What impact do essential newborn care practices have on neonatal mortality in low and lower-middle income countries? Evidence from Bangladesh

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Abstract

Objective

To assess the impact of Essential Newborn Care (ENC) practices on the mortality of neonates delivered at home in Bangladesh.

Methods

This study used cross-sectional data from the 2011 Bangladesh Demographic and Health Survey. Adjusted logistic regression model was used to examine the effect of ENC practices on neonatal mortality based on 3 190 live-born infants.

Findings

Delayed bathing (72 hours after delivery) significantly contributed to reducing neonatal mortality. A significant but counter intuitive relation was observed between the dry cord care and neonatal deaths.

Conclusion

Neonatal mortality may be reduced through emphasising delayed bathing. Specific guidelines on the cleanliness of the fabric used to dry and wrap newborns as well as emphasising the use of clean delivery kits and initiation of immediate and exclusive breastfeeding may improve neonatal outcomes. Further, the ENC guidelines in Bangladesh should include the application of topical antiseptics to the cord stump.

Introduction

Neonatal deaths and essential newborn care

Globally, approximately 3.1 million children die each year in their neonatal period (first 28 days of life) (1). Half of these neonatal deaths occur within the first 24 hours of delivery, while 75 percent occur in the early neonatal period (0-6 days after delivery) due to preterm births, severe infections and birth asphyxia (1). Essential Newborn Care (ENC) practices can contribute to decreasing the incidence of neonatal morbidity and mortality (2). Such ENC practices, as recommended by the World Health Organization (WHO), include drying (wiping) and wrapping the newborn immediately after birth, initiating skin-to-skin (STS) contact, dry cord care (not applying any potentially harmful substance to the umbilical cord), immediate initiation of breastfeeding and delayed bathing (for at least 6 hours) (3).

ENC practice in low and lower-middle income countries

A low coverage of ENC practices has been reported particularly for home deliveries with an unskilled birth attendant in low and lower-middle income countries (LLMIC) (4-6). Based on home delivery data from Nepal, a study found that approximately 58 percent of newborns were immediately dried, 60 percent were immediately wrapped and 25 percent were bathed after the first 24 hours of birth while 64 percent were breastfed within one hour of birth (5). A low uptake of ENC practices along with other socio-demographic factors has also been observed as a major cause of neonatal mortality in sub-Saharan Africa. For example, a study in rural southern Tanzania reported that approximately 41 percent of home-born babies were dried and 28 percent were wrapped within five minutes of birth while only 19 percent were bathed after six hours of birth (6).

Rationale of this study

Examining the impact of specific ENC practices on neonatal mortality may provide key information for planning and implementing interventions that aim to improve newborn health outcomes in LLMIC. However, no studies have analysed the extent to which each of the individual interventions of ENC can reduce neonatal mortality. A review of literature also identified the limited availability of quality studies on the impact of ENC practices on maternal and newborn health outcomes in LLMIC (7). Against this background, this paper investigates the effect of ENC practices on neonatal mortality.

The focus of this study is on Bangladesh which, like other LLMIC, exhibits a high neonatal mortality rate (32 per 1000 live births). Approximately 71 percent of births in the country are delivered at home with more than half of the births assisted by traditional birth attendants who do not have any formal training (8). Only two percent of these newborns have been found to receive all elements of ENC (8). An incomplete or poor delivery of ENC interventions can contribute to high neonatal mortality in the country. Thus, this analysis may be useful in further embedding ENC in health workers' practice and mobilising community support. Such an analysis may also help to improve the design and implementation of ENC in Bangladesh that may transferrable to other LLMIC. Therefore, this study aims to analyse the impact of ENC practices on the mortality of home delivered neonates in Bangladesh.

Materials and methods

Data source

Data was obtained from the 2011 Bangladesh Demographic and Health Survey (BDHS); a periodic cross-sectional survey (8). Participants were recruited via a two-stage stratified

sample design with the aim of collecting nationally representative demographic and health information. The BDHS was administered to a total of 17 141 households. In total, 17 842 ever-married women in these households aging from 12-49 years were interviewed. Male respondents were interviewed only from one-third of the households which included 3 997 male observations. The survey collected data using separate questionnaires for the household, for women and for men. All information obtained in the survey was self-reported and collected by face-to-face interviews. Informed verbal consent was taken from all surveys participants. Details of the design and data collection procedures were described in NIPORT et al. (8).

Study participants

Analyses were restricted to data on live-born infants who were delivered at home. Only the most recent birth by a mother within the preceding three years of the survey was considered because detailed information on ENC practices was available only for these births. A total of 3 190 live-born infants were included in the sample of which 60 (2%) cases experienced neonatal death.

Outcome variable

The primary outcome of interest in this analysis was neonatal mortality, defined as deaths occurring within the first 28 days of life (1). Neonatal mortality was identified from the complete birth history of mothers, which collected information on newborn's gender, date of birth, survival status and age at death (if dead).

Exposure variables

ENC practices were the primary exposures in our study. As a benchmark, we used the National Neonatal Health Strategy and Guidelines (NNHSG) for Bangladesh, which provided

advice on the following six practices: 1) the use of instruments disinfected using boiling water to cut the umbilical cord; 2) cord care, that did not involve the application of any substances to the umbilical cord stump after being cut; 3) drying of the newborn within 5 minutes of birth; 4) wrapping of the newborn within 5 minutes of birth; 5) bathing of the newborn at least 72 hours after birth; and 6) the initiation of breastfeeding within 1 hour of delivery (9). The information on the use of disinfected instruments and the umbilical cord care were collected in binary form (yes, no). The data on the timing of drying after delivery was categorized as a binary variable (<5 minutes, ≥5 minutes/not dried) in our models. Similarly, information on the timing of wrapping after delivery was categorized as a binary variable (<5 minutes, ≥5 minutes/not wrapped). The ENC practices of delayed bathing and immediate initiation of breastfed were also categorized as binary variables (yes, no).

Potential confounding variables

In identifying other factors that might potentially be associated with neonatal deaths, 12 factors were considered in this analysis. These included: administrative divisions; urban/rural status of the interviewees usual place of residence; seasonal variation; socio-economic status (SES) of the participants; mother's education; mother's age at birth; number of antenatal care visit; gender of the child; whether the selected child was first birth; size at birth perceived by mother; assistance received during delivery and the timing; and the provider of a newborn's first postnatal check-up. The SES of participants was represented by a wealth index provided in the data which was constructed using the household asset data and the principal components analysis method (8, 10). The seasonal variation was generated from child's month of birth and, following previous literature, categorized as Winter (December-February), Summer (March-May), Rainy (June-August) and Autumn (September-November) (11). Birth weights were usually unknown for babies born at home in LLMIC. Therefore,

following earlier studies, we considered a baby's size at birth perceived by mother as a proxy for birth weight (8, 11, 12).

Statistical analysis

The differences in the exposure and other variables associated with the survival status of the newborns were examined using chi-square and t-tests. Then, an adjusted logistic regression model was used to examine the effect of the exposures after controlling for the confounding variables (listed above).

Code availability

All statistical analyses were performed using STATA version 11.2. The STATA survey commands were used to adjust for the sampling weights and design. All codes, employed for this analysis, are available from author upon request.

Results

Descriptive statistics indicated statistically significant differences for dry cord care and delayed bathing between alive and deceased neonates (Table 1). Specifically, neonatal mortality was higher if nothing was applied to the umbilical cord ($p<0.001$) and bathing was not delayed ($p=0.004$).

<Insert Table 1 here>

With the exception of two administrative divisions, mother's demographic characteristics were similarly distributed across the survival status (Table 2). Higher neonatal mortality was observed in Barisal and Sylhet divisions ($p=0.006$).

<Insert Table 2 here>

Table 3 provided details of the association between child's demographic characteristics and neonatal deaths. Only the timing of first postnatal check-ups for newborn showed a statistically significant difference between the alive and the deceased children. Specifically, neonatal mortality was more likely for the newborn who had postnatal check-ups within two days of delivery (p=0.002).

<Insert Table 3 here>

The logistic regression model showing the association between ENC practices and neonatal death was presented in Table 4. Neonatal mortality was significantly lower for ENC practices related to the deferment of bathing for 72 hours after delivery. Specifically, the odds of neonatal deaths decreased by 86% for the children who had delayed bathing compared to the children either bathed before 72 hours of delivery or not bathed (OR=0.14; 95% CI: 0.03, 0.68; p=0.015).

<Insert Table 4 here>

With regard to the avoidance of applying any substances to the umbilical cord, the odds of neonatal mortality for those who applied nothing to the umbilical cord were nearly four times more likely compared with those who applied substances to the cord (OR=3.81; 95% CI: 1.75, 8.29; p= 0.001). Note that a detailed investigation revealed a reduction in neonatal mortality for those who applied antiseptic in the umbilical cord though the relation was statistically insignificant (data not shown).

Discussion

Our study, which is the first to report the impact of different components of ENC practice on neonatal mortality, revealed a number of interesting and important findings. Specifically, the practice of deferment of bathing (for 72 hours after delivery) significantly contributed to reducing neonatal mortality, but a counter intuitive relation was observed between the avoidance of applying any substances to the umbilical cord and neonatal mortality. The remaining ENC practices did not show any statistically significant association with neonate deaths.

Impact of deferment of bathing

Delayed bathing is an essential component of thermal care practice that plays a crucial role in reducing neonatal hypothermia (body temperature below 36.5 degree Celsius) (3, 13). A review of recent research found that a significant proportion of neonates born at home in LLMIC experienced hypothermia which contributed as a comorbidity to major causes of neonatal deaths such as infection, asphyxia and preterm birth (14). Therefore, delayed bathing, by reducing the incidence of hypothermia, might significantly contribute in reducing neonatal mortality. The findings of our study on neonatal mortality in Bangladesh provided support to this hypothesis.

Impact of dry cord care

Sepsis or inflammation is a major cause of neonatal deaths in LLMIC. Immediately after cutting the umbilical cord, traditional practices in some countries may dictate the application of substances such as ash, oil, mud, butter and spice pastes that can be harmful causing omphalitis or infection of the cord stump and lead to newborn sepsis and therefore death (15, 16). However, our findings indicated that avoiding the application of any substances to the

umbilical cord significantly increased neonatal mortality. Interestingly, this was consistent with the findings of another study in South Asia where dry cord care was significantly associated with increased odds of death (2).

On the other hand, applying chlorhexidine as an antiseptic to the umbilical cord stump in community and primary care settings in LLMIC had been found to prevent sepsis and reduce neonatal mortality (17). Thus, along with the recommendation of clean and dry cord care, WHO additionally recommends the application of topical antiseptics to the cord stump where the risk of infection is high (18). Until recently, sepsis was a major cause of neonatal deaths in Bangladesh (8). Therefore, the application of antiseptic to the umbilical cord in the context of home births might be effective in reducing neonatal deaths compared to the application of no antiseptic.

Impact of immediate wrapping

As with delayed bathing, the ENC practice of immediate drying and wrapping the neonate is an important intervention to prevent hypothermia and thus reduce neonatal mortality (5, 13). However, we observed an insignificant impact of immediate wrapping on neonatal deaths in Bangladesh. An important point here was that while WHO emphasizes on the use of a soft dry clean cloth to wrap a newborn after birth, a number of studies reported that a significant proportion of newborns delivered at home were either not properly covered or wrapped with dirty fabric (19, 20). Such practices, either by a failure to prevent rapid heat loss, or by increasing the risk of sepsis through contact with unhygienic cloth, might increase the likelihood of neonatal mortality. This could account for the insignificant result of immediate wrapping on neonatal deaths in our study.

Impact of immediate drying

We also observed an insignificant and counter intuitive relationship between neonatal mortality and the practice of the immediate drying of newborns. Studies on newborn skin-wiping indicated that wiping the newborn with chlorhexidine solution, thereby reducing the risk of early neonatal sepsis, reduced neonatal mortality for low birth weight babies (21). An unhygienic method of drying of newborns, in contrast, could be responsible for sepsis and thus neonatal mortality. The discussion in the review by Darmstadt et al. (19), concerning the practice of wrapping neonates with dirty fabric in Bangladesh, could also indicate the possibility of improper drying of newborns in our study. Such an unhygienic practice might explain the increased mortality of children who were dried immediately compared to those who were not.

Impact of boiled instrument

Unlike our study, where we observed a statistically insignificant relationship between the use of boiled instruments to cut the cord and neonatal mortality, other research had noted a reduction in the risk of sepsis and neonatal deaths associated with use of a clean delivery kits that included a boiled blade to cut the cord (2). In contrast Blencowe et al. (22), reviewing four studies on Pakistan, Tanzania and Senegal, did not find any impact of the use of clean birth kits (including boiled/sterile/new blades) on neonatal sepsis or tetanus, and thus on neonatal deaths. However, the review could not provide any reasonable explanation for such findings.

A review of the NNHSG for Bangladesh reveals that the recommendation for clean cord-cutting (new/sterile blade or surgical blade) also includes the use of sterile thread for tying the cord (9). However, the use of sterilized thread to tie the cord was less common in Bangladesh and other South Asian countries where dirty thread (cotton thread from used

quilts or jute fibre) was often used to tie the cord (19, 20, 23, 24). On the other hand, different components of the delivery kit (i.e. the use of a boiled blade to cut the cord, use of boiled thread to tie the cord and using a clean plastic sheet as the delivery surface) were all shown to be associated with significant relative reductions in mortality in South Asia (2). Unfortunately, such information was limited in our data, which being unaccounted for in our analysis could be responsible for a statistically insignificant effect of boiled instrument on neonatal mortality in our model.

Impact of breastfeed within the first hour of birth

Earlier studies found that the risk of neonatal mortality increased with the delay in initiation of breastfeeding, indicating a dose-response relationship (25). Studies in Bangladesh and other developing countries, on the other hand, observed a common practice of premature breast milk supplementation like honey and sweet water which might expose newborns to pathogens (19, 23, 26). Newborns in our study, who started breastfeeding within first hour of birth, might have also consumed other supplements which could be responsible for the statistically insignificant result of the effect of breastfeeding (in the first hour) on neonatal mortality.

Some points are worth mentioning for a better understanding of our results. First, ENC practice is a multi-factorial issue with one component influencing the other. Therefore, a comparison of the cases who reported providing all six ENC practices against those who did not use any one of them could be insightful. However, due to the size of the sample, such analysis was not possible in our case. Second, our analysis showed a higher neonatal mortality for those who had early postnatal check-ups. Such fact could be due to the higher likeliness of morbidity or disease. An earlier study on utilisation of postnatal care among rural women in Nepal also observed a similar outcome (27). Third, our analysis did not find

any effect of the size of birth on mortality. This is counterintuitive, given that the size of birth being associated with birth weight would also be associated with mortality, as confirmed in earlier studies (12). A review of previous studies indicated that this association may depends on cases related to the intrauterine growth restriction, the late preterm (born between 34-36 weeks of gestation), the moderate preterm (born between 32-33 weeks of gestation) and the extremely preterm (born between 28-31 weeks of gestation) (28, 29). Unfortunately, unavailability of this information in our data did not allow us to investigate these factors.

Limitation

This study had several potential limitations. The data relies on self-reporting by the participants. Self-reported information can be biased in a certain direction, while recall bias questions the accuracy of information, particularly about the timing of drying and wrapping. The relatively small sample size, specifically the number of neonatal deaths, may have resulted in low statistical power. Nevertheless, like previous studies (5, 30, 31), such limitations are outstripped by the insights gained through analysing data obtained from such a large, nationally representative sample of newborns.

Conclusion

We investigated the effect of ENC practices on reducing the mortality of neonates delivered at home in Bangladesh. Our analysis offers some important insights for the improvement of ENC policy and health worker practice. Firstly, neonatal mortality may be reduced through emphasising delayed bathing. Secondly, the ENC guidelines in Bangladesh should include the use of topical antiseptics such as chlorhexidine to the cord stump. Such a recommendation may also apply to LLMIC where the incidence of sepsis is high. Thirdly, the insignificant findings in our study associated with immediate drying and wrapping of

newborns may be related to the reportedly common practice of using unclean cloth in Bangladesh. The NNHSG for Bangladesh do not include any instruction relating to the cleanliness of the cloth needed to dry and wrap newborns. Specific guidelines on these practices, as well as community-based interventions are required to improve hygiene at baby's birth. Finally, more emphasis is required on the use of clean delivery kits and initiation of immediate and exclusive breastfeeding. However, we recommend such surveys to collect information on the different components of the delivery kit used at birth and premature breast milk supplementation, as such data may provide more precise insight into the impact of a boiled instrument (to cut the umbilical cord) and immediate initiation of breastfeeding on neonatal death.

Conflict of interest: None declared.

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Table 1: Association between ENC practices and child survival, for most recent home deliveries in the three years preceding the survey

Variables	Survival status within 28 days of birth			
	Alive (n=3130)	Dead (n=60)	Total (n=3190)	p-value*
Instrument boiled before the umbilical cord was cut (%)				
No	343 (12.4)	9 (18.2)	352 (12.5)	0.278
Yes	2657 (87.6)	42 (81.8)	2699 (87.5)	
Nothing applied to umbilical cord (%)				
No	1356 (43.4)	11 (17.2)	1367 (43.0)	<0.001
Yes (Nothing applied)	1653 (56.6)	43 (82.8)	1696 (57.0)	
Dried <5 minutes of birth (%)				
No	1498 (48.0)	25 (38.3)	1523 (47.8)	0.193
Yes	1589 (52.0)	33 (61.7)	1622 (52.2)	
Wrapped <5 minutes of birth (%)				
No	2104 (66.8)	36 (58.7)	2140 (66.7)	0.272
Yes	984 (33.2)	22 (41.3)	1006 (33.3)	
Delayed bathing (bathed 72+ hours after delivery) (%)				
No	2151 (71.1)	57 (93.6)	2208 (71.4)	0.004
Yes	958 (28.9)	3 (6.4)	961 (28.6)	
Initiation of breastfeeding (within 1 hour after birth) (%)				
No	1508 (50.0)	38 (57.6)	1546 (50.1)	0.324
Yes	1614 (50.0)	22 (42.4)	1636 (49.9)	

Note: Weighted analysis.
* Pearson's chi-squared test for categorical variables.

Table 2: Association between mother's demographic characteristics and child survival, for most recent home deliveries in the three years preceding survey

Variables	Survival status within 28 days of birth			
	Alive (n=3130)	Dead (n=60)	Total (n=3190)	p-value*
Rural/Urban (%)				
Rural	2392 (83.6)	48 (89.5)	2440 (83.7)	0.147
Urban	738 (16.4)	12 (10.5)	750 (16.3)	
Division (%)				
Dhaka	508 (30.1)	7 (27.2)	515 (30.0)	
Barisal	368 (6.0)	15 (17.3)	383 (6.2)	
Chittagong	674 (24.7)	7 (13.2)	681 (24.5)	0.006
Khulna	284 (7.3)	2 (3.8)	286 (7.3)	
Rajshahi	380 (13.1)	5 (10.5)	385 (13.1)	
Rangpur	400 (10.8)	7 (11.4)	407 (10.8)	
Sylhet	516 (8.0)	17 (16.6)	533 (8.1)	
Seasonal Variation				
Winter (December-February)	796 (25.3)	16 (25.9)	812 (25.3)	
Summer (March-May)	690 (22.2)	11 (22.9)	701 (22.2)	0.965
Rainy (June-August)	744 (23.6)	15 (20.5)	759 (23.6)	
Autumn (September-November)	900 (28.9)	18 (30.8)	918 (28.9)	
SES(Wealth Index) (%)				
Poorest	873 (29.0)	12 (26.4)	885 (29.0)	
Poorer	708 (23.2)	17 (25.3)	725 (23.2)	
Middle	642 (20.9)	14 (22.3)	656 (21.0)	0.864
Richer	556 (16.6)	13 (19.9)	569 (16.6)	
Richest	351 (10.3)	4 (6.1)	355 (10.2)	
Mother's Education (%)				
No education	669 (21.9)	12 (24.0)	681 (22.0)	
Primary incomplete	652 (21.7)	15 (21.3)	667 (21.7)	
Primary complete	429 (13.1)	8 (8.0)	437 (13.0)	0.808
Secondary incomplete	1169 (37.2)	21 (38.4)	1190 (37.2)	
Secondary/higher	211 (6.0)	4 (8.4)	215 (6.0)	
Mean of mother's age (years) at birth (SD in parenthesis)	23.0 (5.6)	22.7 (6.8)	23.0 (5.7)	0.762

Note: Weighted analysis.

* Pearson's chi-squared test for categorical variables and t-test for continuous variable.

Table 3: Association between child's demographic characteristics and their survival, for most recent home deliveries in the three years preceding survey

Variables	Survival status within 28 days of birth			
	Alive (n=3130)	Dead (n=60)	Total (n=3190)	p-value*
Gender of child (%)				
Male	1567 (50.2)	36 (55.4)	1603 (50.3)	0.490
Female	1563 (49.8)	24 (44.6)	1587 (49.7)	
First birth (%)				
No	2156 (69.7)	38 (59.2)	2194 (69.6)	0.136
Yes	974 (30.3)	22 (40.8)	996 (30.4)	
Size at birth (%)				
Small/very small	594 (18.5)	13 (22.0)	607 (18.5)	
Average	2128 (68.6)	36 (61.5)	2164 (68.5)	0.595
Large/larger than average	408 (12.9)	11 (16.5)	419 (13.0)	
Assistance during delivery (%)				
Trained	174 (4.5)	2 (2.3)	176 (4.4)	
Untrained	2934 (94.9)	56 (96.5)	2990 (95.0)	0.512
No one	16 (0.6)	1 (1.2)	17 (0.6)	
Timing of first postnatal check-ups (Newborn) (%)				
Within 2 days of delivery	642 (20.1)	21 (40.0)	663 (20.4)	
3-28 days after delivery	256 (8.1)	1 (2.0)	257 (8.0)	0.002
29+ days after delivery/did not receive postnatal check-ups	2227 (71.8)	38 (57.9)	2265 (71.6)	
Type of provider for first postnatal check-ups (%)				
No postnatal check-ups	2040 (66.3)	37 (57.4)	2077 (66.1)	0.406
Untrained	696 (22.7)	13 (26.0)	709 (22.7)	
Trained	389 (11.1)	9 (16.5)	398 (11.2)	
Mean of antenatal care visit – (SD in parenthesis)	1.7 (2.2)	1.7 (2.1)	1.7 (2.2)	0.952

Note: Weighted analysis.
* Pearson's chi-squared test for categorical variables and t-test for continuous variable.

Table 4: Logistic regression model output of the associations between neonatal mortality and the ENC practices

Variables	Odds Ratio*	95% Confidence Interval	p-value
Instrument boiled before the umbilical cord was cut			
No	1.00		
Yes	0.63	0.26, 1.55	0.319
Nothing applied to umbilical cord			
No	1.00		
Yes (Nothing applied)	3.81	1.75, 8.29	0.001
Dried <5 minutes of birth			
No	1.00		
Yes	1.64	0.75, 3.58	0.213
Wrapped <5 minutes of birth			
No	1.00		
Yes	0.96	0.44, 2.12	0.921
Delayed bathing (72+ hours after delivery)			
No	1.00		
Yes	0.14	0.03, 0.68	0.015
Initiation of breastfeeding (within 1 hour after birth)			
No	1.00		
Yes	0.86	0.41, 1.82	0.696

Note: Weighted analysis.

* Adjusted for residence, division, seasonal variation, wealth index, mother's education, mother's age at birth, antenatal care visit, gender of child, first birth, size at birth, assistance during delivery and timing and provider of first postnatal check-ups.