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Original Article

Predictors of neonatal mortality referred to a tertiary care teaching institute: A descriptive study

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ABSTRACT

Objective: To assess the predictors of neonatal mortality transported to our institution from other hospitals. **Methods:** In this descriptive study, neonates who were delivered outside of the hospital premises and were referred to our tertiary care teaching institute were enrolled in the study and the following information were recorded - gestational ages in completed week, place of birth, stabilization of newborn before and during transportation, and clinical parameter on hospital arrival. Management of neonatal illness was performed as per the standard protocol. Predictors of neonatal mortality were assessed. **Results:** Out of 245 referred neonates included in the study, 45 expired. Number of babies delivered at home and conducted by unskilled birth attendant was 46 (18.8%) and at private hospitals was 82 (33.5%). Government ambulance facility for neonatal transport was used only in 80 (32.6%). Among the expired neonate, 73.3% of the babies were delivered by unskilled birth attendants (odds ratio [OR]: 16.60, 95% confidence interval [CI]: 4.57-60.19, p=0.0001). Neonatal mortality was significantly less when baby referred or admitted early, i.e. <24 h age at the time of admission (p=0.02) and total duration of transport <1 h (OR: 0.01, 95% CI: 0.001-0.05, p=0.001). **Conclusions:** Significant predictors of neonatal mortality were birth weight <1.5 kg, gestational age <28 weeks, duration of transport > 1 h, delivery by traditional birth attendants, oxygen saturation <90%, poor perfusion (capillary refill time), and cyanosis at the time of admission. The most common cause of mortality was birth asphyxia, followed by sepsis and prematurity.

Key words: *India newborn action plan, Neonatal transport, Predictors of neonatal mortality*

In India, neonatal mortality rate (NMR) is 29 per 1000 live birth, and it contributes 56% to the under 5 mortality (SRS 2012). As per the India Newborn Action Plan, it is expected that India will achieve the goals of "Single Digit NMR" by 2030 [1]. Neonatal mortality reflects overall utilization of health-care services by the community, infrastructure, and involvement of health-care personnel in providing neonatal care. There is a huge gap between urban and rural mortality rates and geographical variation due to inequitable distribution of the health-care services [2,3].

Previous studies done by Baqui et al. and Narang et al., showed prematurity (32%) as the most important cause of mortality while Aggarwal et al., and Sehgal et al., showed sepsis as the main cause of neonatal deaths. All these studies were conducted in a tertiary care center in urban area. Our aim was to find out the predictors of neonatal mortality among the neonates transported to a tertiary care center in rural area.

METHODS

A descriptive study was conducted in the department of pediatrics at Uttar Pradesh Rural Institute of Medical Sciences and Research, Saifai, India, from May 2015 to October 2015. A pretested pro forma was used to record data regarding birth details, modes of transport, stabilization before and during transport, and neonatal condition on admission. The study protocol was fully explained to parents/guardian and written informed consent was obtained. Ethical clearance was obtained from the Institutional Ethical Committee.

During the study period, neonates delivered outside our hospital premises (at home, government, private hospitals) and referred to our neonatal intensive care unit were enrolled in the study. Birth details were noted in terms of mode of delivery (vaginal/cesarean section), place of delivery (home, government or private hospital), personnel who conducted the delivery (Dai/skilled birth attendants), stabilization before transport (in terms of oxygen, intravenous fluids, temperature maintenance), mode of transport (government ambulance, private ambulance, or personal means), and time taken to reach hospital.

Neonates were assessed on admission for gestational age (last menstrual period and new Ballard scoring), weight (on electronic weighing scale), hypothermia (axillary temperature measured by digital thermometer), capillary refill time (CRT) (>3 s was taken as prolonged), oxygen saturation (by pulse oximetry, <90% or >90%), blood sugar by glucometer (<45 mg/dl was taken as hypoglycemia). Birth asphyxia was, as per the WHO definition, considered in the presence of failure to establish breathing at birth. Respiratory distress was diagnosed in presence of at least 2 of the following criteria: (1) respiratory rate >60/min recorded for at least 1 min, (2) chest in drawing, and (3) expiratory grunt/groaning. Meconium aspiration syndrome (MAS) was diagnosed in the presence of two of the following: (1) meconium staining of liquor or staining of nails or umbilical cord or skin, (2) respiratory distress soon after birth/within 1 h of birth, and (3) radiological evidence of aspiration pneumonitis (atelectasis and/or hyperinflation).

Septicemia was classified as early-onset (onset <72 h) or late-onset (onset >72 h). Culture negative or clinical sepsis was diagnosed in presence of any one of the following criteria: (1) existence of predisposing factors such as maternal fever or foul smelling liquor or prolonged rupture of membranes (>18 h) or gastric polymorphs (>5 per high power field), (2) positive septic screen (three of the five parameters, namely, total leukocyte count <5000/mm^3, band to total polymorph ratio of >0.2, absolute neutrophil count <1800/mm^3, C-reactive protein >1 mg/dl, and micro-erythrocyte sedimentation rate>10 mm in 1st h), and (3) radiological evidence of pneumonia. Culture-positive sepsis was diagnosed in an infant having clinical picture suggestive of septicemia, pneumonia, or meningitis along with isolation of pathogens from blood or cerebrospinal fluid or urine or abscess.

Neonates were investigated, managed, and monitored as per the standard treatment protocols. Outcome was assessed in terms of expiry or survival. Neonates who left against medical advice were excluded from the study; therefore, data of these neonates were not collected. Separate data regarding birth injuries were not included in the study; however, major congenital malformations incompatible for life were excluded from the study.

Data were analyzed using SPSS version 13.0. All quantitative variables such as gestational age and birth weight were compared using Student's t-test and categorical variables were analyzed using Chi-square test and Fisher's exact test. A p<0.05 was considered statistically significant. Multivariate regression analysis was used to adjust confounding factors on mortality.

RESULTS

A total of 245 referred neonates were included in the study, out of which 60.8% were male and 39.2% were female. Primary diagnosis at the time of admission was sepsis (34.7%), asphyxia (33.1%), prematurity (26.5%), neonatal hyperbilirubinemia (38%), MAS (10%), and others (3%). Table 1 shows maternal characteristics and Table 2 shows the profile of expired and survived patients. Out of 245 neonates, 45 expired; thus,

Table 1: Maternal characteristics

Parameters	n (%)			p-value[1]
	Number of neonates (n=245)	Expired (n=45)	Survivors (n=200)	
Gestational age in weeks				
<28	28 (11.4)	23 (51.1)	5 (2.5)	0.0001*
28-34	56 (22.9)	11 (24.4)	45 (22.5)	
35-37	60 (24.5)	7 (15.6)	53 (26.5)	
>37	101 (41.2)	4 (8.9)	97 (48.5)	
Place of delivery				
Home	46 (18.8)	22 (48.9)	24 (12.0)	0.0001*
Government hospital	117 (47.8)	7 (15.6)	110 (55.0)	
Private hospital	82 (33.5)	16 (35.6)	66 (33.0)	
MOD				
LSCS	44 (18.0)	7 (15.6)	37 (18.5)	0.64
NVD	201 (82.0)	38 (84.4)	163 (81.5)	
Delivery conducted by				
TBA	54 (22.0)	33 (73.3)	21 (10.5)	0.0001*
SBA (Doctor/Nurse)	191 (78.0)	12 (26.7)	179 (89.5)	

[1]Chi-square test, *Significant. TBA: Traditional birth attendant, MOD: Mode of delivery, LSCS: Lower segment cesarean section, NVD: Normal vaginal delivery, SBA: Skilled birth attendant

Table 2: Profile of survived and expired neonates

Parameters	n (%)			p-value[1]
	Number of neonates (n=245)	Expired (n=45)	Survivors (n=200)	
Probable diagnosis at admission[$]				
Asphyxia	81 (33.1)	20 (44.4)	61 (30.5)	0.07
Prematurity	65 (26.5)	11 (24.4)	54 (27.0)	0.72
Sepsis	85 (34.7)	15 (33.3)	70 (35.0)	0.83
MAS	10 (4.1)	1 (2.2)	9 (4.5)	0.48
NNH	38 (15.5)	3 (6.7)	35 (17.5)	0.07
Others	3 (1.2)	0 (0.0)	3 (1.5)	0.40
Mode of transport				
Government ambulance	80 (32.7)	16 (35.6)	64 (32.0)	0.07
Private	82 (33.5)	20 (44.4)	62 (31.0)	
Own vehicle	83 (33.9)	9 (20.0)	74 (37.0)	
Duration of transport (h)				
<1	187 (76.3)	8 (17.8)	179 (89.5)	0.0001*
1-2	29 (11.8)	15 (33.3)	14 (7.0)	
>2	29 (11.8)	22 (48.9)	7 (3.5)	
Age at admission in days				
<1	69 (28.2)	12 (26.7)	57 (28.5)	0.02*
1-2	42 (17.1)	14 (31.1)	28 (14.0)	
3-4	39 (15.9)	8 (17.8)	31 (15.5)	
>4	95 (38.8)	11 (24.4)	84 (42.0)	
Sex				
Male	149 (60.8)	29 (64.4)	120 (60.0)	0.58
Female	96 (39.2)	16 (35.6)	80 (40.0)	
Weight at admission in kg (g)				
<1000	22 (9.0)	16 (35.6)	6 (3.0)	0.0001*
1000-1500	56 (22.9)	14 (31.1)	42 (21.0)	
1500-2500	99 (40.4)	9 (20.0)	90 (45.0)	
>2500	68 (27.8)	6 (13.3)	62 (31.0)	
Hypothermia	52 (21.2)	14 (31.1)	38 (19.0)	0.07
Hypoglycemia	9 (3.7)	2 (4.4)	7 (3.5)	0.76
Delayed CRT	27 (11.1)	10 (22.2)	17 (8.5)	0.008*
Cyanosis peripheral	38 (15.5)	13 (28.9)	25 (12.5)	0.006*
Stabilization before and during transport (IVF, oxygen, temperature)	117 (47.8)	26 (57.8)	91 (45.5)	0.13
SPO_2 (%)				
<90	75 (30.6)	27 (60.0)	48 (24.0)	0.0001*
≥90	170 (69.4)	18 (40.0)	152 (76.0)	

[1]Chi-square test, [$]Multiple response, *Significant. CRT: Capillary refill time, IVF: *In-vitro* fertilization, MAS: Meconium aspiration syndrome, NNH: Neonatal Hyperbilirubinemia

mortality rate was 18.3%. The most common cause of death was birth asphyxia (44.4%), followed by sepsis (35.6%), prematurity (24.4%), MAS (4.4%) and kernicterus (2.4%).

Number of babies delivered at home and conducted by unskilled birth attendant was 46 (18.8%) and at private hospitals was 82 (33.5%). Government ambulance facility for neonatal transport was used only in 80 (32.6%). Neonatal mortality was significantly less when baby referred or admitted early, i.e. <24 h age at the time of admission (p=0.02) and total duration of transport <1 h (OR: 0.01, 95% CI: 0.001-0.05, p=0.001).

Table 3 depicts the association between various factors and mortality by logistic regression analysis. Among the expired neonate, babies delivered by traditional birth attendants (TBAs) were 73.3% (OR: 16.60, 95% CI: 4.57-60.19, p=0.0001), total

Table 3: Factors associated with the mortality: Multivariate logistic regression analysis

Parameters	Adjusted OR of mortality	95% CI	p-value
Duration of transport (h)			
<1	0.01	0.001-0.05	0.001*
1-2	0.42	0.07-2.40	0.32
>2	1.00 (Ref)		
Weight at admission in gram			
<1000	21.64	2.28-205.23	0.007*
1000-1500	6.74	1.16-39.11	0.03*
1500-2500	3.24	0.54-19.35	0.19
>2500	1.00 (Ref)		
Delivery conducted by			
Unskilled birth attendants (Dai)	16.60	4.57-60.19	0.0001*
SBA (doctor/nurse)	1.00 (Ref)		
SPO_2 (%)			
<90	3.69	1.08-12.58	0.03*
≥90	1.00 (Ref)		

OR: Odds ratio, Ref: Reference, *Significant, CI: Confidence interval, SBA: Skilled birth attendant

duration of transport >1 h, weight at the time of admission <1000 g (OR: 21.64, 95% CI: 2.28-205.23, p=0.007), SPO_2 <90% at the time of admission (OR: 3.69, 95% CI: 1.08-12.58, p=0.03), and baby delivered at a private hospital had high mortality rate (35.5%) as compared to a government hospital (15.6%).

In our study, the main predictors of neonatal mortality were birth weight <1.5 kg, gestational age <28 weeks, duration of transport >1 h, delivery by TBAs, oxygen saturation<90%, poor perfusion (CRT), and cyanosis at the time of admission.

DISCUSSIONS

We aimed to find out the predictors of neonatal mortality in rural areas as there is a huge gap between urban and rural NMRs and inequitable distribution of the resources in our country. States with higher institutional births (e.g. Kerala) have lower neonatal mortality than those with lower institutional births (e.g. Uttar Pradesh) [4]. In our study, 46 (18.8%) deliveries took place at home and were conducted by unskilled birth attendants which constitute significant proportion of neonatal death (22 [48.9%]). In our study, birth asphyxia (44.41%) was the most important cause of neonatal mortality followed by sepsis (35.6%) and prematurity (24.4%). This is in contrast to the results of studies conducted by Baqui et al., [5] and Narang et al. [6], where the most important cause of mortality was prematurity (32%). Aggarwal et al. [7] and Sehgal et al. [8] showed sepsis as the main cause of death. This may be because of the fact that babies admitted to our institute were referred mostly from the rural areas where there is lack of trained health-care personnel involved in neonatal resuscitation.

It is perceived by the community that private sector hospital are better health-care providers; therefore, more male babies are admitted to private hospital and more female babies are usually admitted to government hospitals [4]. A study done by Narang et al. showed that 58% of females were admitted to a tertiary care government hospital [6]. However, in our study, lesser female (39.2%) babies were admitted than the male babies (60.8%). This may be because this is the only tertiary care referral hospital in this area providing better care facility.

Mortality is inversely related to gestational age, birth weight, and time taken to reach the hospital [9]. In our study, neonates below 28 weeks of gestation had significantly greater mortality as compared to full term neonates. Further, extremely low birth babies have higher mortality (35.6%) than normal birth weight neonates (13.3%). Both these findings were similar to previous studies done by Narang et al. and Aggarwal et al.

Studies have shown that prior stabilization before and during transport will reduce morbidity and mortality [10]. In our study, government ambulance facility for neonatal transport was used only in 80 (32.6%) cases, and none of the neonates was completely stabilized in terms of *in-vitro* fertilization, oxygenation, and temperature maintenance. The duration of transport is considered as a probable risk factor for adverse neonatal outcome [11-13]. Our study also showed that the prolonged transport (>1 h) increases the mortality significantly (p=0.0001). Incidence of hypothermia among the referred neonates in our study was not comparable to previous study [6-8]. This may be because less time required reaching the hospital facility. However, incidence of hypoglycemia was comparable to the previous study done by Narang et al., and Aggarwal et al.

By multivariate logistic regression analysis, deliveries conducted by unskilled birth attendant (OR: 21.64, 95% CI:

4.57-60.19), birth weight <1 kg (OR: 21.64, 95% CI: 2.28-205.23), and transportation time >1 h (OR: 0.01, 95% CI: 0.001-0.05), poor oxygenation, i.e. SPO_2 <90% (OR: 3.69, 95% CI: 1.08-12.58), delayed CRT (>3 s), and presence of peripheral cyanosis have been found to be significant predictors of mortality. The mortality rate in our study was 18.3 % which is similar to that shown by Aggarwal et al. (20%) but lower than the study results of Narang et al. (36%) and Sehgal et al. (36%).

The above results have significant implications for policies making in reducing neonatal deaths in India. Many of these interventions will remain ineffective in reducing neonatal mortality without well-equipped emergency obstetric and neonatal care in India. Even if such facilities are available, there occur the delay in seeking care, referral, and actually receiving care after arriving at the facility [14,15]. Limitations of our study were small sample size and lack of newborn tracking system after discharge.

CONCLUSIONS

A significant number of baby delivered at home and conducted by unskilled birth attendants constitutes the significant proportion of neonatal death. Important predictors of neonatal mortality among the referred neonate were deliveries conducted by unskilled birth attendant (Dai), birth weight <1 kg, transportation time >1 h. Birth asphyxia is still a major cause of neonatal mortality in rural areas followed by prematurity and sepsis.

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