# Predictors of Mortality among Neonates at a Department of Neonatology of a Tertiary Hospital in Bangladesh

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## Abstract

**Background:** The high neonatal mortality rate is still a major challenge facing Bangladesh. Identifying the predictors of mortality plays an important role in decreasing neonatal mortality. This study aimed to assess the mortality pattern and identify independent predictors of mortality among the neonates admitted to the Special Care Neonatal Unit (SCANU) of a tertiary hospital in Bangladesh.

**Materials and methods:** This cross sectional study was conducted at the SCANU of Chittagong Medical College Hospital, including 6167 neonates admitted from July 2017 to December 2017. Predictors of mortality were determined by multivariate binary logistic regression analysis.

**Results:** The neonatal case fatality rate was 21.4%. Major causes of death included perinatal asphyxia (39.4%), sepsis (26.6%) and respiratory distress syndrome (15.9%). Around 40% of neonates died within 24 hours of hospital admission. In the multivariate analysis, mortality was associated with age ≤1 day (Adjusted Odds Ratio [AOR]: 2.18; 95% CI: 1.70-2.78), referral from other districts of Chattogram division (AOR: 1.68; 95% CI: 1.37-2.06), outborn babies delivered at other hospitals (AOR: 1.60; 95% CI: 1.35-1.89), and at home (AOR: 2.21, 95% CI: 1.75-2.80), vaginal delivery (AOR: 1.35; 95% CI: 1.15-1.59), preterm gestation (AOR: 3.80, 95% CI: 3.13-4.59) and weight at admission below 2500gm (AOR: 1.64; 95% CI: 1.37-1.95).

**Conclusions:** Implementing a better referral link, delivery in a well-equipped hospital and timely intervention could decrease neonatal mortality in Chattogram, Bangladesh.

**Key words:** Neonatal mortality; Predictors; Special care neonatal care.

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## Introduction

The neonatal period poses the greatest mortality risk to the children, with an estimated global average of 17 fatalities per 1,000 live births in 2022.[1] Most neonatal deaths occurred primarily in South Asia and sub-Saharan Africa.[2] According to the Bangladesh Sample Vital Statistics report (2022), the neonatal mortality rate was 20 deaths per 1,000 live births in Bangladesh in 2022.[3] Despite notable advancements in the reduction of neonatal mortality since 1990, increased endeavors are still needed to achieve the Sustainable Development Goal (SDG) target.[2]

Regular neonatal audit is essential as disease trends and contributors to neonatal deaths vary from region to region.[4-8] The struggle towards reducing neonatal mortality is closely linked to identifying the predictors of mortality. Over the past decade, Bangladesh has established Special Care Neonatal Unit (SCANU) in medical facilities countrywide in an effort to improve newborn survival.[9] Limited research has been conducted in Bangladesh regarding the predictors of neonatal mortality in SCANU, an instrument that has proven to be highly effective in reducing infant mortality in the country. A relatively small sample size was used in the studies that have been published till now.

It is imperative to address the predictors of neonatal mortality as their identification not only aids in reducing morbidity and mortality rates among neonates but also facilitates the implementation of suitable interventions for preventing and treating health complications among this population. Therefore, this study aimed to determine neonatal mortality incidence and identify mortality predictors in a cohort of neonates admitted to the SCANU at a tertiary hospital in Chattogram, Bangladesh.

## Materials and methods

This cross sectional study was conducted among all neonates admitted to the SCANU at the Chittagong Medical College Hospital from July 1, 2017, to December 31, 2017. The Ethical Review Committee of Chittagong Medical College granted ethical approval for the study.

The number of neonatal admissions in this period was 6167. Among them, 4539 neonates were included in this study. Rest 1628 neonates were excluded from the study because 1588 neonates were discharged against the medical advice before completing treatment and another 40 neonateswere referred to another department or higher centre.

The researchers extracted data directly from patient's admission ticket at the time of outcome by a structured case record form. Data regarding gestational age, weight at admission, place of birth, delivery mode, residence and admission diagnosis, length of hospital stay and day and time of death or discharge were noted.

SPSS version 23.0 was used for data entry and analysis. The outcome of the neonates was classified into two categories: death and discharge with medical advice served as dependent measure or outcome variable. Initially, demographic variables such as age and weight at admission, gender, residence, mode and place of delivery were assessedby simple descriptive analysis (Frequency and percentage).Statistical analysis was then conducted to determine whether the type of outcome was associated with additional relevant variables. Using a chi-square, associations between categorical variables were assessed. Univariate and multivariate binary logistic regression analyses were done to determine the predictors of mortality. Crude Odds Ratio (COR) Adjusted Odds Ratio (AOR) and Confidence Interval (CI) were reported. p value <0.05 was considered as statistical significance.

## Results

The total number of neonatal deaths during the six-month study period was 1322 out of 6167 neonates, resulting in a case fatality rate of 21.4%. The bed occupancy rate during the study period was 141.2%. Among deceased neonates, 77.5% were admitted before 24 hours of age. SCANU is the tertiary care and referral center for the neonates of greater Chittagong. Majority of neonates (50.3%) were referred from Chattogram division but outside city corporation area. Only 23.9% of neonates were referred from urban area. More than half of the neonates (64.2%) were male. The ratio of male to female was 1.8:1. The percentage of outborn neonates was 69.3%. Mortality was high among neonates (65.4%) who had less than 2500 g weight at admission. Maximum deceased neonates were delivered by vaginal delivery (68.3%). Mortality is inversely proportionate to gestational age. Among term neonates, mortality was 15.13% but increased in late preterm (27.6%) and early preterm (55.24%) group. Table I shows that neonates' age at admission, residence, place of delivery, mode of delivery, gestational age at delivery and birth weight were significantly associated with mortality.

**Table I** Maternal and neonatal factors

| Variables | Total (n=4539) | Outcome | | p value |
|---|---|---|---|---|
| | | Dead n=1322 | Survived n=3217 | |
| Age at admission | n (%) | n (%) | n (%) | |
| ≤1 day | 3087 (68.0) | 1025 (33.2) | 2062 (66.8) | <0.001* |
| 2-7 days | 895 (19.7) | 191 (21.3) | 704 (78.7) | |
| 8-28 days | 557 (12.3) | 106 (19.0) | 451 (81.0) | |
| **Residence** | | | | |
| Chittagong urban | 1221 (26.9) | 316 (25.9) | 905 (74.1) | <0.001* |
| Chittagong non urban | 2413 (53.2) | 665 (27.6) | 1748 (72.4) | |
| Others | 905 (19.9) | 341 (37.7) | 564 (62.3) | |
| **Gender of neonates** | | | | |
| Female | 1640 (36.1) | 473 (28.8) | 1167 (71.2) | 0.752* |
| Male | 2899 (63.9) | 849 (29.3) | 2050 (70.7) | |
| **Place of delivery** | | | | |
| Inborn | 1606 (35.4) | 406 (25.3) | 1200 (74.7) | <0.001* |
| Other hospital | 2139 (47.1) | 642 (30.2) | 1497 (70.0) | |
| Home | 794 (17.5) | 274 (34.5) | 520 (65.5) | |
| **Mode of delivery** | | | | |
| LSCS | 1830 (40.3) | 419 (22.9) | 1411 (77.1) | <0.001* |
| Vaginal | 2709 (59.7) | 903 (33.3) | 1806 (66.7) | |
| **Gestational age** | | | | |
| Term | 3451 (76.0) | 704 (20.4) | 2747 (79.6) | <0.001* |
| Preterm | 1088 (24.0) | 618 (56.8) | 470 (43.2) | |
| **Weight at admission** | | | | |
| <2500 gm | 2053 (45.2) | 865 (42.1) | 1188 (57.9) | <0.001* |
| ≥ 2500 gm | 2486 (54.8) | 457 (18.4) | 2029 (81.6) | |

LSCS: Lower Segment Cesarean Section, Chii-square test. Chittagong Urban: Chittagong city corporation area. Chittagong Nonurban: Chittagong district outside city corporation area, including 14 Upazila. Others: Other Districts of

Chittagong division including North-western Districts, Hill tracts, Cox's bazar and Islands.

Majority of the newborn (39.4%) died due to Perinatal Asphyxia (PNA) followed by neonatal sepsis (26.6%). Respiratory Distress Syndrome (RDS) (15.9%) is the third most common cause of death. Prematurity and low birth weight was enlisted as variable of gestational age and birth weight and was not defined as separate diagnosis. Percentage of congenital anomaly was 6.9% among died neonates. (Fig 1).

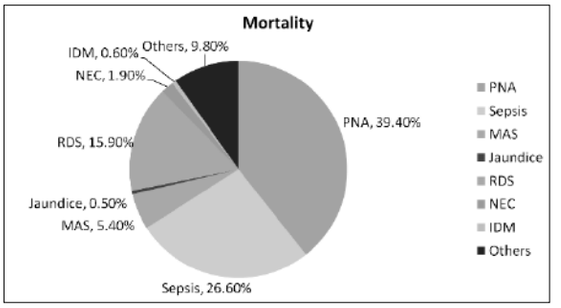


**Figure 1** Major causes of mortality

PNA: Perinatal Asphyxia, IDM: Infant of Diabetic Mother, MAS: Meconium Aspiration Syndrome, NEC: Necrotizing Enterocolitis,
RDS: Respiratory Distress Syndrome.

The majority of neonates (n=1166, 88,2%) died within seven days of hospital admission. About 529 neonates (40%) died within 24 hours of hospital admission.Most of the neonates died at night (41.1%). The percentage of mortality among total admissions was less (26.95%) in weekdays and more (44.77%) in weekly holidays and festive time (Table III).

**Table III** Duration of hospital stay, day of outcome and time of outcome of the neonates

| Variables | Total (n=1322) | | Dead (n=3217) | | Survived | | p value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| **Hospital stay** | | | | | | | |
| 1 day | 1184 | 26.1 | 529 | 40.01 | 655 | 20.36 | <0.001* |
| 2-7days | 2465 | 54.3 | 637 | 48.19 | 1828 | 56.82 | |
| ≥8 days | 890 | 19.6 | 156 | 11.80 | 734 | 22.82 | |
| **Day of outcome** | | | | | | | |
| Working day | 3985 | 87.8 | 1074 | 81.24 | 2911 | 90.50 | <0.001* |
| Holiday | 554 | 12.2 | 248 | 18.76 | 306 | 9.50 | |
| **Time of outcome** | | | | | | | |
| Morning | 3594 | 79.2 | 385 | 29.12 | 3209 | 99.75 | <0.001* |
| Evening | 402 | 8.9 | 394 | 29.80 | 8 | 0.25 | |
| Night | 543 | 12.0 | 543 | 41.08 | 0 | 0.00 | |

Chai-square test.

Table IV revealed the findings of logistic regression analysis to explore the influence of independent variables on the probability of death.In the multivariate analysis, mortality was associated with age ≤1 day (Adjusted Odds Ratio [AOR]: 2.18; 95% CI: 1.70-2.78) referral from other districts of Chattogram division (AOR: 1.68, 95% CI: 1.37-2.06) outborn babies from other hospitals (AOR: 1.60, 95% CI: 1.35-1.89) and delivered at home (AOR: 2.21, 95% CI: 1.75-2.80). Additionally, vaginal delivery (AOR: 1.35; 95% CI: 1.15-1.59) preterm gestation (AOR: 3.80, 95% CI: 3.13-4.59) and weight at admission below 2500gm (AOR: 1.64, 95% CI: 1.37-1.95) were associated with increased odds of death. Neonates diagnosed with PNA (AOR:1.79, 95% CL: 1.36-2.36) sepsis (AOR: 1.82, 95% CI: 1.36-2.43) Meconium Aspiration Syndrome (MAS) (AOR: 3.36, 95% CI: 2.25-5.01) RDS(AOR: 7.11, 95% CI: 4.75-10.65) and Necrotizing Enterocolitis (NEC) (AOR: 14.92, 95% CI: 5.13-39.85) were identified as significant predictors of death. The risk of mortality was notably higher when neonates presented with birth defects: A single defect (AOR: 2.75, 95% CI: 1.88-4.04) and multiple defects (AOR: 17.28, 95% CI: 6.80-43.92).

**Table IV** Univariate and multivariate logistic regression analysis of factors associated with neonatal mortality

| Variables | COR (95% CI for COR) | p value | AOR (95% CI for AOR) | p value |
|---|---|---|---|---|
| **Age at admission** | | | | |
| ≤1 day | 2.15 (1.69-2.65) | <0.001 | 2.18 (1.70-2.78) | <0.001 |
| 2-7 days | 1.15 (0.89-1.51) | 0.289 | 1.12 (0.84-1.48) | 0.443 |
| 8-28 days | Reference | | Reference | |
| **Residence** | | | | |
| CTG urban | Reference | | Reference | |
| CTG non urban | 1.09 (0.93-1.27) | 0.282 | 1.07 (0.94-1.27) | 0.424 |
| Others | 1.73 (1.44-2.09) | <0.001 | 1.68 (1.37-2.06) | <0.001 |
| **Place of delivery** | | | | |
| Inborn | Reference | | Reference | |
| Other hospital | 1.27 (1.10-1.47) | 0.001 | 1.60 (1.35-1.89) | <0.001 |
| Home | 1.56 (1.30-1.87) | <0.001 | 2.21 (1.75-2.80) | <0.001 |
| **Mode of delivery** | | | | |
| LSCS | Reference | | Reference | |
| Vaginal | 1.68 (1.47-1.93) | <0.00 | 1.35 (1.15-1.59) | <0.001 |
| **Gestational age** | | | | |
| Term | Reference | | Reference | |
| Preterm | 5.13 (4.34-5.94) | <0.00 | 3.80 (3.13-4.59) | <0.001 |

| Variables | COR (95% CI for COR) | p value | AOR (95% CI for AOR) | p value |
|---|---|---|---|---|
| **Weight at admission** | | | | |
| <2500 gm | 3.23 (2.83-3.70) | <0.00 | 1.64 (1.37-1.95) | <0.001 |
| ≥2500 gm | Reference | | Reference | |
| **Diagnosis** | | | | |
| PNA | 0.79 (0.63-0.99) | 0.05 | 1.79 (1.36-2.36) | <0.001 |
| Sepsis | 0.86 (0.68-1.10) | 0.23 | 1.82 (1.36-2.43) | <0.001 |
| MAS | 1.19 (0.83-1.69) | 0.34 | 3.36 (2.25-5.01) | <0.001 |
| RDS | 9.94 (6.81-14.51) | <0.001 | 7.11 (4.75-10.65) | <0.001 |
| NEC | 11.12 (4.17-29.7) | <0.001 | 14.92 (5.13-39.85) | <0.001 |
| Others | Reference | | Reference | |
| **Birth Defect** | | | | |
| None | Reference | | Reference | |
| Single Defect | 2.06 (1.48-2.85) | <0.001 | 2.75(1.88-4.04) | <0.001 |
| Multiple Defect | 8.71 (3.75-20.28) | <0.001 | 17.28 (6.80-43.92) | <0.001 |

COR: Crude Odds Ratio, CI: Confidence Interval, AOR:Adjusted Odds Ratio, CTG: Chattogram, LSCS: Lower Segment Cesarean Section, PNA: Perinatal Asphyxia, MAS: Meconium Aspiration Syndrome, RDS: Respiratory Distress Syndrome, NEC: Necrotizing Enterocolitis.

## Discussion

Neonatal mortality is an issue of significant importance in developing as well as developed countries. Globally, infant deaths have been declining consistently, whereas neonatal mortality rate changes have been considerably slower.[10] Mortality among all admitted neonates was 21.4% (1322/6167) as per the present study. Study on neonates admitted to the SCABU of Dhaka Shishu (Children) Hospital (10.9%) and the Neonatal Intensive Care Unit (NICU) of Bangabandhu Sheikh Mujib Medical University (14.9%) revealed a significantly lower mortality rate.[11,13] A significant mortality rate was found in the study of Kumar et al. (39%) conducted at SCANU of Faridpur Medical College Hospital.[14] The variation in the fatality rate among studies might be due to difference of NICU practices, severity of cases admitted and referral process, infant characteristics and socioeconomic conditions.

Admission of male neonates was higher (63.9%) consistent with findings from other studies in Bangladesh and other low-income nations.[5-8,10-14] This may suggest that the male neonates have a greater susceptibility to illness or it may be the result of cultural and social influences that result in parents devoting more attention to male infants compared to females. Though, there were no significant differences in mortality based on gender. The proportion of preterm deaths was 46.7% and weight <2500 gm at admission was 65.4% in the present series, which are comparable with studies from India and South Africa.[5-7]

The leading cause of death in this study was PNA (39.4%) followed by sepsis (26.6%). Other studies reveal similar admission patterns as well as some variations.[5-8,10-14] In developing nations, the incidence of PNA is tenfold greater as a result of insufficient access to maternal and neonatal health care.[15] Neonatal sepsis is an important cause of death in SCANU due to combination of factors including immature immune responses, environmental and maternal risk factors and challenges in diagnosis and treatment, particularly in preterm and low birth weight infants.[16] Significant predictors of mortality were identified in neonates who were diagnosed with the following conditions: PNA (AOR:1.79, 95% CL: 1.36-2.36) sepsis (AOR: 1.82, 95% CL: 1.36-2.36) MAS (AOR: 3.36, 95% CI: 2.25-5.01) RDS (AOR: 7.11, 95% CI: 4.75-10.65) NEC (AOR: 14.92, 95% CI: 5.13-39.85). As preterm neonates presented with various complications including sepsis, RDS and asphyxia, we accounted for it as a variable of gestational age due to the chance of duplication of data. Most of the preterm neonates in present study died due to respiratory complications (33.7%) sepsis (30.1%) and birth asphyxia (14.6%) which supports previous study.[17]

In this study, admission to the SCANU within the first day of life was identified as an independent predictor of mortality, with a 2.18-fold increased likelihood compared to admission after seven days of age. Present study results agreed with the study of Worku et al. where the neonates with age one day or less were 2.53 (AOR: 2.53, 95% CI:1.66, 3.85) more likely to die than the neonates age more than 3 days.[5] It is an established fact that mortality rate of neonates is overwhelmingly high within first 24 hours.[18]

Another two independent predictors of mortality were outborn babies (Born in other hospitals and home-delivered babies) and babies came from outside Chattogram area. The higher results for outborn neonatal mortality than inborn in the present study were consistent with most previous research.[19,20] There are many possible reasons for the increased mortality rate of outborn neonates, including inadequate stabilization techniques used before or during transport as well as delays in the use of assisted ventilation and exogenous surfactant.[21] The promotion of in-utero patient transfer through enhanced maternal transport has the potential to further improve neonatal outcomes.

Cesarean sections are frequently performed in order to avert potentially hazardous conditions that could harm both the mother and the infant. Significant public interest was sparked by the rising incidence of cesarean section in Bangladesh.[22] However, the present study demonstrated that infants having vaginal delivery were 1.35 times more likely to die than the cesarean-delivery baby. Although vaginal delivery offers numerous advantages over cesarean section, cesarean section can significantly reduce maternal and neonatal mortality and morbidity, particularly in emergency situations.[23]

Prematurity and low weight at admission (<2500 g) remained the most significant predictors of neonatal mortality, according to this study, despite reports of improved survival of preterm and LBW infants primarily as a result of interventions implemented at the labor and delivery site and enhanced admission and treatment in intensive care units.[24]This finding is in agreement with the study in Ethiopia by Worku et al.,in Saudi Arabia by Arafa et al. and at Idia by Saini et al.[5,7,25]

Birth defects were also found to be a strong predictor of neonatal death especially when multiple birth defects [AOR:17.28 95% CL: (6.80-43.92)] were present. Congenital anomaly-related death rate was 6.78 per 1000 live births in 20 years study in India.[26] A previous study on preterm neonates found that birth defects remained strongly associated with neonatal morbidity (AOR: 6.44, 95% CI 3.94-10.51) and perinatal mortality (OR: 3.08, 95% CI 2.04-4.65).[27]

**Limitations**

This study possesses various limitations. The socioeconomic status of the patients, as well as their referral and pretreatment status, were not documented, which is crucial for conducting a comprehensive death review. Furthermore, being a hospital-based study, the results obtained may differ from those of a community-based study.

**Conclusions**

Neonatal mortality rate in this study is not less; preterm birth and home delivery were identified as the most significant predictors of neonatal mortality. It emphasized the need for increased access to antenatal care that can effectively identify and manage risk groups. It is necessary to conduct additional prospective studies to identify additional maternal, neonatal, and care-related predictors of neonatal mortality.

**Recommendation**

Multicenter study should be carried for actual scenaria of whole community.

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**Contribution of the authors**

SHH-Conception, acquisition of data, data analysis, manuscript drafting & final approval.

MJBAC-Conception, acquisition of data, critical revision & final approval.

JCC-Acquisition of data, critical revision & final approval.

KN-Acquisition of data, data analysis, drafting & final approval.

JF-Acquisition of data, data analysis, drafting & final approval.

TH-Data analysis, manuscript drafting & final approval.

FA-Data analysis, interpretation of data, critical revision & final approval.

TZ-Data analysis, interpretation of data, critical revision & final approval.

**Disclosure**

All the authors declared no competing interest.

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