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Effect of WHO Newborn care Training on Neonatal Mortality by Education

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Abstract

Background—99% of the 4 million neonatal deaths per year occur in developing countries. The WHO Essential Newborn Care (ENC) course sets the minimum accepted standard for training midwives on aspects of infant care (neonatal resuscitation, breastfeeding, kangaroo-care, small baby care and thermoregulation), many of which are provided by the mother.

Objective—To determine the association of ENC with all cause 7 day (early) neonatal mortality among the infants of less educated mothers compared to those of more educated ones.

Design/Methods—Protocol- and ENC-certified research nurses trained all 123 college-educated midwives from 18 low-risk first level urban community health centers (Zambia) in data collection (one week) and ENC (one week) as part of a controlled study to test the clinical impact of ENC implementation. The mothers were categorized into two groups, those who had completed 7 years of school education (primary education) and those with 8 or more years of education.

Results—ENC training is associated with decreases in early neonatal mortality; rates decreased from 11.2/1000 live births pre-ENC to 6.2/1000 following ENC implementation ($p<0.001$). Prenatal care, birth weight, race, and gender did not differ between the groups. Mortality for infants of mothers with 7 years of education decreased from 12.4 to 6.0/1000 ($p<0.0001$) but did not change significantly for those with 8 or more years of education (8.7 to 6.3/1000, $p=0.14$).

Conclusions—ENC training decreases early neonatal mortality, and the impact is larger in infants of mothers without secondary education. The impact of ENC may be optimized by training health care workers who treat women with less formal education.

Keywords

maternal; education; neonatal mortality

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Introduction

Of the 4 million neonatal deaths worldwide, 99% occur in poorly-resourced countries. The highest numbers of deaths occur in South-central Asia and the highest rates are in sub-Saharan Africa.[1] Neonatal deaths now account for 38% of the under 5 mortality, with ~75% of the deaths occurring within the first week of life.

Zambia, located in the sub-Saharan region, has an infant mortality rate of 102/1000 live births[2] a neonatal mortality of 40/1000 live births[2] and a perinatal rate of 50/1000 live births[3]. The gross national income, per capita is (US $) 490 (2005) and government spending on health, per capita is (US $) 13 (1994–2004).[4] There is no budget line for newborn and maternal health.

The disease burden in Zambia is one of the highest in the world, primarily as a result of HIV AIDS (prevalence of 13.5–20.0%) in the adult population (15–49).[5] In addition, there has been a decrease in the number of experienced midwives as result of early deaths due to HIV AIDS and migration to developed countries for better standards of living; the reduction in trained birth attendants has contributed to the high neonatal mortality and morbidity rates found in Zambia.

The problems of poor health indicators are compounded by poor education. In a demographic and health survey 2001– 2002, the median number of years of formal education amongst females was 5.8 urban and 2.0 in rural Zambia, while the neonatal mortality rate was 31 per 1000 for urban births and 35 per 1000 for rural births. Research has also shown that the neonatal mortality rate for women without education was 39 per 1000 as compared to 34 per 1000 for those with primary education, and 27 per 1000 for those with secondary education.[6]

Bolam et al found that individual health education for postnatal mothers in poor communities has no impact on infant feeding, care, or immunization, although uptake of family planning may be slightly enhanced.[7] However a study by K Yunis et al in Lebanon found that maternal education was strongly associated with improved neonatal health as reported elsewhere[8–10] but had no independent effect on pregnancy outcome.[11–13]

While several studies have shown that maternal education improves neonatal and infant survival, we are not aware of any studies that have assessed the associations between health worker training and perinatal survival by level of maternal education. The most common causes of neonatal deaths in Zambia are sepsis, birth asphyxia, and prematurity/low birth weight and most of these deaths occur within the first 24 hours of life.[14]

We hypothesized that training of health workers in a Essential Newborn Care package (ENC) would reduce all cause 7-day neonatal mortality among women accessing delivery services at the study clinics and that this reduction would be the same across women with different education levels. The elements included in the ENC developed by the World Health Organization (WHO) are routine neonatal care, resuscitation, thermoregulation, early and exclusive breastfeeding, kangaroo (skin to skin) mother care, and care of the small baby.

Methodology

Study Location and population

Zambia has a population 10.8 million[15] and is one of the most highly urbanized countries in the developing world with 36% of the population living in urban areas.[15] The study sites were in two urban locations with the highest population densities (Lusaka, with a population of 1.8 million and 0.5 million for Ndola).[16]

For the study, 123 nurses from 18 health centers were trained in baseline data collection, research concepts, ethics and clinical assessments (Apgar scores, gestational assessments; and neurological examinations Ellis 2000[17] during a one week course). The research nurse trainers trained all the practicing midwives at their centers before initiating baseline data collection. Following four months of data collection, training on ENC for the trainers was conducted by a WHO officer assisted by Dr S. Lang, the developer of the new ENC course[18] .and by one of the developers of the previous WHO ENC course (Dr. F Uxa).

The research nurse trainers in turn trained the midwives at each the health centers before the initiation of post ENC data collection. The health worker directors facilitated the organization of midwives at the health centers, and the trainer of trainers (TOT) model was used in the training. 99.9% of deliveries conducted in these centers are low-risk. High-risk deliveries are referred to tertiary hospitals. There is a critical shortage of experienced midwives with a high turnover; the new recruits were trained at the sites to ensure they were well inducted in the ENC package.

The study was approved by the University of Alabama Birmingham Institutional Review Board (IRB), Research Triangle Institute, as well as the Research Ethics Committee University of Zambia.

The study population included all births at these health centers. A screening log was used at each health centre to enter limited demographic data on all deliveries including immediate outcomes (stillbirths and deaths before discharge). Further maternal pregnancy, delivery, and neonatal data collection including 7 day outcome was limited to those births with parental consent (see tables for list of variable collected). Data summarizing the 7 day outcome were collected on or after day 7 at the health centre visits. A tracking system was used to facilitate 7 day follow up data for infants transported to a hospital following delivery or seen for follow up at any other health facility for further care.

Study design and statistical analysis

This is a secondary analysis of a study whose primary hypothesis was that ENC training and implementation would decrease all cause 7-day mortality[14]. We hypothesized that there would be no difference in the reduction of mortality rates at the time of discharge nor at 7 days based on the maternal education level. Babies in these health centers were either discharged at 6 hours post delivery or transferred to the local hospital. The neonatal mortality rates were compiled from age 0 – 7 days.

Based on the neonatal mortality data during the active baseline data collection period, a 7-month post-ENC data collection period was needed to detect a greater than 40% relative risk reduction in all cause 7-day neonatal mortality with more than 90% power, with 5% level of significance using a two tailed test, with at least a 62.6% 7-day follow-up rate during the post-ENC period.

The statistical analyses between groups employed Mantel – Haenszel statistic to test the overall differences between groups controlling for centre and other variables. Logistic regression and generalized estimating equations (GEE) models were used to perform the analysis of the primary and secondary variables.

Data management and statistical analysis

All data were entered centrally. Data edits, including inter and intra-form consistency checks, were performed at entry with additional edits performed by the data center. The data were analyzed using SAS version 9.0.[19]

The statistical analyses were performed on all collected maternal and neonatal characteristics. Chi-square tests were utilized to test the differences between the pre-ENC and post-ENC data for marital status of mother, education categories, race of mother, gender of infant, receipt of prenatal care, complications during pregnancy, complications during delivery, and type of delivery room resuscitation. Wilcoxon tests were used in the case of skewed data to test gestational age, birth weight, and 1 minute Apgar score. Proportion tests were used to test the various mortality rates between each data collection period. In addition, appropriate Chi-square and Wilcoxon tests were done to compare the maternal and neonatal characteristics of those with a completed 7-day follow-up and those missing the 7-day follow-up. This analysis only included infants alive at discharge from the clinic. We also employed the Bonferroni p-value correction for multiple-comparisons and used p-value <.001 for all comparisons. The data were analyzed using SAS version 9.0[19].

Results

A total of 41,282 women in labor were screened and 98.4% were enrolled in the study. The reason for non-enrollment was maternal refusal of consent. The maternal and neonatal demographic characteristics were comparable in the pre- and post- ENC periods (Table 1). The majority of women married was (98%), had ≤ primary education (56%), were African (99.9%), and had prenatal care (99%). Mean gestational age was 38 weeks and mean weight was 3061 grams (Table 2). The non-fatal pregnancy and delivery complications were rare (less than 0.4%) pre-ENC but decreased significantly post-ENC; because of the high volume of deliveries, these were only captured if recorded on the patient chart and thus may under-represent the complications (Table 3).

Overall, all cause 7 day mortality decreased from 11.2/1000 live births pre ENC to 6.2/1000 ($p<0.0001$) following ENC implementation. Prenatal care, birth weight, race, and gender did not differ between the groups. Mortality for infants of mothers with 7 years or less of education decreased from 12.4 to 6.0/1000 ($p<0.0001$) but did not decrease significantly for those women with 8 years or more education (8.7 to 6.3/1000, $p=0.14$) (Table 4 and Figure 1). When the causes of deaths were analyzed, birth asphyxia accounted for 29%, low birth weight for 34% and sepsis for 13 % of the mortality. The proportion of deaths due to birth asphyxia was the same (29%) in the pre-post periods as was the proportion of malformations (2%). The proportion of deaths due to low birth weight/prematurity increased from 25 to 34% while those due to infection decreased from 21 to 13%, in the pre and post-ENC periods respectively. Fifteen deaths pre-ENC and 16 post-ENC were classified as other, with more than half (18/31) of these deaths having no cause identified. The remaining neonatal deaths were attributed to various causes including, meconium aspiration, jaundice, encephalopathy and hypothermia (Table 5).

Discussion

This large controlled multicenter study conducted in low-risk pregnancies in community health centers demonstrates that ENC training and implementation may result in a large reduction in 7-day neonatal mortality. The reduction in mortality was significantly greater among mothers with a lower education level. Although Zambia has a high proportion of women without education, it is not among the countries with the lowest rates. For example, in Zambia almost 70% of women are enrolled in some education whereas the average is 60% across the African region.[23] In poorly resourced countries with high rates of illiteracy and low maternal educational levels, it would suggest that training midwives in ENC could reduce perinatal mortality in this vulnerable group.

An important potential limitation of this study is the pre-post design. However, the pre-ENC period was an active (prospective) baseline data collection period: all training (except ENC) was done before the pre-ENC data were collected to reduce bias[20]. Another limitation of the study is the relatively low follow-up rates which could bias the mortality results markedly because the event rate is low. However, our comparisons of maternal and neonatal characteristics between the two periods suggested that those lost to follow-up were at a comparable risk for mortality as those followed at 7-days.

In our previous work, we have found that the current ENC course significantly improved the knowledge and skills of midwives working in primary low-risk health care clinics in Zambia[27]. The original WHO ENC Training program[21] has been used extensively in Europe[22] but its impact on patient outcomes has not been tested. Because both conventional 5-day and self-directed ENC training courses have been found to be as effective in acquisition of knowledge[23], effective low cost training may be achieved with this course.

The current study adds to these findings by suggesting that implementation of the ENC course results in improved neonatal outcomes in the same primary health care settings and that the impact is greater among those women with less formal education. Since our study suggests that the outcomes may vary based on the population characteristics, an important consideration would be how to best adapt the ENC course to optimize the decrease in neonatal mortality.

While ENC training has not been tested before in large clinical trials, other neonatal care packages have been evaluated[24]. Although none of the studies were randomized and most used historic controls, reductions in neonatal mortality were comparable to that observed in the current study. Bhutta et al. concluded that, even though the data strongly support their implementation, these interventions need both effectiveness trials and cost-effectiveness evaluations[25].

While several studies have shown that maternal education improves infant survival, we are not aware of studies that training of midwives in ENC package would vary based on maternal education. Maternal education has been repeatedly shown to influence the chances of infant and child survival, independent social and economic conditions.[26–29] In a study by Pena et al, mortality risks were lower among infants of the most educated mothers showing a gradual decrease in IMR from 65 per 1000 newborns in the group without formal education to 30 per 1000 among infants of women with secondary education or more.[30]

The WHO ENC training of nurse midwives who deliver low-risk women in community health centers is effective in reducing early neonatal mortality in the developing world. The emphasis of the ENC program on thermoregulation, breastfeeding, kangaroo care, and small baby care may preferentially reduce 7-day mortality rather than immediate newborn outcomes. It was of particular interest in our study that the greatest proportion of decrease in mortality was associated with neonatal infection, which can be prevented through the basic techniques, such as hand washing, exclusive breastfeeding and care following delivery, taught in ENC. These results support our findings that the ENC's effectiveness may have been mediated by the mothers' level of education. However, the increase in deaths associated with prematurity/low birth weight suggest that additional work should be done to evaluate these training modules with women from various educational backgrounds.

Our study suggests that training of midwives in ENC could reduce perinatal mortality significantly, especially among births of those with a low education level. However, more studies using the same strategy are needed, especially in rural areas with the lowest educational levels and highest neonatal mortality rates. There is also need to test the strategy in high risk urban delivery centers in order to replicate the same approach and document whether this strategy will have the same effect in other settings. If we are to realize the United Nations'

Millenium Development Goal - 4 to reduce childhood mortality by two-third by 2015, new strategies are needed. Training midwives in ENC, if proven to be effective in other settings, offers such an innovative strategy.

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REFERENCES

1. Lawn JE, Cousens S, Zupan J. the Lancet Neonatal Survival Steering Team. 4 million neonatal deaths: when? Where? Why? Lancet 2005;365:891–900. [PubMed: 15752534]
2. UNICEF. The state of the world's children: 2003. [URL last accessed April 07, 2008]. http://www.unicef.org/sowc05/english/Table1_E.xls.
3. Justesen A, Kunst A. Postneonatal and child mortality among twins in Southern and Eastern Africa. Int J Epidemiol 2000 Aug;29(4):678–683. [PubMed: 10922345]
4. [URL last accessed April 07, 2008]. Available at http://www.unicef.org/infobycountry/zambia.html.
5. World Health Organization. The World Health Report 2005: Make every mother and child count. Geneva: World Health Organization; 2005.
6. Zambia Central Statistics Office. Zambia Demographic Health Survey 2001–2002. [URL last accessed April 07, 2008]. Available at: http://www.zamstats.gov.zm.
7. Bolam A, Manandhar DS, Shrestha P, Ellis M, Costello AM. The effects of postnatal health education for mothers on infant care and family planning practices in Nepal: a randomised controlled trial. BMJ 1998 Mar 14;316(7134):805–811. [PubMed: 9549449]
8. Yunis K, Beydoun H, Khogali M, Alameh M, Tamim H. the National Collaborative Perinatal Neonatal Network. Low socioeconomic status and neonatal outcomes in an urban population in a developing country. Journal of Maternal-Fetal and Neonatal Medicine 2003;14:338–343. [PubMed: 14986809]
9. Koupilova I, Rahu M, Karro H, et al. Social determinants of birth weight and length of gestation in Estonia during the transition to democracy. Int J Epidemiol 2000;29:118–124. [PubMed: 10750613]
10. Howell EM, Vert P. Neonatal intensive care and birth weight-specific perinatal mortality in Michigan and Lorraine. Paediatrics 1993;91:464–469.
11. Pefia R, Liljestrand J, Zelya E, et al. Fertility and infant mortality trends in Nicaragua:1964–1993. The role of women's education. J Epidemiol Community Health 1999;53:132–137. [PubMed: 10396488]
12. Tuntiseranee P, Olsen J, Chongsuvivatwong V, et al. Socioeconomic and work related determinants of pregnancy outcome in Southern Thailand. J Epidemiol Community Health 1999;53:624–629. [PubMed: 10616674]
13. Kirksey A, Rahmanifar A, Wach s TD, et al. Determinants of pregnancy outcome and newborn behaviour of a semirural Egyptian population. AmJ Clin Nutr 1991;54:657–667. [PubMed: 1897473]
14. Carlo, WA.; McClure, EM.; Chomba, E.; Chakraborty, H.; Harris, H.; Lincetto, O.; Wright, LL. Impact of World Health Organization (WHO) Essential Newborn Care Course (ENC) training: a multicenter study. Abstract available at E-PAS2006:59:2860.203
15. Zambia Census 2000. [URL last accessed April 7, 2008]. Available at http://www.who.int/healthmetrics/tools/logbook/en/
16. Joint Review of the International HIV/AIDS/STI/TB Intervention Strategic Plan (2002–2005) and Operations of the National AIDS Council Zambia.
17. Ellis M, Manandhar DS, Manandhar N, Wyatt J, Bolam AJ, Costello AM. Stillbirths and neonatal encephalopathy in Katmandu, Nepal: an estimate of the contribution of birth asphyxia to perinatal mortality in a low-income urban population. Pediatr Perinatal Epidemiol 2000;14:39–52.
18. Lang, S. World Health Organization Essential Newborn Care Course. Geneva: World Health Organization; 2006.
19. SAS Institute Inc.. SAS release 9.0. North Carolina: Cary; 2006.

20. World Health Organization. Country Health Fact Sheet. Accessed at: http://www.afro.who.int/home/countries/fact_sheets/zambia.pdf
21. Spilker, B. Guide to Clinical Trials. Lippincott Williams & Wilkins; 1997. p. 612
22. Essential newborn care and breast feeding. Copenhagen: WHO Regional Office for Europe; 1997.
23. Uxa F, Bacci A, Mangiaterra V, et al. Essential newborn care training activities: 8 years of experience in Eastern European, Caucasian and Central Asian countries. Semin Fetal Neonatal Med 2006;11:58–64. [PubMed: 16344014]
24. Vidal SA, Ronfani L, da Mota Silveira S, Mello MJ, et al. Comparison of two training strategies for essential newborn care in Brazil. Bull World Health Organ 2001;79:11.
25. McClure EM, Wright LL, Chomba E, Harris H, Lincetto O, Carlo WA. Evaluation of the educational impact of essential newborn care (ENC) course in Zambia. Acta Paediatrica 2007;96(8):1135–1138. [PubMed: 17608829]
26. Bhutta ZA, Darmstadt GL, Hasan BS, Haws RA. Community-based interventions for improving Perinatal and neonatal health outcomes in developing countries: A review of the evidence. Pediatrics 2005;115:595–596.
27. Pena R, Wall S, Persson LA. The effect of poverty, social inequity and maternal education on infant mortality in Nicaragua 1988–1993. American Journal of Public Health 2000 Jan;Vol. 90(No 1):64–69. [PubMed: 10630139]
28. Caldwell J, McDonald P. Influence of maternal education on infant and child mortality, levels and causes. Health Policy Educ 1982;2:251–267. [PubMed: 10256648]
29. Arntzen A, Moum T, Magnum P, Bakketeig LS. The association between maternal education and postneonatal mortality trends in Norway, 1968–1991. Int Epidemiol 1996;25:578–584.

Table 1

Maternal and Neonatal Demographic Characteristics

	Pre-ENC*	Post-ENC*
Screened, n	13,606	27,676
Enrolled, n (%)	13,209 (97.1)	27,404 (99.0)
Married, n (%)	12,697 (96.1)	26,639 (97.2)
No formal education, n (%)	583 (4.4)	1,137 (4.1)
Primary education (1–7), n (%)	6,709 (50.8)	13,432 (49.0)
Secondary education (8–12), n (%)	5,399 (40.9)	11,930 (43.5)
College (12 +), n (%)	56 (0.4)	78 (0.3)
African, n (%)	13,018 (98.6)	26,994 (98.5)
Male, n (%)	6,925 (52.4)	13,902 (50.7)
Gestational age, mean (SD)	37.5 (2.6)	37.5 (2.4)
Birthweight, mean (SD)	3,052 (448)	3,066 (457)

*Essential Newborn Care (ENC)

Table 2

Characteristics by Maternal Age

	0–7 Years (n=21,861)	**≥ 8 years (n=17,463)**
Received prenatal care (%)	99.2	99.1
Gestational Age at delivery		
< 27 weeks (%)	0.4	0.3
28–31 weeks (%)	1.9	1.3
32–36 weeks (%)	40.1	37.0
> 37 weeks (%)	57.6	61.4
Birthweight		
<1500 grams (%)	0.6	0.4
1501–2000 grams (%)	1.9	1.8
2001–2500 grams (%)	8.9	9.2
≥ 2501 grams (%)	88.7	88.5
Male (%)	52.0	52.0

Table 3

Delivery Outcomes

	Pre-ENC* (n= 13,209)	Post-ENC* (n = 27,404)	p-value
Any complication during pregnancy, n (%)	10 (0.08)	2 (0.01)	<0.001
Any complications during delivery, n (%)	42 (0.3)	18 (0.07)	<0.001
Cord complications, n (%)	22 (0.2)	11 (0.04)	--
Maternal hemorrhage, n (%)	11 (0.08)	3 (0.01)	--

* Essential Newborn Care (ENC)

Table 4

7-day Mortality Rates (per 1000 births)

	Pre-ENC*	Post-ENC*	
	13,004 (98.4) **8,162 (61.8)**	**27,038 (98.7)** **20,502 (74.8)**	
Education			**p-value**
Mothers with 0–7 years	12.4	6.0	<0.001
Mothers with ≥ 8 years	8.7	6.3	0.14
Total	11.2	6.2	<0.0001

* Essential Newborn Care (ENC)

Table 5

Cause of Death

	Pre ENC*		Post ENC*	
	n=91	Percent	n=127	Percent
Birth asphyxia, n (%)	26	29	37	29
Low birth weight/prematurity, n (%)	23	25	43	34
Infection	19	21	17	13
Malformation	2	2	3	2
Hypoxic ischemic encephalopathy, n (%)	0		1	1
Other, n (%)	16	18	15	12
Missing, n (%)	5	5	11	9

*Essential Newborn Care (ENC)