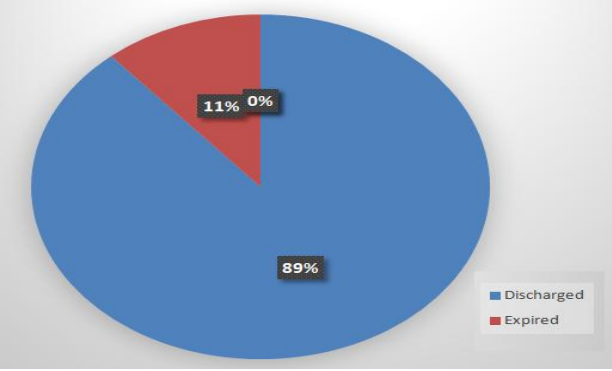

Fig 2: Distribution of study subjects as per outcome

Table 4: Disease-specific mortality rates among neonates admitted to the NICU

Disease	Frequency (N)	Expired	Mortality Rate
Neonatal hyperbilirubinemia (NNH)	327	3	0.92
Early-onset sepsis (EOS)	226	21	9.29
Perinatal hypoxia-ischemia (Birth asphyxia)	203	34	16.74
Preterm (prematurity)	138	31	22.46
Respiratory Distress Syndrome RDS)	101	19	18.81
Meconium Aspiration Syndrome (MAS)	85	14	16.47
Late-onset sepsis (LOS)	71	15	21.13
Necrotizing enterocolitis (NEC)	9	1	11.11
Total	**1160**	**138**	**11.89**

The data was analyzed for case fatality rates and it was observed that out of 1222 neonates, prematurity (22.46%), late-onset sepsis (LOS) (21.13%), and respiratory distress syndrome (RDS) (18.81%) had the highest case fatality rates (Table 5).

On analysis of the mortality data, it was seen that in terms of simple proportion of all neonatal deaths (138), perintal hypoxia-ischemia (birth asphyxia) (34 out of 138, 24.63%), prematurity (31 out of 138, 22.46%), early-onset sepsis (EOS) (21 out of 138, 15.22%), respiratory distress syndrome (RDS) (19 out of 138, 13.77%), late-onset sepsis (LOS) (15 out of 138, 10.87%), and meconium aspiration syndrome (MAS) (14 out of 138, 10.14%) accounted for most of the mortality in the NICU (Table 6).

Table 5: Disease-wise case fatality rates of the neonates admitted to NICU

	Outcome					
	Discharged		Expired		Total	
Disease	N	%	N	%	N	%
Neonatal hyperbilirubinemia (NNH)	324	99.08	3	0.92	327	100
Early-onset sepsis (EOS)	205	90.71	21	9.29	226	100
Perinatal hypoxia-ischemia (Birth asphyxia)	169	83.26	34	16.74	203	100
Preterm (prematurity)	107	77.54	31	22.46	138	100
Respiratory Distress Syndrome (RDS)	82	81.19	19	18.81	101	100
Meconium Aspiration Syndrome (MAS)	71	83.53	14	16.47	85	100
Late-onset sepsis (LOS)	56	78.87	15	21.13	71	100
Transient tachypnea of newborn (TTN)	25	100	0	0	25	100
Polycythemia	14	100	0	0	14	100
Hypothermia	11	100	0	0	11	100
Apnea	9	100	0	0	9	100
Necrotizing enterocolitis (NEC)	8	88.89	1	11.11	9	100
Total	**1081**		**138**		**1219**	

Table 6: Proportional and frequency distribution of the causes of neonatal mortality

Disease	Number of deaths	Percentages
Perinatal hypoxia-ischemia (Birth asphyxia)	34	24.63
Preterm (prematurity)	31	22.46
Early-onset sepsis (EOS)	21	15.22
Respiratory Distress Syndrome (RDS)	19	13.77
Late-onset sepsis (LOS)	15	10.87
Meconium Aspiration Syndrome (MAS)	14	10.14
Neonatal hyperbilirubinemia (NNH)	3	2.17
Necrotizing enterocolitis (NEC)	1	0.72
Total	**138**	**100**

Discussion

Accurate data on the neonatal disease volume and pattern are useful for many reasons. It is important for the providers of care, investigators, local and national health administrators, and for decision makers to design interventions for prevention and treatment and to implement and evaluate health care programs.The data from NICUs of hospitals in India is very limited and there are very few published reports from these hospitals. This is a hospital-based study from a rural area of one of the most backward states of India, although it might not be representative of the neonatal morbidity and mortality patterns in the community. This five-year retrospective study was done in order to document the most common type of diseases with which the neonates were admitted, treatment/ interventions they received, and their outcomes in the neonatal intensive care unit (NICU) of NMCH, Sasaram.It was found that a total of 1222 neonates were admitted in the NICU during the period of study. A study conducted by Aijaz et al[9] at Karachi found that the average length of stay (ALS) was 6.5 days whereas the average length of stay (ALS) of the neonates admitted to NICU in our study was 6.4 days which is almost the same. Aijaz et al[9] also found that the average age at admission was 3.5 days whereas it was 5.24 days in our study. Anjum et al[10]found in their study from Pakistan that 85% of neonates were in the age group of 0-7 days, followed by 6% in 8-14 days age group. The age distribution of admitted neonates in our study was similar, and most neonates were in the age group of 0-7 days (81.13%) group, followed by 10.38% in 8-14 days age group. These findings are logical and expected as neonates in early neonatal period are at higher risk of contracting diseases and at risk neonates are identified by healthcare workers immediately if they are born in hospitals.Our study also showed that among neonates requiring admission to the NICU, male newborns (61%) outnumber their female (39%) counterparts. It is consistent with local literature reported by Kumar et al[4] (60% male versus 40% female) and international studies by Seyal et al[11] from Pakistan (59.55% male versus 40.45% female newborns), by Ugwu[12] from Nigeria (54.3% male versus 45.7% female newborns), and by Nahar et al[13] from Bangladesh (55.4% males and 44.6% females). The ratio of males (61%) and female (39%) neonates was 1.56:1 in our study, almost similar to the studies by Kumar et al[4] (1.50), Seyal et al[11] (1.47) and slightly more than the studies of Ugwu[12] (1.19) and Nahar et al[13] (1.24). In contrast to our findings, Aijaz et al found that the female babies outnumbered their male counterparts with a ratio of 2:1.3[9]In this study about two-third of the neonates were full term (65.1%) and one-third were preterm (34.9%), which was similar to the study conducted by Gauchan et al[14] in which there were 67.5% term babies and 31.3% preterm babies. In contrast to our findings, the Pakistani study by Seyal et al[12] had a higher proportion of preterm neonates among the NICU admissions (42.8%). Our findings are understandable, because Janani Suraksha Yojana (JSY) (since 2005) and Janani Shishu Suraksha Karyakram (JSSK) (since 2011) schemes- two flagship programmes under the National Rural Health Mission (NRHM) have enhanced access to and general quality of antenatal care, obstetric care and neonatal care for the general population in India.Our study also revealed that most of the admitted neonates were delivered in health institutions (90%) and only a small number was delivered at home (10%). The findings of our study are comparable the findings of Rahim et al[15] and Seyal et al[12]In our study, neonatal hyperbilirubinemia

(NNH) (26.68%) was the most common morbidity necessitating admission to NICU, followed by early-onset sepsis (EOS) (18.49%), perinatal hypoxia-ischemia (birth asphyxia) (16.61%), prematurity (11.29%), respiratory distress syndrome (RDS) (8.30%), meconium aspiration syndrome (MAS) (6.98%) and late-onset sepsis (LOS) (5.85%), in that order. Sepsis alone (early- and late-onset together) accounted for almost one fourth of all NICU admissions. The diseases leading to NICU admission in our study were similar to other studies, e.g., Anjum et al[10], Seyal et al[11], Ugwu[12], Nahar et al[13], Gauchan et al[14], and Rahim et al[15]. However, the pattern and frequency distribution of disease in our study were not similar to the above-mentioned studies, probably due to different sociocultural conditions of Bihar.The most common causes of neonatal deaths in our NICU were perintal hypoxia-ischemia (birth asphyxia) (34 out of 138, 24.63%), prematurity (31 out of 138, 22.46%), early-onset sepsis (EOS) (21 out of 138, 15.22%), respiratory distress syndrome (RDS) (19 out of 138, 13.77%), late-onset sepsis (LOS) (15 out of 138, 10.87%), and meconium aspiration syndrome (MAS) (14 out of 138, 10.14%). Early- and late-onset sepsis together accounted for about 26% of all deaths in our NICU (36 out of 138). These figures are uncannily similar to Ugwu[12]from Nigeria, but very different from other studies, such as Nahar et al[13].It is essential to know the outcome of the admissions for evaluating the effectiveness of care provided in a hospital setting. There is a great variation in neonatal mortality statistics between NICUs from different parts of the world. This variation likely reflects the difference in the attending population, antenatal care, admission criteria, specific exclusion and inclusion criteria and the level of neonatal care.Out of the 1222 neonates admitted to the NICU in our study, 1081 (88.46%) were discharged, 138 (11.29%) died, while three were taken away against medical advice. The neonatal mortality rate (11.29%) in the NICU of NMCH, Sasaram was similar to the study conducted by Aijaz et al[9] (13.8%) from Karachi, Pakistan. Comparatively higher rates have been reported by Arafa et al[17] (22.4%) from Saudi Arabia and Agbere et al[18] (27%) from Togo. Lower neonatal mortality rates were found in the studies by Tariq et al[16] (9%) from Pakistan, Sankaran et al[19](4%) from Canada, and Zullini et al[20] (6%) from Brazil.

Conclusion

Neonatal mortality rate (NMR) plays an important role in health planning and it has shown a considerable decline over the last two decades[21], yet there is much scope for improvement. Our study shows neonatal hyperbilirubinemia (NNH) (26.7%) as the most common neonatal morbidity requiring admission to the NICU. Early-onset sepsis (EOS) (18.49%), perinatal hypoxia-ischemia (birth asphyxia) (16.60%), prematurity (11.32%), respiratory distress syndrome (RDS) (8.30%), meconium aspiration syndrome (MAS) (6.98%) and late-onset sepsis (LOS) (5.85%) were the other important causes of NICU admission. Common causes of neonatal mortality in the NICU were perinatal hypoxia-ischemia (birth asphyxia) (24.63%), prematurity (22.46%), early-onset sepsis (EOS) (15.22%), respiratory distress syndrome (RDS) (13.77%), late-onset sepsis (LOS) (10.87%), and meconium aspiration syndrome (MAS) (10.14%). Much of the morbidity and subsequent mortality can be prevented by developing infrastructure and training staff for providing effective antenatal and peripartum obstetric care, and neonatal care and resuscitation.

Limitations of the study

1. This was a hospital-based study and may not truly represent the neonatal morbidity and mortality statistics in the community.
2. As this was a record-based study, examination of study subjects was not possible and it relied on the case notes and reports in the medical records.

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