PEDIATRICS

Cost-effectiveness of Essential Newborn Care Training in Urban First-Level Facilities

Albert Manasyan, MD, MPH, Elwyn Chomba, MD Elizabeth M. McClure, MEd, Linda L. Wright, MD, Sara Krzywanski, BA, MS, Waldemar A. Carlo, MD, and the Eunice Kennedy Shriver National Institute of Child Health and Human Development Global Network for Women's and Children's Health Research

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WHAT'S KNOWN ON THIS SUBJECT: Training of birth attendants in essential newborn care courses can reduce neonatal and perinatal mortality, but the cost of effective interventions may prevent their adoption.

WHAT THIS STUDY ADDS: The World Health Organization's Essential Newborn Care training for midwives with implementation of improved newborn care in low-risk first-level facilities is a very cost-effective intervention that may have a major positive impact and lead to decreased early neonatal mortality.

abstract

OBJECTIVE: To determine the cost-effectiveness of the World Health Organization (WHO) Essential Newborn Care (ENC) training of health care providers in first-level facilities in the 2 largest cities in Zambia.

METHODS: Data were extracted from a study in which the effectiveness of the ENC training was evaluated (including universal precautions and cleanliness, routine neonatal care, resuscitation, thermoregulation, breastfeeding, skin-to-skin care, care of the small infant, danger signs, and common illnesses). The costs to train an ENC instructor for each first-level delivery facility and the costs of salary/benefits for 2 coordinators responsible for maintenance of the program were recorded in 2005 US dollars. The incremental costs per life gained and per disability-adjusted life-year averted were calculated.

SETTING: A 5-day ENC training-of-trainers was conducted in Lusaka, Zambia, to certify 18 college-trained midwives as ENC instructors. The instructors trained all clinic midwives working in their first-level facilities as part of a before-and-after study of the effect of ENC training on early neonatal mortality conducted from Oct 2004 to Nov 2006.

RESULTS: All-cause 7-day (early) neonatal mortality decreased from 11.5 per 1000 to 6.8 per 1000 live births after ENC training of the clinic midwives (relative risk: 0.59; 95% confidence interval: 0.48–0.77; $P < .001$; 40 615 births). The intervention costs were $208 per life saved and $5.24 per disability-adjusted life-year averted.

CONCLUSIONS: ENC training of clinic midwives who provide care in low-risk facilities is a low-cost intervention that can reduce early neonatal mortality in these settings. *Pediatrics* 2011;127:e1176–e1181

AUTHORS: Albert Manasyan, MD, MPH,[a] Elwyn Chomba, MD[a,b,c] Elizabeth M. McClure, MEd,[d] Linda L. Wright, MD,[e] Sara Krzywanski, BA, MS,[a] Waldemar A. Carlo, MD,[a,b] and the Eunice Kennedy Shriver National Institute of Child Health and Human Development Global Network for Women's and Children's Health Research

[a]Department of Pediatrics, University of Alabama, Birmingham, Alabama; [b]Centre for Infectious Disease Research in Zambia, Lusaka, Zambia; [c]Department of Pediatrics, University of Zambia, Lusaka, Zambia; [d]RTI International, Durham, North Carolina; [e]Eunice Kennedy Shriver National Institute of Child Health and Human Development, Bethesda, Maryland

KEY WORDS

developing countries, low-middle income countries, neonatal mortality, perinatal mortality, midwives

ABBREVIATIONS

WHO—World Health Organization
ENC—Essential Newborn Care
DALY—disability-adjusted life-year
LMIC—low-middle income countries
GDP—gross domestic product

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Address correspondence to Waldemar A. Carlo, MD, University of Alabama at Birmingham, 9380 Women and Infants Center, 1700 6th Avenue South, Birmingham, AL 35233. E-mail: wcarlo@peds.uab.edu

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Each year ~3.6 million infants die in the first 28 days after birth, and the majority of these deaths occur within 7 days of birth.[1] Of the 3.6 million neonatal deaths per year, 98% occur in low-middle income (developing) countries. Effective interventions that may reduce neonatal deaths, such as essential newborn care, resuscitation, and support for exclusive breastfeeding, are not readily available to newborns in many parts of the world because of poverty, lack of health care providers and infrastructure, and lack of access to health care (low-density and fragile health systems), among other reasons.[2] Educational opportunities that include packages of information on neonatal care interventions, such as the World Health Organization (WHO) Essential Newborn Care (ENC) course, may lead to improvements in newborn care because they provide a platform for exchange of experience among care providers, development of policies to improve the health of newborns, and training in updated newborn care practices.[3,4] The ENC course is an in-depth program to train birth attendants to provide neonatal care at birth and during the first days after birth. The ENC course can be used to strengthen the capacity of educators to train birth attendants in evidence-based guidelines for newborn care because it includes minimum standards for training health care providers, including content specifications, educational materials and methods, specified instruction and supervised practice, and documentation of performance. The ENC course complements the program Pregnancy, Childbirth, Postpartum, and Newborn Care: A Guide for Essential Practice,[5] which is also used in the training. These educational materials provide evidence-based guidelines for routine care and initial management of neonates during the first week after birth.[6]

A major barrier to action on neonatal health has been the erroneous perception that only expensive, highly technological care can reduce mortality.[7,8] Several of the interventions that could reduce neonatal mortality (resuscitation only, exclusive breastfeeding only, and ENC that includes resuscitation and breastfeeding) are relatively inexpensive. Personnel in first-level facilities in low-income and middle-income countries may benefit from appropriate training in newborn care. However, there are limited data on cost-effective interventions that can be implemented to reduce neonatal mortality in infants born in health care facilities in such countries. Economic evaluations have been recognized as important tools to assist policymakers and funders in deciding which interventions and programs provide the best value for the money and thus should be funded.[8] Cost-effectiveness data are needed to guide the development of policies and strategies to accomplish the United Nations' Millennium Development Goal 4 to reduce childhood mortality by two-thirds by 2015. Therefore, we sought to evaluate the cost per life saved and cost per disability-adjusted life-year (DALY) by using data from a large study in which ENC training reduced all-cause early neonatal mortality in births that occurred in first-level facilities.[9]

METHODS

This cost-effectiveness analysis was done by using data from an active baseline-controlled (before and after) design study by the Global Network for Women's and Children's Health Research.[10,11] This study was performed to evaluate the effectiveness of the training of midwives who worked in first-level (primary care, low-risk) health facilities in Zambia and participated in the WHO ENC course on 7-day neonatal mortality.[9]

Intervention

The ENC course, which included universal precautions and cleanliness; routine neonatal care; initiation of breathing and resuscitation; prevention of hypothermia; early and exclusive breastfeeding; kangaroo (skin-to-skin) care; small infant care; counseling on infant care; and danger signs, recognition, and initial management of illnesses, was conducted in Lusaka, Zambia, as part of a study of the effect of ENC on neonatal mortality in Zambian primary care clinics. The 5-day training course was attended by 18 college-educated (minimum of 3 years) midwives, who were trained as ENC instructors, 1 for each of the largest 18 low-risk first-level urban community public-sector delivery clinics located in the 2 largest cities in Zambia (Lusaka and Ndola). All ($N = 123$) clinic midwives were trained in ENC at each of the facilities during their working hours by the 18 ENC instructors.

Intervention Effect

The effect of the ENC training on early mortality in neonates was calculated by comparing the cumulative 7-day neonatal mortality rate from the pre-ENC training period (October 2004 to October 2005) to that of the post-ENC training period (December 2005 to November 2006) after completion of all training by November 2005. The clinic delivery registries were maintained by the clinic midwives, who entered data on all births, including stillbirths, and outcomes until neonates were discharged from the hospital. Two half-time nurses, 1 each in Lusaka and Ndola, provided continuing ENC education, clinical supervision and oversaw data collection as part of maintaining the intervention.

Intervention Costs

The data on resources used for the intervention were calculated from ac-

tual additional expenses throughout the study and reported in 2005 US dollars (Table 1). Costs that were not included were those related to research (data collection and training in data collection and research) and to the existing infrastructure (eg, nurse midwives' salaries, low-risk clinic operations). Program-level costs for the training were divided into initial costs (ie, for training, training equipment and materials, and initial implementation and supervision) and maintenance (ie, for ongoing supervision). Patient-level costs incurred to provide general, obstetrical, and perinatal care to the pregnant women and the newborns, such as bags and masks and other equipment and supplies for the clinic midwives and all the patient care staff, as well as the costs of providing pregnant mothers with access to the services (eg, travel costs) were not included.[12,13] Per diem costs for training the clinic midwives were not included because they were trained during hours when they were working for the Zambian government. The costs per year for subsequent maintenance of the program were also calculated.

TABLE 1 Total Program Implementation Costs Including Training and Maintenance During the 12-Month Intervention Period

Item	Quantity	Cost, US $	Total Cost, US $
Bags/masks	36	25.00	900.00
Stethoscope	18	10.00	180.00
Stopwatches	18	8.12	146.16
Scales	18	96.00	1728.00
Duffel bags	18	9.99	179.82
Dolls	18	20.00	360.00
Sippy Cups	18	0.43	7.74
Mannequins	18	90.00	1620.00
Baby blankets	18	0.67	12.06
PCPNC books	18	40.00	720.00
Binders, supplies	18	19.35	348.30
ENC trainer manual	18	10.00	180.00
ENC participant books	18	5.00	90.00
Shipping	1		599.42
Training cost[a]	1		2880.00
Travel[b]	1	3216.33	3216.33
Part-time nurse[c]	2	3528.00	7056.00
Total			20 223.83

[a] The cost to hold the 5-day training for 18 participants, including board and lodging.

[b] The master trainer traveled from abroad to conduct the 5-day training on a voluntary basis, but travel costs were covered.

[c] Two part-time nurses (in Lusaka and Ndola) hired (December 2005 to November 2006) for teaching and maintenance purposes. Monthly salary was $294 per month per nurse.

Cost-effectiveness was calculated as cost per life saved = cost/reduction in death (or effect size × number of births). Cost per DALY was calculated as cost per life saved/life expectancy.

RESULTS

A total of 40 615 neonates were enrolled during the 2 study periods (pre-ENC and post-ENC). The pre-ENC and post-ENC populations were comparable, as reported in a previous publication.[9] This population comprised 98% of all the neonates born with low-risk institutional deliveries in the 2 cities. All-cause 7-day neonatal mortality decreased from 11.5 per 1000 to 6.8 per 1000 after ENC training (relative risk: 0.59; confidence interval: 0.48–0.77; $P < .001$) and was associated with a decrease in deaths caused by birth asphyxia (3.4–1.9 per 1000; $P = .02$) and infection (2.1–1.0 per 1000; $P = .02$).

Costs for ongoing training, retraining, and supervision of the clinic midwives included the salary for the 2 half-time nurses who oversaw the activities in health centers in their respective communities. Initial costs included: (1) equipment required for the implementation of the intervention (mannequins, resuscitation bags and masks, stop watches, scales, stethoscopes, dolls appropriate for breastfeeding practice, sippy-cups, and duffle bags) and the equipment-shipping costs (Table 1); (2) training materials (ENC course trainer manuals and individual participant books, the *Pregnancy, Childbirth, Postpartum and Newborn Care: A Guide for Essential Practice* books for trainers) and their shipping costs; (3) a 5-day training course (including board and lodging) for the 18 ENC instructors in Lusaka; and (4) travel, board, and lodging costs for a volunteer trainer from abroad. Maintenance costs (long-term costs of maintaining the program for a year) included the cost of the 2 half-time nurses (1 for Lusaka, 1 for Ndola) to teach and maintain the program in the facilities in Lusaka and Ndola for the 12-month study period (December 2005 to November 2006) after the training. Table 1 summarizes all costs of the implementation and first year of the program. The total cost in US dollars was $20 224.

During the post-ENC period 20 534 neonates survived and did not suffer 7-day early neonatal mortality. On the basis of this outcome we estimated that a total of 97 lives were saved during the study period, with a cost per life saved of $208. The calculation of cost-effectiveness is expressed as cost per DALY averted through the implementation of the ENC course, with the assumption of no morbidity made on the basis of the preliminary data (Dr Carlo, et al, unpublished data 2011). On the basis of life expectancy in Zambia, cost per DALY was calculated as follows: [$20 224/20 534 neonates completed 7-day outcome × (0.0115 − 0.0068)]/ 39.7 years' life expectancy = $5.24.

After the program was established, the estimated yearly costs to maintain the program, including equipment replacement, training manuals, and personnel (2 part-time nurses) was $14 128 per year, and the program resulted in a cost per DALY of $3.68. If all equipment and training materials were reused, maintenance cost per DALY would decrease to $1.84.

DISCUSSION

The ENC educational intervention conducted in 2 large Zambian cities was effective in reducing 7-day neonatal

mortality.[9] This cost analysis documents the cost-effectiveness and relatively low cost of the ENC educational intervention compared with other interventions aimed at reducing neonatal mortality in developing countries.

The study had several strengths. The study design included a multicenter population-based approach with a large sample size, an active baseline to reduce bias, training conducted exclusively by local trainers, and accurate clinic registries. A limitation of the study was that it included data only from births that occurred in low-risk clinics. In resource-poor countries such as Zambia, ~50% of the deliveries are performed by traditional birth attendants in rural communities, either in health centers or in the home.[11] The costs per birth of training in ENC in these settings are likely to be higher because birth attendants perform fewer infant deliveries. In a recent large multicountry study that was conducted in 96 rural communities and included a large proportion of home births and traditional birth attendants, ENC training was associated with significantly decreased stillbirths and decreased perinatal mortality in births with birth attendants.[11]

The master trainer was invited from abroad to conduct the 5-day training on a voluntary basis (only airfare, board, and lodging were included); therefore, the training costs would have been higher if salary had been included. Alternatively, use of a local master trainer would reduce the costs. We did not include cost for salaries of trainers, because training occurred during working hours, although trainee salaries have been included in some cost studies. In our international work, trainees usually have not been paid an additional salary when they were getting trained. Additional expenses required for the care of ill neonates have been estimated to include time for a physician (1 hour), midwife (2 hours), and auxiliary nurse (1 hour per day); the costs of drugs and supplies; and other hospitalization costs.[4] We did not include subsequent health care costs of additional survivors, some of whom may have required advanced neonatal care. Because of improved follow-up rates throughout this study, imputation methods[9] indicated that the reduction in neonatal mortality was even larger and thus the cost per life saved and cost per DALY averted are likely to be even lower than reported. The calculation of cost per DALY averted assumed no major morbidity nor increased post neonatal risk for mortality according to limited preliminary data with up to 1 year of follow-up.[13] A 3-year follow-up of those patients is planned, which will provide better data on which to base DALY calculations. Infants who require resuscitation at birth are likely to be at increased risk for subsequent mortality and major morbidities, thus possibly leading to a decrease in the estimated DALY averted in the current study.

Determining the value of an intervention in a specific country depends on the cost per DALY averted relative to the gross domestic product (GDP) per person of that country, because the government may consider the intervention only if the cost per DALY averted due to an intervention is relatively low in comparison to the GDP. WHO standards suggest that interventions that cost less than 3 times the GDP per capita for each DALY averted represent good value for the money spent.[14] The GDP per person in Zambia is about $1500[15] and the cost per DALY averted was about $5 ($208 cost per life gained).[14] Thus ENC training is a relatively good value intervention in local primary health care facilities in Zambia and may be of good value in similar settings in many countries with high neonatal mortality.

Additional evidence of cost-effectiveness can be obtained by reviewing the WHO *Choosing Interventions That Are Cost Effective* database.[16] A cost of about $5 per DALY averted compares favorably with other neonatal interventions reported at all coverage levels (50%–95% coverage) in the WHO African Regional Office East and South Region coverage area, including the community newborn care package ($8 at 50% coverage and $9 at 95% coverage per DALY, in US dollars for the year 2000), normal delivery by a skilled attendant ($37 and $42 per DALY, respectively); tetanus toxoid + normal delivery by a skilled attendant + resuscitation ($27 and $33 per DALY, respectively); community newborn care package + tetanus toxoid ($10 and $13 per DALY, respectively).[16] Analyses conducted on other effective interventions to reduce infant mortality in developing countries report $50 per DALY[17] for the introduction of improved oxygen systems and $100 per DALY for the administration of a pneumococcal conjugate vaccination.[18]

Packages of maternal and newborn care interventions may be more cost-effective than individual interventions largely because of the synergistic effects of costs and larger impacts.[19] Maternal and neonatal packages of interventions were found to be highly cost-effective in countries in Sub-Saharan Africa and Southeast Asia with high child mortality.[19] Therefore, despite the low cost per DALY of some interventions, these interventions can be combined into packages with a common service delivery model to optimize the impact, rather than providing them separately in a vertical manner.[20] The reduction in mortality of the ENC package in this study is comparable to that of other very effective interventions.[19]

Several factors can affect the cost-effectiveness of ENC training. With low baseline mortality, the costs of a program will be relatively higher because the same resources will be required to save fewer lives. Similarly, the variability of population density, specifically the density of births per newborn care provider, can influence cost-effectiveness. Inclusion of home and health-clinic births in sparsely populated areas will increase the cost of the intervention and thus decrease the cost-effectiveness. The expected increase in life expectancy with improved care would further reduce the cost per DALY averted.

Despite the availability of cost-effective interventions for preventing neonatal deaths, their availability is low in resource-poor settings.[20] This may in part be attributable to lack of cost-effectiveness data. Analysis of cost-effectiveness can guide decisions about where best to spend limited resources and which interventions (single or package) will best fit the needs of the target population. To accomplish the Millennium Development Goal 4, additional resources will be required to improve the availability of effective perinatal care. Cost-effectiveness should be an important consideration. It has been estimated that more than a million newborn lives could be saved per year with low cost-effective interventions.[21] In general, clinical care services are more costly to implement than outreach or family-community services. However, given the great impact compared with outreach or family-community care, clinical care interventions are very cost-effective.[20] In addition, intrapartum and postnatal packages have a twofold to threefold greater effect on mortality than antenatal care interventions.[20]

Training of midwives who deliver in low-risk health clinics in the ENC course is a low-cost intervention that reduced early neonatal mortality in Zambia by 40%.[9] Training in ENC in facilities is an important cost-effective intervention that may improve perinatal outcomes worldwide. Training in ENC also significantly decreased stillbirths and perinatal mortality in births with trained birth attendants [11] in a recent, much larger multicountry community-based study. ENC training should be considered by health policy makers as part of the educational programs to reduce perinatal mortality and achieve the 2015 Millennium Developmental Goals. Additional research to evaluate cost-effectiveness of ENC and other perinatal interventions is needed to assist governments in setting priorities to improve perinatal outcomes.

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