Original Article

Incidence and factors associated with early neonatal near miss in a tertiary care hospital in Bengaluru

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ABSTRACT

Background: Neonatal near miss is defined as, a neonate who has suffered a life-threatening condition but survived the first 28 days of life. As neonatal near miss is a predictor for early neonatal death, the lessons learned from near misses will be useful to help prevent early neonatal mortality. **Objectives:** The objectives of the study were to estimate the incidence of neonatal near miss and its associated factors in the early neonatal period in a tertiary hospital. **Materials and Methods:** This was a longitudinal study where all the cases of early neonatal near miss and early neonatal mortality were documented over a 1-year period. A face-validated structured questionnaire was used to collect information from mothers. The data were described using proportions, mean, and standard deviation. Regression analysis and adjusted odds ratio (aOR) were used to identify the determinants of early neonatal near miss. **Results:** The study was conducted among 210 neonates born to 197 mothers. The neonatal near miss rate in our study was found to be 75.43/1000 live births. The total live births during the study period were 2784. The most common cause of near miss was identified as birth weight of <1750 g. The absence of antenatal ultrasound scans (aOR 6.124), anemia (aOR 3.945), preterm premature rupture of the membranes (aOR 3.136), presence of oligohydramnios (aOR 3.624), and malpresentation (aOR 5.581) was independent determinants of early neonatal near miss. **Conclusion:** These findings demonstrate the importance of better antenatal care including prevention of anemia, screening and management of high-risk cases, and antenatal complications to avoid the incidence of near miss.

Key words: Apgar, Incidence, Mortality, Near miss, Neonatal, Newborn

The neonatal period constituting the first 28 days of life, is the most vulnerable period of a child's life. There are about 2.6 million annual deaths of neonates reported globally in the 1st month of life [1], that is, approximately 7000 newborn deaths daily. The global neonatal mortality rate (NMR) is 18.6 deaths/1000 live births [2]. In India 748,000 newborns die annually, constituting 27.7% of the global neonatal deaths. The United Nations sustained development goals (SDGs) were adopted by the countries on September 25, 2015. The Goal 3 of the SDGs is to ensure healthy lives and promote well-being for all at all ages. One of its main targets is to reduce neonatal mortality to 12/1000 live births or less by 2030 [3]. India still has a long way to reach this target, with the current NMR of 24/1000 live births [4].

One of the reasons for the slow decline of neonatal mortality in India is the large chunk of early neonatal mortality (death of neonates in the 1st week of life) which contributes to 75.0–80.0% of the total [5]. Neonatal near miss, defined as a neonate who has suffered a life-threatening condition but survived the first 28 days of life [6], is a preventable precursor of neonatal death [7].

There are various advantages of documenting and auditing neonatal near miss cases. It allows identification of sufficient number of cases to study and understand health system failures within a short span of time as compared to mortality studies. Studying near miss is more acceptable for health-care providers as it is associated with a positive outcome of survival. A low neonatal near miss rate indicates high quality of care [8]. It is an important tool to evaluate and improve the quality of health services that are being provided as part of perinatal care [6,9]. As neonatal near miss is a predictor for early neonatal death [10], the lessons learned from near misses will be useful to help prevent early neonatal mortality [11]. There is a paucity of data regarding near miss in the Indian setting.

Therefore, this study was conducted with the aim of estimating the incidence of neonatal near miss and its associated factors in the early neonatal period in a tertiary hospital in South India.

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MATERIALS AND METHODS

This was a longitudinal study conducted in the neonatal intensive care unit (NICU) and the obstetrics and gynecology wards in a tertiary hospital of South India, with prior approval from the Institutional Ethics Committee (IEC) (IEC no. 283/2016). The list of live births during this time period was obtained from labor room records. All inborn neonates admitted to the NICU during the study period of 1 year (February 1, 2017–January 31, 2018) were included in the study along with their mothers. They were followed up from birth to 7 days of life. All neonates, born elsewhere, admitted to the hospital, were excluded from the study.

Written informed consent was obtained from the mothers before administering a face-validated structured questionnaire which consisted of three parts: (1) Sociodemographic details of the mother; (2) maternal profile – including present and past obstetric history, antenatal care and investigations, supplements taken, and complications during the current pregnancy, and (3) Neonatal profile – including delivery details, birth weight, gender, gestational age at delivery, Apgar scores, complications during and after delivery, and the interventions done for the newborn in the NICU. The following criteria were used to determine neonatal near miss [6]:

Pragmatic criteria: Birth weight <1750 g, low gestational age <33 weeks, and low Apgar score at 5 min of life <7.

Management criteria: Parenteral antibiotic therapy, intubation or mechanical ventilation, phototherapy within 24 h of life, cardiopulmonary resuscitation, use of vasoactive drugs, use of anticonvulsants, use of surfactant, use of blood products, use of steroids for the treatment of refractory hypoglycemia, and any surgical procedure.

Neonatal near miss case was identified as a neonate with any one of the above criteria. Thus, all the cases of early neonatal near miss and early neonatal mortality were documented over a 1-year period. A follow-up visit was done on the 8th day of neonatal period in the NICU.

The data collected were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences version 16 software. The data were described using proportions, mean, and standard deviation. The outcome variables: Birth weight <1750 g, gestational age: <33 weeks, and Apgar score <7 at 5 min of life were associated with various sociodemographic and obstetric variables by performing regression analysis and calculating odds ratios with 95% confidence limits. p<0.05 was considered statistically significant.

RESULTS

The study was conducted among 210 neonates with near miss, born to 197 mothers. The mean age of the mothers in the study was 26.02±3.63 years. In this study, 82.0% of the mothers were of the age group 21–30 years and 6.0% were teen pregnancy. The majority of the mothers were homemakers. The median family income was 16,000 rupees (interquartile range 10,000–27,000). Among the mothers, only 17.2% belonged to lower or lower middle class. In our study, 141 (71.6%) belonged to a nuclear family. No first-degree consanguinity was found among the parents of the study subjects.

In this study, most of the mothers were primiparous, that is, 118 (59.9%). In the study, 51 (25.9%) mothers had full antenatal care (Table 1) and 83 (42.1%) had taken 100 mg of elemental iron for a minimum of 100 days. In our study, 64 (32.5%) mothers had anemia.

The total live births during the study period were 2784. The neonatal near miss rate was found to be 75.43/1000 live births. The number of early neonatal deaths in our study was being 0, the early NMR was found to be nil.

Considering the pragmatic criteria for near miss, 87 (41.4%) had gestational age <33 weeks (Table 2). On day 8 of the newborns, 137 (65.2%) were still in NICU, while the rest was discharged from NICU to ward. All the near miss newborns by management criteria were also near miss by pragmatic criteria.

The absence of antenatal ultrasound scans was associated with increased chance of neonates born with birth weight <1750 g (adjusted odds ratio [aOR] 6.124, 95% confidence interval [CI]

Table 1: Antenatal care visit details of the mothers (n=210)

Variable	Category	n (%)
Gestational age at first visit for ANC	5–8 weeks	142 (72.1)
	9–12 weeks	55 (27.9)
	>12 weeks	0
Total ANC visits	1–3	75 (38.1)
	4–8	110 (55.8)
	9 and more	12 (6.1)
Predominant place of antenatal visits	Government facility	139 (70.6)
	Private hospital	58 (29.4)
Number of home visits by ASHA/ANM	0	67 (34.0)
	1	52 (26.4)
	≥2	78 (39.6)
Full antenatal care*	Yes	51 (25.9)

ANC: Antenatal care, ASHA: Accredited Social Health Activist, ANM: Auxiliary nurse midwife. *Full antenatal care – minimum of four antenatal visits, 100 iron folic acid (IFA) tablets for a minimum of 100 days, and at least one tetanus toxoid (TT) injection

Table 2: Distribution of the near miss criteria among the newborns (n=210)

Near miss criteria	n (%)
Pragmatic criteria	
Birth weight <1750 g	138 (65.7)
Low gestational age: <33 weeks	87 (41.4)
Low Apgar score at 5 min of life: <7	66 (31.4)
Management criteria	
Parenteral antibiotic therapy	125 (60.0)
Intubation or mechanical ventilation	79 (37.6)
Cardiopulmonary resuscitation	22 (10.5)
Use of vasoactive drugs	11 (5.2)
Use of anticonvulsants	20 (9.5)
Use of blood products	7 (3.3)
Therapeutic cooling	4 (1.9)

2.351–15.212) (Table 3). Those neonates with birth weight <1750 g had almost 9 times higher chance of staying in NICU for a longer period up to 8 days (aOR 8.887).

Mothers who had hemoglobin levels below 9.9 g/dL had almost 4 times increased chances (aOR 3.945, 95%CI 1.199–12.988) and those with no antenatal ultrasound scans had a greater chance (aOR 2.658, 95%CI 1.124–8.594) of getting delivered at gestational age of <33 weeks (Table 4). Preterm premature rupture of the membranes (PPROM) was also found to be an independent determinant of delivery at gestational age of <33 weeks (aOR 3.136, 95% CI 1.414–6.954).

The presence of oligohydramnios and malpresentation was independent determinants of Apgar score <7 at 5 min (Table 5). Mothers who had antenatal checkups predominantly in a government facility were associated with increased chances of having an Apgar score of <7 among their newborns (aOR 2.786, 95% CI 1.104–7.034).

DISCUSSION

The neonatal near miss rate in our study was found to be 75.43/1000 live births. The neonatal near miss rate in the World Health Organization Multicountry Survey on Maternal and Newborn Health was 72.5/1000 live births, almost equal to our current study [10]. In the study conducted by Shroff and Ninama, the neonatal near miss rate was found to be 86.7/1000 live births [12]. A study conducted by Pileggi *et al*. in Brazil identified that the near miss rate was 21.4/1000 live births (4.5–42.3 cases/1000 live births) [9]. The difference in near miss rate between these studies may be due to the difference in geographical location and health systems of the two countries and also the choice of pragmatic and management markers in the study. In the study conducted by Silva *et al*., the neonatal near miss rate was 39.2 per thousand live births [13], which used stringent pragmatic criterion including birth weight <1500 g and gestational age <32 weeks. The same study also did not include few management pragmatic indicators including laboratory markers for organ dysfunctions. This would have resulted in lower rate of near miss cases in the study compared to our current study and the multicountry study [10].

The mean age of the mothers in the study was 26.02±3.63 years. Majority of the mothers belonged to the age group of 21–25 years. The youngest study subject was 18 years old while the oldest study subject was 35 years of age. In many of the studies including the multicountry survey and the study conducted in Brazil on near miss neonates, the majority of the mothers belonged to the 20–34 age group [14,15]. The mean age of marriage in India according to the census 2011 is 21.2 years [16], accounting for the younger mothers in our study.

In this study, 41.4% of the near miss cases had gestational age <33 weeks, which was one of the pragmatic criteria used for

Table 3: Independent determinants of birth weight of newborns with near miss: Multivariate logistic regression

Factors		Total n (%)	Birth weight <1750 g n (%)	aOR	95% CI for odds ratio		p-value
					Lower	Upper	
Antenatal ultrasound scan	No	27 (12.9)	23 (16.7)	6.124	2.351	15.212	0.032*
Prolonged labor	No	194 (92.4)	135 (97.8)	1.551	0.189	12.722	0.683
Obstructed labor	No	184 (87.6)	134 (97.1)	9.454	1.481	60.368	0.018*
Malpresentation	No	199 (94.8)	136 (98.6)	2.260	0.311	16.445	0.421
Anticonvulsant use	No	190 (90.5)	134 (97.1)	17.748	4.591	68.604	<0.001*
Condition on day 8 of life	Still in NICU	137 (65.2)	109 (79.0)	8.887	4.135	19.097	<0.001*

*p<0.05 significant, NICU: Neonatal intensive care unit, aOR: Adjusted odds ratio, CI: Confidence interval

Table 4: Independent determinants of gestational age at delivery of newborns with near miss: Multivariate logistic regression

Factors	Total n (%)	Gestational age <33 weeks	aOR	95% CI for odds ratio		p-value
				Lower	Upper	
Hb (g/dl)						
<7	8 (3.8)	8 (9.2)	1	-	-	-
7.1–9.9	36 (17.1)	16 (18.4)	3.945	1.199	12.988	0.024*
10–10.9	29 (13.8)	7 (8.0)	1.716	0.641	4.593	0.283
≥11	137 (65.2)	56 (64.4)	0.000	0.000	-	0.999
Gestational hypertension						
Yes	48 (22.8)	10 (11.5)	0.584	0.170	2.005	0.392
Preeclampsia						
Yes	44 (21.0)	9 (10.3)	0.335	0.101	1.110	0.074
Antenatal ultrasound						
No	24 (11.4)	18 (20.7)	2.658	1.124	8.594	0.032*
PPROM						
Yes	60 (28.6)	38 (43.7)	3.136	1.414	6.954	0.005*

*p<0.05 significant. Hb: Hemoglobin, PPROM: Preterm premature rupture of the membranes, aOR: Adjusted odds ratio, CI: Confidence interval

Table 5: Independent determinants of Apgar score at 5 min of newborns with near miss: Multivariate logistic regression

Factors	Total n (%)	Apgar score at 5 min <7 n (%)	aOR	95% CI for odds ratio		p-value
				Lower	Upper	
Predominant place of antenatal visit						
Government hospital	146 (69.5)	53 (80.3)	2.786	1.104	7.034	0.030*
Oligohydramnios						
Yes	17 (8.1)	9 (13.6)	3.624	1.194	10.998	0.023*
PPROM						
Yes	60 (28.6)	26 (39.4)	2.006	0.995	4.045	0.052
Prolonged labor						
Yes	16 (7.6)	10 (15.2)	2.313	0.461	11.601	0.308
Obstructed labor						
Yes	26 (12.4)	14 (21.2)	1.867	0.464	7.511	0.379
Malpresentation						
Yes	11 (5.2)	7 (10.6)	5.581	1.249	24.938	0.024*
Condition on the 8th day of life						
Still in NICU	137 (65.2)	49 (74.2)	2.047	0.953	4.397	0.066

***p<0.05 significant, PPROM: Preterm premature rupture of the membranes, NICU: Neonatal intensive care unit, aOR: Adjusted odds ratio, CI: Confidence interval**

identifying neonatal near miss. In the study conducted by Pileggi-Castro *et al*., 15.2% of the near miss cases were of gestational age <33 weeks [10]. The percentage of newborns with gestational age <32 weeks, among the neonatal near miss cases, in a study conducted in Brazil was found to be 87.0% [17], while it was observed among only 18.1% of the neonatal near miss cases in a study conducted in Benin, Burkina Faso, and Morocco [18]. The study conducted by Silva *et al*., found that 44.1% of the neonatal near miss cases had gestational age <32 weeks, which was similar to this study [13]. Kale *et al*. identified 70.2% of the near miss cases with gestational age <33 weeks [19]. Few authors had used <32 weeks of gestation as one of the pragmatic criteria of near miss. Various authors used different pragmatic and management criteria to define neonatal near miss. Hence there are disparities in the frequencies and percentages of various criteria of near miss between different studies.

Apgar score of <7 at 5 min was the second pragmatic criteria used for neonatal near miss in this study. Out of the 210 neonates with neonatal near miss, 31.4% had an Apgar score <7. In the studies conducted by Pileggi-Castro *et al*., Silva *et al*., Ronsmans *et al*., and Kale *et al*., Apgar score <7 was observed in 30.0%, 25.5%, 76.2%, and 36.3% of the near miss cases, respectively [10,13,18,19]. In this study, birth weight <1750 g was considered as the third pragmatic criteria and 65.7% of the near miss neonates were observed. The studies conducted by Pileggi-Castro *et al*., Silva *et al*., Ronsmans *et al*., and Kale *et al*., 19.8%, 42.1%, 26.7%, and 72.1% of the near miss cases, respectively, had birth weight <1750 g [10,13,18,19]. From the multivariate analysis, we found out that low gestational age at delivery, longer stay in NICU, lower levels of hemoglobin, absence of antenatal ultrasounds, presence of PPROM, antenatal visit to a government facility, presence of oligohydramnios, and malpresentation were the independent determinants of neonatal near miss.

Considering the early neonatal near miss rate of 75.43/1000 live births, mothers should be monitored from the first trimester of the pregnancy. Antenatal visits to a public health facility were associated with a higher incidence of near miss, suggesting for a better reform in the public health sector. Prevention of anemia among the pregnant women can significantly improve the near miss rates. Mothers who had no antenatal ultrasound scans were found to have higher incidence of neonatal near miss. Thus, it shows the importance of antenatal scans in prevention of neonatal near miss. The presence of PPROM and oligohydramnios was found to be independent determinants of neonatal near miss, which can be prevented with better antenatal care.

Although we were able to estimate the incidence and types of near miss as well as the factors determining the near miss in a tertiary hospital in an urban Indian setting, the study had a few limitations. First, we did not have a comparison group of normal newborns. Second, social desirability bias might have arisen while the mothers were responding to questions related to substance use. Therefore, a future case–control study can further strengthen the findings of the study.

CONCLUSION

The findings of the study demonstrate the importance of better antenatal care including prevention of anemia, screening and management of high-risk cases, and antenatal complications to avoid the incidence of near miss. Capacity building at all levels of health care is required to classify and manage neonatal near miss.

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