Essential Care for Every Baby: Improving Compliance with Newborn Care Practices in Nicaragua

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A Master's Paper submitted to the faculty of
The University of North Carolina at Chapel Hill
in partial fulfillment of the requirements for
the degree of Master of Public Health in the
Public Health Leadership Program.

Chapel Hill

2016

Abstract:

Background: Neonatal mortality is a major contributor to childhood mortality in the developing world. In Nicaragua, neonatal mortality rates have been slow to improve despite significant improvements in childhood mortality over the last 2 decades. As in many parts of Latin America, disparities in neonatal mortality between rural and urban areas in Nicaragua are significant. Studies have demonstrated that the implementation of evidenced-based bundles of care reduces neonatal mortality, and widespread implementation of training in these practices may improve outcomes in resource-limited areas. A challenge for many health authorities is how to implement these guidelines at scale. *Helping Babies Breathe* (HBB) and *Essential Care for Every Baby* (ECEB) are two simplified, low fidelity training programs that could be used to improve newborn care in rural regions of Nicaragua. Other elements of implementation, including monitoring and evaluation, continuous quality improvement (CQI) and supportive supervision, may be necessary adjuncts for implementation.

Objective: To pilot an HBB-ECEB implementation package using HBB-ECEB training combined with monitoring and evaluation, CQI and supportive supervision in rural Nicaragua. We hypothesized that evidence-based newborn care practices and critical short-term outcomes would improve.

*Methods***:** We employed an HBB-ECEB implementation package in the rural municipalities of El Ayote and Santo Domingo. We used a pre-post data collection design. Following a period of baseline data collection from June to August 2015, all providers were trained in HBB-ECEB using a train-the trainer model. Representatives from each health center were also trained in CQI using a QI workbook. An external supportive supervisor conducted monitoring and evaluation and QI coaching. Data on newborn care processes and short-term outcomes were continuously collected from facility medical records and analyzed using standard run charts. Home visits were conducted to determine breastfeeding rates at 60 days.

Results: There were 444 institutional births and 24 home births during the study period (June 2015-May 2016). No neonatal deaths occurred. Following the HBB-ECEB implementation package, cord care improved (pre-intervention median 73%; post-intervention shift to ≥96%) and early skin-to-skin care improved (pre-intervention median 0%; post-intervention shift to ≥76%). Rates of administration of tetracycline and vitamin K were high pre-intervention (median 98% and 100%) and remained unchanged. Early initiation of breastfeeding increased with a pre-intervention median of 40% and post-intervention shift to ≥88% through April 2016, though declined to 38% in May 2016. The percentage of mothers reporting exclusive breastfeeding at 60 days of life increased from 9.5% to 19% post-intervention.

Conclusions: Overall, essential newborn care practices improved following the HBB-ECEB implementation package. Nonetheless, rates of exclusive breastfeeding remained low. CQI may provide a mechanism for continued improvements in essential newborn care practices, including exclusive breastfeeding. Longer term follow-up will be needed to determine effects of CQI.

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ACKNOWLEGEMENTS

I would like to thank all those who aided in bringing this project to life, both in the U.S. and in Nicaragua. In Nicaragua, I want to especially thank Dr. Laura Parajon and Dr. David Parajon, whose humility and selflessness are truly inspirational. Their organization, Amos Health and Hope, remind those most vulnerable that they are not forgotten. To Ana Williams, Ann Marie Castleman,and Amelia Ward, thank you for all of the hard work, sweat and tears that I know went into making this project what it continues to be today. Ann Marie and Ana Williams, I wish you the very best as your own careers blossom, and I look forward to the day when we work together again. Thank you to Dr. Jackie Patterson, it has been a pleasure to grow and discover together both personally and professionally.

A special thank you to Dr. Carl Bose, whose enthusiasm and knowledge made me want to achieve more. Your constant encouragement and subtle suggestions have allowed me to grow into the more confident person I am today. I feel so blessed to have you as mentor and role model. Dr. Wayne Price, thank you for allowing me the opportunity to further my education and providing an unparalleled silent patience that forced me to self-reflect and make decisions on my life and career, even when it seemed I needed redirection. Dr. Matthew Laughon, thank you for your continued support and advice, even as my interests shifted. Thank you to Dr. Melissa Bauserman, whose door seemed always open, practical advice bountiful, and a smile always ready. Also, a thank you to my master's paper advisor Dr. Sue Tolleson-Rinehart for her palpable enthusiasm for teaching. You have guided me into realms of interpretation and policy I never dared to enter and further inspire me to make time for those side interests in life- be it wood working or painting.

Last but not least, thank you to my family and friends, and especially my husband, Eduardo, for your unending support and encouragement. I am sure I could not have achieved what I have without you by my side. Finally, to my mom and dad, for laying the foundation and giving me the tools to achieve what I have always dreamed- I can never thank you enough.

INTRODUCTION

Neonatal mortality, defined as death within the first 28 days of life, is the main contributor to childhood mortality in the developing world, accounting for over 40% of deaths under 5 years-of-age in 2010 (Liu, et. al 2012; Blencowe et al. 2013). Over 90% of neonatal deaths occur in low or low-middle income countries (LICs or LMICs) (Liu, et. al 2012; Blencowe et al. 2013). While the rates of death under 5 years have improved dramatically in the last decade, neonatal death rates have declined at a much slower rate, making the reduction of neonatal mortality a priority.

Similar trends exist in Nicaragua where the estimated mortality rate in 2006/2007 among children under 5 years-of-age was 35 per 1,000 live births, less than half the rate of 72 per 1,000 live births in 1992/3 (INIDE & MINSA 2008). Unfortunately, the neonatal mortality rate, estimated at 16 per 1,000 live births, has remained nearly the same since the 1990s. Another feature of child mortality in Nicaragua is the disparity between rates in rural and urban areas. Infant mortality (death before 1 year-of-age) is approximately 43 per 1,000 live births in the rural regions of Nicaragua near the Atlantic coast, almost twice the rate of 24 per 1,000 live births in urban areas (INIDE & MINSA 2008).

Nearly all neonatal deaths are attributable to three main causes: complications of preterm birth, birth asphyxia, and infection (Oza, Lawn, Hogan, Mathers & Cousens 2015). Evidence supports the effectiveness of over 20 perinatal and newborn health practices in reducing neonatal mortality (Bhutta, Darmstadt, Hasan & Haws 2005). Most of these practices are included in the bundle of care recommended by the World Health Organization (WHO) and, together, are often called essential newborn care (ENC). Many health authorities have understood the value of implementing these interventions in the care of all newborns and have adopted ENC guidelines as their standard of care. The Nicaraguan Ministry of Health (MINSA) recommends a set of newborn care guidelines that are very similar to the WHO ENC guidelines.

Although evidence suggests that implementation of ENC may dramatically improve outcomes in resource-limited areas, there remains uncertainty about how best to achieve this goal at scale (Carlo et al. 2010). This is particularly challenging in remote areas where care is delivered by both public and private health providers. Implementation in these areas may improve with the use of educational programs that are simplified, adaptable to the local environments, and deliverable using a train-the-trainer model.

A variety of training programs in neonatal resuscitation has been developed as a means of improving neonatal mortality in LICs and LMICs by reducing deaths from birth asphyxia. In 2010, a private-public consortium led by the American Academy of Pediatrics (AAP) introduced a simplified, low-cost curriculum for teaching newborn resuscitation in resource-limited areas, *Helping Babies Breathe* (HBB; see Appendix 1 for action plan outlining content). This low-fidelity program uses small group demonstration, paired learning, and simulation as a teaching model and a train-the-trainer strategy for dissemination. Implementation of HBB appears to reduce rates of early neonatal death presumably due to birth asphyxia. The program's implementation, however, is not associated with reducing death after the first day of life (Msemo et al. 2013; Goudar at al. 2013). Deaths beyond the first days of life result primarily from other causes (e.g. prematurity and sepsis) (Bhutta et al. 2014; Perez, Pena, Persson & Kallestal 2011). It seems likely that the training programs with greatest effect on overall mortality will be those that address all causes of neonatal mortality.

In 2010, the WHO developed a training program based on their recommendations for ENC. This program is resource intensive, including the extensive use of projection of digital images, and is therefore not ideal for the environments and resources in many LICs and LMICs. The barriers created by resource intensivity suggested a need for an easily disseminated, simplified program

for training birth attendants in resource-limited areas. To address this need and avoid some of the handicaps of the WHO training program, a group of educators and neonatal care specialists in North America, in collaboration with international experts, developed a simplified, low fidelity educational program, *Essential Care for Every Baby* (ECEB; see Appendix 1 for action plan outlining content).

One newborn care practice that significantly lowers mortality is early and exclusive breastfeeding. A recent systematic review reported a more than 40% reduction in all cause neonatal mortality and infection-related neonatal mortality when breastfeeding was initiated within one hour after birth (Debes, Kohli, Walker, Edmond & Mullany 2013). The ECEB curriculum has specific content to promote early and exclusive breastfeeding. Promotion of exclusive breastfeeding may be particularly important in Nicaragua, where rates of exclusive breastfeeding during early infancy are low. Fewer than half of two month-old infants are exclusively breastfed, and the proportion of exclusive breast fed infants falls with increasing age (INIDE & MINSA 2008).

The ECEB program was developed primarily for the education of facility-based medical professionals. However, the program's success may be enhanced by the education of all providers. In rural Nicaragua, this would include community-based, non-medical health promoters. Recent systematic reviews demonstrate improvements in household practices, care seeking, and perinatal and newborn outcomes in community settings when community health workers deliver packages of care for maternal and newborn care (Carlo et al. 2010). The ECEB program may be an ideal training program for health promoters because portions of the curriculum can be used to prepare health promoters to help families provide improved newborn care.

Evidence also suggests that other elements of implementation are necessary to improve outcomes, including monitoring and evaluation, maintenance of knowledge and skills, continuous quality improvement (CQI) and supportive supervision (NASEM 2015; Rowe, de Savigny, Lanata, & Victoria 2005). Adding these elements of implementation to education may increase the likelihood of sustainable changes in practice.

Objective

The overall goal of this project was to improve newborn care, including exclusive breastfeeding practices, and subsequently reduce neonatal mortality, in rural Nicaragua. In order to achieve this goal, we tested the effectiveness of a strategy for sustainable implementation of the *Helping Babies Breathe* (HBB) and *Essential Care for Every Baby* (ECEB) programs in rural regions of Nicaragua. We hypothesized that newborn care would be improved by training newborn care providers in these programs. In addition, we planned to facilitate the translation of knowledge and skills into practice by also training providers in quality improvement (QI) methodologies using a newly-developed QI workbook.

METHODS

Study Design

This was a pilot study to test the effectiveness of training providers of maternal and newborn care in two rural regions of Nicaragua using HBB, ECEB and a novel QI workbook followed by supportive supervision. We use the term “pilot” because the sample size was relatively small, and because we chose a convenience sample taking into consideration practical issues, such as funding and time constraints, rather than on estimates needed to demonstrate a change in the primary outcome.

The study was a population-based, prospective interventional study conducted in two phases. In the first phase, we collected baseline data describing selected newborn care practices and outcomes. This period of data collection was followed by an intervention that included HBB and ECEB training, the introduction to QI methods and a QI workbook and supportive supervision, followed by continuation of data collection.

Catchment Area and Study Population

The study's catchment area included communities within the municipalities of Santo Domingo of the Chontales Department and El Ayote of the Región Autónoma del Atlántico Sur (RAAS) Department (see Appendix 7). Health care in these communities is provided by one SILAIS, the government-sponsored local system of primary care responsible for health centers and posts within its region, located in Juigalpa. Most obstetrical care is provided in two health centers, one in each municipality. There are 2 to 3 health posts associated with each of these health centers; these provide preventive outpatient care. The majority of deliveries occur at the health centers. Mothers may occasionally deliver at health posts when transportation to the health center is not possible. To facilitate delivery in the health centers, mothers who reside at great distance from a health center or post may live in *casas maternas* (maternal homes) close to the health center during the weeks prior to their estimated date of delivery, although some decline this opportunity and deliver at home. Home deliveries are attended by midwives or traditional birth attendants from the surrounding communities. Home delivery is more common in the El Ayote municipality compared to the Santo Domingo municipality. Community health promoters, lay-persons residing in each community who have limited medical training, assist with maternal newborn care by providing counseling of families on recommended perinatal care practices. Community health promoters receive training in basic health counselling, postpartum outpatient care referral for medical care when indicated.

The study population included women and their live born newborns, who delivered within the catchment area during the study period (June 2015 through May 2016). This included women who delivered in either of the area's health centers or posts. It also included women who delivered at home in select communities in the El Ayote municipality as outlined below.

The Intervention

The primary element of the intervention was education of newborn care providers in the catchment area using the HBB and ECEB programs. These programs are based on evidenced-based newborn care practices recommended by the WHO. HBB outlines care in the immediate newborn period and emphasizes requisite care during the "golden minute" (the first minute after birth), including steps of immediate neonatal resuscitation (see Appendix 1 for HBB Action Plan). ECEB is a program that outlines the subsequent steps in newborn care (see Appendix 2 for ECEB Action Plan).

In this study, we modified ECEB content to conform to the current Nicaraguan Ministry of Health (MINSA) recommendations. The modifications included the insertion of the national recommendations for cord care (chlorhexidine 4%) and eye care (tetracycline 1% solution). Spanish versions of HBB and ECEB were provided by the American Academy of Pediatrics, and these materials were further adapted so that they were culturally appropriate, including the alteration of skin tones of illustrations as well as alterations of some attire.

After baseline data collection (see below), we trained all newborn care providers in the participating communities using a train-the-trainer model. Our goal was to train all personnel who participated in the care of mothers and infants, both medical professionals and lay workers. In the first level of training, Dr. Laura Parajon, the Medical Director of AMOS (the Nicaraguan-based non-governmental agency that was a collaborating partner in the project) and Dr. Perez

trained a cadre of Master Trainers. These included six personnel from AMOS. These Master Trainers became the trainers for the next level of training.

The next level of training was at a regional workshop in Juiglapa. The trainers included the Master Trainers and one additional trainer from the United States. The trainees included two providers from each study health center and selected personnel from the SILAIS. At the request of the SILAIS director, two providers from each of eight additional health centers in the SILAIS region also participated, though continued data collection in these areas was not planned. For HBB-ECEB training, trainees were assembled into groups of six providers per one trainer. Training occurred over three days, one day for HBB training and two days for ECEB training. In addition to their training in HBB-ECEB, we prepared trainees to become teachers of the programs in recognition of their subsequent responsibility to teach the program within each of their facilities. In total, 23 facility-based trainers from the 10 SILAIS municipalities, including 2 each from El Ayote and Santo Domingo, were trained.

Finally, we provided training in QI methodology in conjunction with HBB-ECEB training during the third day of training. This half-day session emphasized basic quality improvement methodology, including the collection and interpretation of data. We introduced the QI Workbook as a resource for further training and conduct of QI initiatives in the facility.

Over the 2 months following their training (August to October 2015), the two facility-based providers from El Ayote and Santo Domingo who participated in the regional training, trained all of the maternal and newborn care providers in their health centers. They were assisted and supervised in their training by a Supportive Supervisor, a nurse hired by the project. Although the regional training occurred over three consecutive days, subsequent training of a majority of

providers in the health centers was divided into 2 to 3 days. An additional 7 physicians and 12 nurses were trained in El Ayote, and 5 physicians and 10 nurses were trained in Santo Domingo between August and October 2015 (see Appendix 5). Additionally, 3 Master Trainers from AMOS and 3 MINSA staff members went to the communities in El Ayote and trained 23 midwives in HBB-ECEB much later in the study period (in February 2016) over a 2-day period.

AMOS Master Trainers also trained community health promoters in the parts of ECEB most relevant to continued education of families, specifically as it related to the modified ECEB parent guide (see Appendix 6 for parent guide).

Data Collection

Phase 1: Pre-Intervention Data Collection

Two months prior to HBB-ECEB training (June to July 2015), we collected baseline data describing births within the catchment area. All data were entered into a digital data collection system on a computer dedicated for that purpose within each health center. Community Coordinators abstracted data from the medical charts at each health center and posts within the catchment area using Infant Study form IS01 (see Appendix 3). Community Coordinators were specially-trained health promoters employed by the study; they did not participate in patient care. Each municipality had one Community Coordinator responsible for the collection of data. Baseline data describing home births in El Ayote was collected by the midwife or traditional birth attendant at each birth. Following completion, community health promoters collected the study forms and delivered them to the Community Coordinator at one of the health centers. The Supportive Supervisor verified the data and supervised these Community Coordinators.

During scheduled home visits at 7-, 30- and 60-days, community health promoters collected outcome data, including deaths following discharge and breastfeeding practices using Infant Study form IS02 (see Appendix 4). Community health promoters conducted home visits in selected communities of El Ayote and Santo Domingo. This visits occurred within communities where AMOS was already well-established and trusted or those in relatively close proximity to the health centers. We trained Community Coordinators, midwives and traditional birth attendants and community health promoters on methods of data collection prior to initiation of baseline data collection.

Phase 2: Post-Intervention Data Collection

Following HBB/ECEB training, data was again collected in the same fashion as in phase 1. All data were entered into a digital data collection system on a computer dedicated for that purpose within each health center.

Community health promoters conducted three visits to the homes of live-born infants at approximately 7-, 30- and 60-days after birth in select communities in the Santo Domingo and El Ayote area. However, during phase 2, the home visits served the dual purpose of collecting data using Infant Study form IS02 (Appendix 4) and continuing the education of families on recommended newborn care. The community health promoters educated families on the continued care of the newborn according to ECEB guidelines in accordance with MINSA recommendations. They were trained in select portions of ECEB such that they would be able to recognize “red flags” and counsel families to seek further medical care for the infant if necessary (see Appendix 6).

Outcomes, Sample Size and Analytic Techniques

The primary outcome in the determination of effectiveness of the implementation of essential newborn care practices using HBB and ECEB training and the introduction of QI methods was exclusive breastfeeding at 60 days following birth. Our hypothesis was that this implementation strategy would increase the absolute rate of exclusive breastfeeding at 60 days by 30%.

Although the sample size was determined by practical constraints (i.e. the number of births during a defined study period), we predicted that the sample would be sufficient to detect large improvements in rates of exclusive breastfeeding. The size needed to detect absolute changes in exclusive breastfeeding rates are listed below, assuming a baseline exclusive breastfeeding rate of approximately 35%[8] using 80% power and 5% significance:

Absolute change (%)	**Sample size needed**
5%	1,469
10%	373
20%	95
30%	40

Secondary outcomes included the following process measures: 1) early and continuous skin-to-skin care (during the first hour after birth), 2) eye care (tetracycline), 3) cord care (chlorhexidine), and 4) early initiation of breastfeeding within 1 hour of birth; and outcome measures: 1) rates of hypothermia (less than 36.5° C) at one hour following birth, and 2) neonatal mortality.

We analyzed process measures and hypothermia continuously using run charts. Data points were created for each month, and unknown or missing data was excluded from the run charts.

Medians were created from baseline data for comparison. Significant changes in measures were identified by “shifts” and “trends.” Shifts were defined by six or more consecutive points above or below the median. Trends were defined as a series of five or more points all directed in the same direction (Perla, Provost & Murray 2011).

Approvals and Consent

The institutional review boards at The University of North Carolina (UNC) and the Universidad Nacional Autónoma de Nicaragua in Leon (UNAN Leon) reviewed the study. We obtained waivers of written consent from participants from both boards.

Responsibilities of the Student (Dr. Perez)

The study was a joint effort of the UNC, AMOS, MINSA, and the UNAN Leon. As the study principal investigator, I had specific responsibilities. I created the study protocol and was responsible for establishing partnerships in Nicaragua. I obtained “buy-in” from key stakeholders for the project prior to the study’s implementation, including the Ministry of Health in Nicaragua, and aided in applying for institutional review board approvals. I collaborated with representatives from each of these organizations in the development of the protocol, implementation of the study and monitoring and evaluation of the study. I created the data collection forms that were translated into the digital/electronic database. I was also responsible for training Master trainers in Nicaragua. Along with AMOS personnel, I analyzed and interpreted the data.

RESULTS

During the study period, 444 institutional births and 24 home births occurred, the majority of them in El Ayote (Figure 1). The majority of facility births occurred in the health centers with 1 birth occurring in a health post. Ten infants had a birth weight less than 2500 grams. No

neonatal deaths occurred, nor did any neonatal death occur following a home birth, although we know of the death of one infant at 35 days following a home birth.

Following implementation of the HBB-ECEB package, compliance with newborn care practices at health facilities increased or remain unchanged. Appropriate cord care using chlorhexidine increased significantly with a post-training shift to ≥96% compared to the pre-training median of 73% (Figure 2). Rates of administration of tetracycline and vitamin K were high pre-training, with pre-training medians of 98% and 100% respectively, creating stiff ceiling effects for any post-training change. These high compliance rates persisted after-training with no shifts or trends noted. Post-training compliance with recommended eye care using tetracycline ranged from 96-100% and vitamin K administration 96-100%. Early skin-to-skin care and early initiation of breastfeeding within the first hour of life had the largest improvements. Early skin-to-skin experienced a post-training shift to ≥76% compared to the pre-training median of 0%. Early initiation of breastfeeding was similarly improved after training, evidenced by a shift from a pre-training median of 40% to a post-training rate ≥88% until May 2016, when the rate of early breastfeeding returned to 38%. The number of infants with hypothermia varied around a pre-training median of 8% without significant shifts or trends, with a post-training range from 0% to 13%. Continuous run chart data are displayed in Figure 2.

Of note, there were a number of missing data. Missing data from medical records was highest pre-intervention for the processes of skin-to-skin care and early initiation of breastfeeding. There were 49 infants for whom there was no documentation of when breastfeeding was initiated for 75 births captured pre-intervention (65%). Thirty-seven of the 75 infants (49%) were missing data on whether skin-to-skin care was performed pre-intervention. For the processes of Vitamin K administration, tetracycline administration, and chlorhexidine application, data was missing for 1 (1%), 1 (1%) and 7 (9%) infants, respectively, pre-intervention. Initial temperature was missing

in 2 of 75 infants (3%) pre-intervention. Post-intervention, documentation of skin-to-skin care and initiation of breastfeeding improved. Data detailing early initiation of breastfeeding and skin-to-skin care was missing from 23 (7%) and 41 (13%), respectively, of 325 charts reviewed. Vitamin K administration, tetracycline administration, and chlorhexidine application as well as initial temperature remained well documented post-intervention. Missing data was excluded from the run charts.

Home visits for 7-, 30- and 60-day newborn follow-up were limited in number and were conducted in a convenience sample of selected families. Twenty-three home visits took place before training and 50 home visits occurred after training. Follow-up to 60-days occurred for 22 of 23 infants pre-training and 43 of 50 infants post-training. Exclusive breastfeeding rates were estimated from these home visits. The percentage of mothers reporting exclusive breastfeeding increased from 17.4% to 52% at 7 days (RR 1.72; 95% CI 1.22 to 2.43, $p=0.002$), from 4.5% to 49% at 30 days (RR 1.87; 95% CI 1.40 to 2.50, $p<0.0001$) and from 9.1% to 19% 60 days (RR 1.12; 95% CI 0.92 to 1.36, $p>0.05$) following birth during the pre-intervention compared to the post-intervention period (Figure 3). Despite these improvements, exclusive breastfeeding rates steadily declined from 7 days to 60 days both before and after the intervention.

A QI project was not initiated during the study period. At present, QI activity has been limited to formation of a QI team and identification of gaps in quality; other activities are forthcoming.

DISCUSSION

As in many other areas of Latin America, Nicaragua has made significant strides to improve newborn care and reduce neonatal and infant mortality (Perez et al. 2011). However, improvement in neonatal survival has lagged behind improvement in overall child survival, and significant urban-rural disparities in outcomes persist (INIDE & MINSA 2008). This pilot project

tested a strategy to improve newborn care in rural regions of Nicaragua through training using the HBB and ECEB programs and a novel QI program based on a workbook and supportive supervision. We hypothesized that this strategy would be an effective way to improve health outcomes in the rural regions of Nicaragua and reduce health outcome disparities between rural and urban areas. Further, we speculated that this strategy might be a model for implementation of newborn care practices in other countries in the region.

In the short-term, the project was successful. There were improvements or at least no change in rates of compliance with recommended newborn care practices following the intervention. Most notable were significant improvements in maternal-newborn skin-to-skin care immediately following birth and in early initiation of breastfeeding (within the first hour following birth). These improvements were noted soon after training, and compliance with both of these practices was sustained during the 8 months following training. We suspect that one explanation for the sustained improvements in skin-to-skin care and early breastfeeding can be attributed to motivation of providers to improve compliance with these practices; a goal expressed by providers at the completion of the regional training workshop. Additionally, although appropriate cord care with chlorhexidine was relatively high at baseline, a significant post-training shift occurred. We suspect that some of this improvement was attributable to improved availability of the chlorhexidine. We observed high baseline compliance with the administration of tetracycline for eye care and vitamin K. Importantly, the intervention did not reduce compliance with these practices.

Although rates of skin-to-skin care and early initiation of breastfeeding, practices that are known to increase the likelihood of exclusive breastfeeding in infancy, increased after the intervention, rates of exclusive breastfeeding remained undesirably low. Further, the significant increase in the rate of exclusive breastfeeding at 7- and 30-days after birth pre- and post-intervention did

not persist, and there was no significant difference pre- and post-intervention by 60-days after birth. There was a steady decline in exclusive breastfeeding rates from nearly 50% at 7 days to less than 20% at 60 days following birth in the period after the intervention. We conclude that the beneficial effects of early newborn care practices that are known to increase the subsequent rates of breastfeeding are outweighed by other, later factors that are barriers to breastfeeding.

National Nicaraguan data would have predicted at least 6 deaths in our birth cohort, yet no neonatal deaths were reported. The majority of our data described care and outcomes that occurred within the facility and, thus, only during the duration of hospitalization of the mother and infant. We had 30- and 60-day outcomes on only about 10% of the birth cohort. Therefore, we cannot account for deaths after discharge from the facility in the remainder of the cohort. We did not have outcome data on infants who were transferred to a higher-level facility for care and, because all very low birthweight infants were referred for care, it is possible that some of them died. Finally, although we attempted to collect data describing all births in the catchment area during the study period, it is possible that some home births were not reported, and therefore deaths following these births would not have been counted.

This study had a number of limitations. Because of practical constraints, we were able to conduct follow up visits and capture outcome data in a small subset of the study population. The catchment area was large and sparsely populated. Homes at furthest distance from the health centers, where our staff were positioned, were in areas where roads were poor and there was little to no public transportation; thus, we could not afford to collect data in these regions. The percentage of the study population seen in follow-up was small and potentially biased. Outcomes after discharge are estimates based on this small sample and should be interpreted with caution.

Another limitation of the study was the method of data collection. Data were collected by abstraction from the medical record. Data were sometimes missing, and the quality of the data was always dependent on the care provider. We discovered by occasional observation some inconsistencies between information recorded and observed. It is possible that some activities recorded as completed in the record were not being performed, or conversely were performed but not recorded. Also, we could not be certain that when the record indicated that a practice was performed that it was performed correctly. An alternative method of data collection would have been to base all data collection on direct observations. This alternative would have been prohibitively expensive. Also, observation may influence practice and may confound study results.

We monitored key processes of care and selected facility-based outcomes continuously for a period of approximately 10 months following the training of providers. Improvements in the processes and outcomes persisted throughout this period, with one exception. We cannot be certain that this quality of care will continue. Knowledge and skills acquired during HBB and ECEB training may decline over time, as has been observed following other training programs (NASEM 2015; Rowe et al. 2005). Also, staff turnover at the facilities may result in providers without adequate knowledge and skills. In April of 2016, a significant number of providers at El Ayote were transferred to other facilities and were replaced with new providers. These new providers were not trained in HBB and ECEB. We believe that these changes explain the decline in the rate of EIBF observed in May. Repetitive low-dose simulated training and periodic refresher training has been shown to reduce early neonatal mortality following HBB training.[3] We believe that a similar strategy will be necessary to sustain improvements following our intervention.

The intervention also included introduction to QI methods and a QI workbook. We anticipated that the workbook would guide facility-based improvements activities, and that the supportive supervisor would facilitate these activities. During the study period, QI activities did not proceed beyond the formation of a QI team. The lack of further involvement in QI may have resulted from the absence of a detectable gap in quality in facility-based care, and this may have resulted from the choice of processes of care and outcomes selected for monitoring. It is possible that monitoring other processes (e.g. use of bag/mask ventilation) or outcomes (e.g. timing of cord clamping) might have revealed a gap in quality and a potential focus of a QI project.

The undesirably low rates of exclusive breastfeeding and the declining rate with advancing postnatal age represents a significant gap in quality. In fact, improving rates of exclusive breastfeeding was the overall goal of this project. We had hoped that improving the early initiation of breastfeeding, support of breastfeeding during subsequent postpartum care in the birth facility (both elements of ECEB) and the engagement of community health workers in continuing to support breastfeeding would result in improved rates of exclusive breastfeeding beyond the neonatal period. Although our follow up data suggest that the intervention may improve these rates, they remain unacceptably low. It is clear that improving this outcome will depend upon additional interventions in the community. Discovering barriers to exclusive breastfeeding and developing an improvement strategy is ongoing.

We believe that our intervention may be a model for improving facility-based newborn care practices. While country-specific policies, demographics and geography may influence successful implementation of similar project elsewhere, the structure of the current project lends itself well to further implementation in other rural areas. The project highlighted the potential success of private and public partnerships, and a manner in which in-country and international organizations can collaborate successfully. The support of MINSA and their motivation of local

providers to improve newborn care practices undoubtedly aided in the improvement in compliance with recommended newborn care practices.

Conclusions

Our study demonstrates that essential newborn care practices can be improved in facilities in resource-poor communities using a train-the-trainer cascade to implement the HBB and ECEB programs. This strategy led to improvements in a number of care practices with low compliance rates prior to training. However, improvement in care practices known to increase the likelihood of exclusive breastfeeding during infancy did not result in acceptable rates at 30- and 60-days following birth. Strategies to understand and overcome barriers to exclusive breastfeeding will be required to improve this outcome.

We describe an implementation strategy that may be a model for programs in other rural, resource-limited areas. The key elements of the strategy included engagement of collaborating partners; in our project this included an established non-governmental organization and the Ministry of Health. We adapted the educational material so that it was compliant with local recommendations for care, culturally appropriate and context specific. Finally, we provided supportive supervision within the facilities. This additional resource, although somewhat costly, may be essential for successful implementation.

FIGURE 1. Births by Location

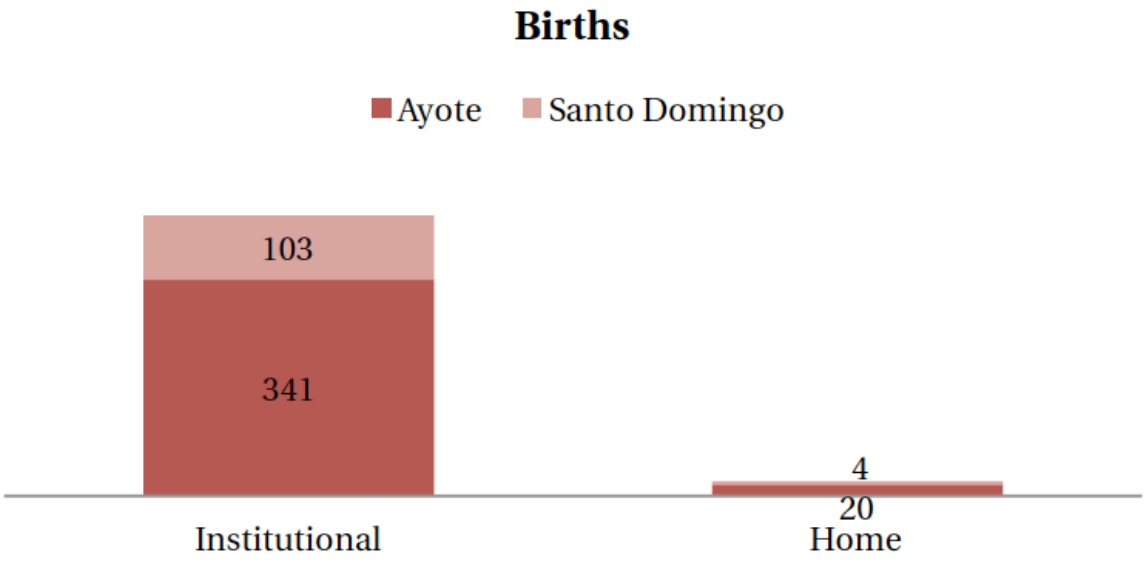


FIGURE 2. Run Chart Data on Newborn Processes of Care

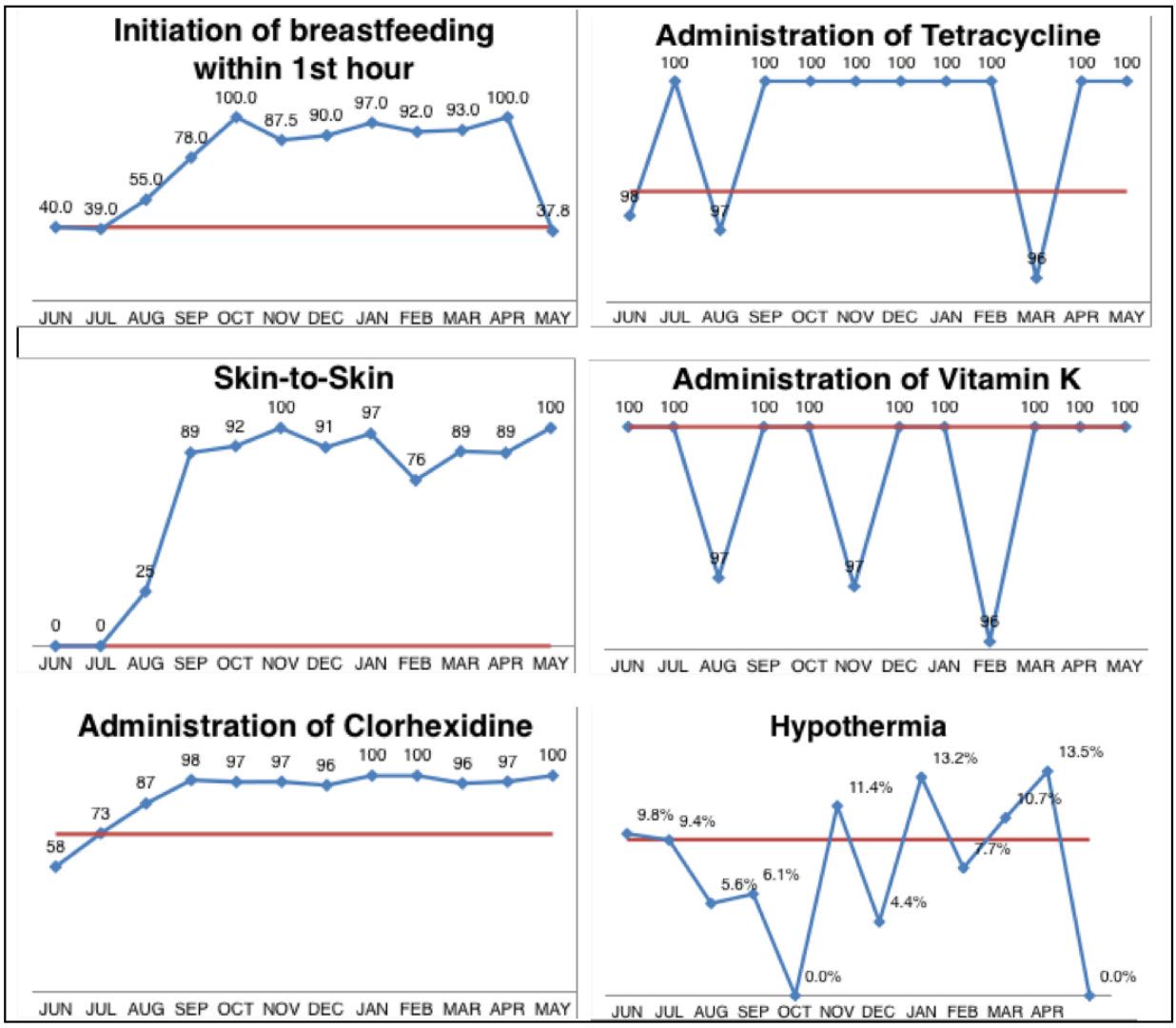
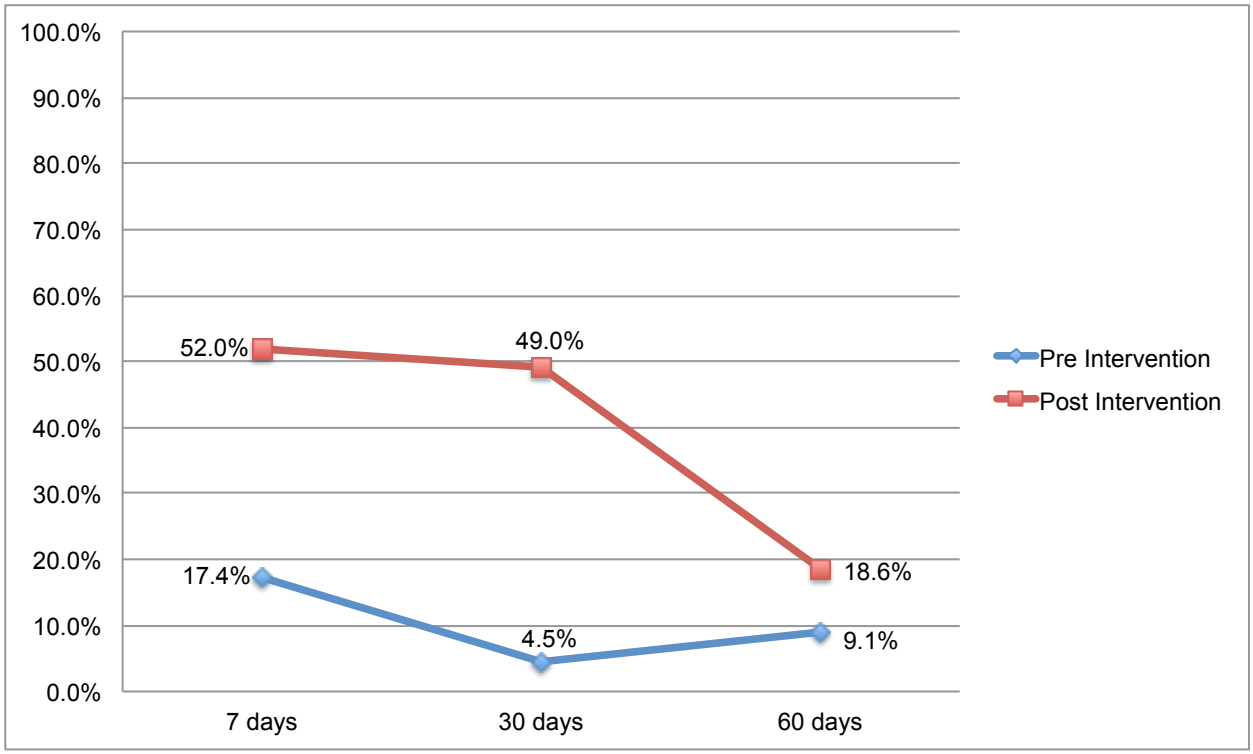
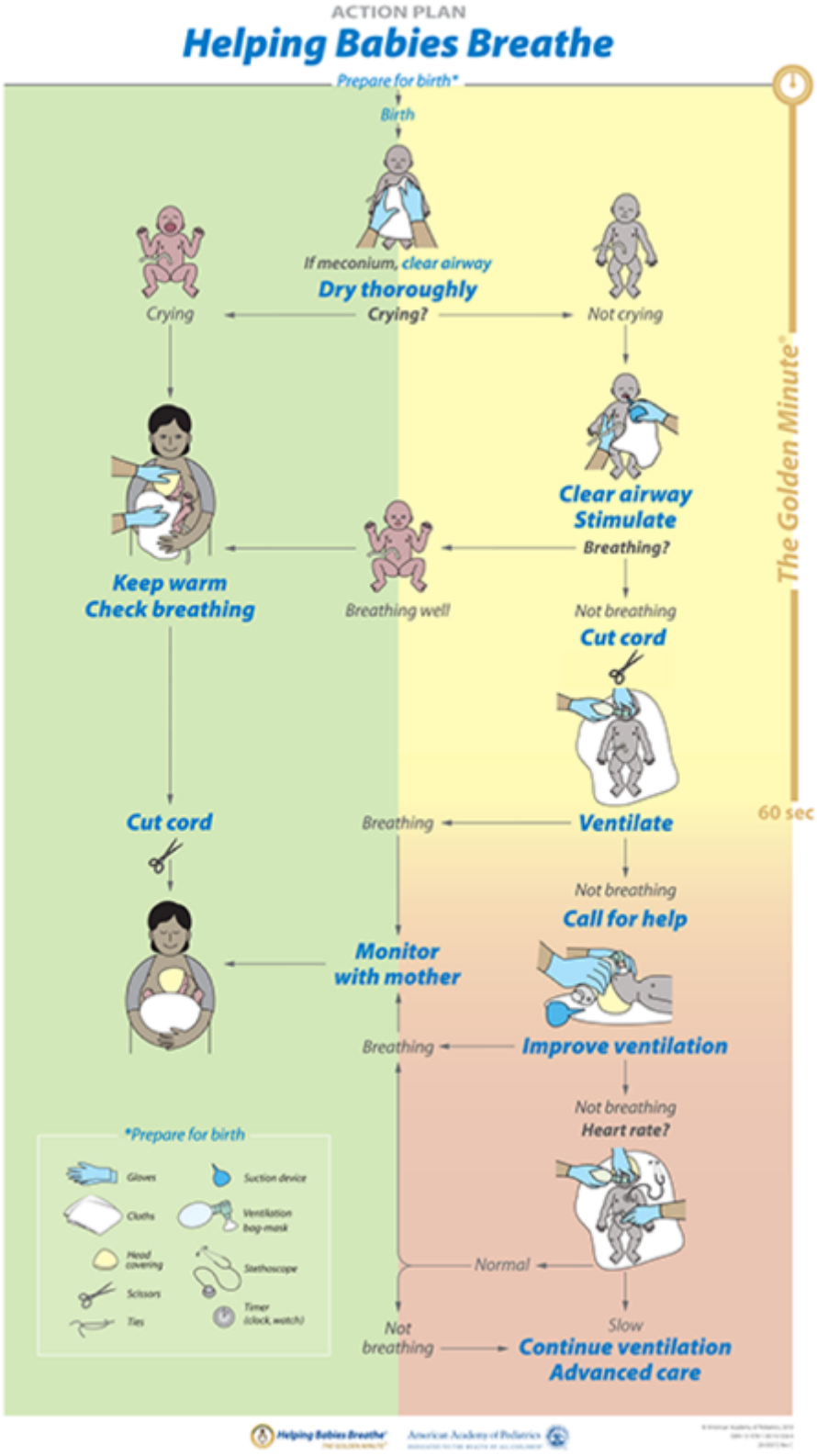


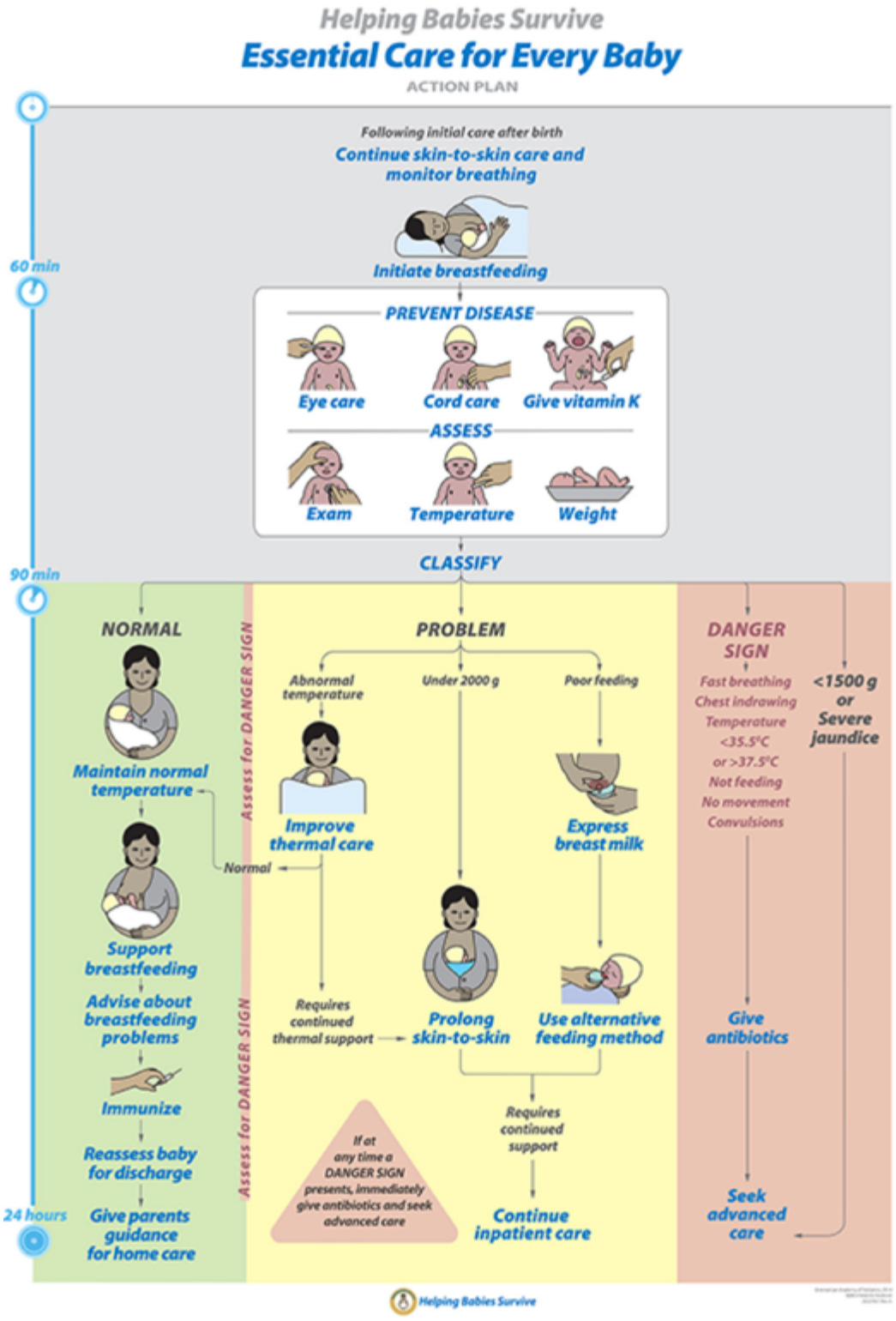
FIGURE 3. Rates of Exclusive Breastfeeding Pre- and Post-Training



APPENDIX 1: HBB Action Plan



APPENDIX 2: ECEB Action Plan



APPENDIX 3: Maternal and Infant Data form IS01

	ECEB Nicaragua Maternal & Infant Data	IS01
Page 1 of 1	SUBJECT ID: |___|___|- |___|___|___|___|-|___|___|	Version 1.2 02/26/2015

This form is to be completed by the Community Coordinator or Birth Attendant.

SECTION A. HEALTH STATUS OF MOTHER/INFANT

1. BIRTH WEIGHT:
\|___\|___\|___\|___\| grams ☐ N/A

2. ESTIMATED GESTATION:
\|___\|___\| weeks ☐ N/A

3. Was the infant born in a facility or at home?
1☐ Facility Birth 2☐ Home Birth → SKIP TO **QUESTION 5**

4. How long did mother stay in the facility?
1☐ <6 hour 3☐ >24 hours
2☐ 6-24 hours 4☐ N/A

5. Was the infant alive at the time of maternal discharge (or at the time the birth attendant left the home)?
1☐ Yes 2☐ No → SKIP TO **SECTION C**
3☐ DON'T KNOW

SECTION B. BREASTFEEDING HABITS

1. What was the first substance the infant consumed?
1☐ Breast Milk 4☐ Formula
2☐ Water 5☐ Sugar Water/ Glucose
3☐ Honey 6☐ Medicine
7☐ Other → SPECIFY: _____
8☐ DON'T KNOW

2. Since birth, the infant had anything to drink other than breast milk?
1☐ Yes 2☐ No 3☐ DON'T KNOW
If YES → SPECIFY: _____

SECTION C. INFANT CARE

1. How long was the infant in skin-to-skin contact with the mother immediately after birth?
1☐ 0 minutes 3☐ > 1 hours
2☐ <1 hour 4☐ N/A

2. How old was the infant at the first breastfeeding?
1☐ <1 hour 3☐ >4 hours
2☐ 1-4 hours 4☐ N/A

3. Was a temperature obtained?
1☐ Yes 2☐ No→ SKIP TO **QUESTION 6**

4. RECORD FIRST INFANT TEMPERATURE:
\|___\|___\|. \|___\| Celsius

5. How old was the infant when the first temperature was obtained?
1☐ <90 minutes 3☐ >4 hours
2☐ >90 minutes – 4 hours 4☐ DON'T KNOW

6. Was cord care with chlorhexidine provided?
1☐ Yes 2☐ No→SPECIFY: _____
3☐ DON'T KNOW

7. Was eye care with tetracycline provided?
1☐ Yes 2☐ No→SPECIFY: _____
3☐ DON'T KNOW

8. Was vitamin K administered?
1☐ Yes 2☐ No
3☐ DON'T KNOW

9. What immunizations were administered to the infant? (SELECT ALL THAT APPLY)
1☐ BCG
2☐ Polio
3☐ Hepatitis B
4☐ Pneumococcal
5☐ Other → a. SPECIFY:_____
6☐ None
7☐ DON'T KNOW

SECTION D. COMPLETION OF FORM

1a. ID of person completing this form:
\|___\|___\|___\|

1b. Date form completed:
\|__\|__\| - \|__\|__\| - \|__\|__\|__\|__\|
dd mm yyyy

2a. ID of person reviewing this form:
\|___\|___\|___\|

2b. Date reviewed:
\|__\|__\| - \|__\|__\| - \|__\|__\|__\|__\|
dd mm yyyy

APPENDIX 4: Infant Outcome Data form IS02

	ECEB Nicaragua Infant Outcome Data	IS02
Page 1 of 1	SUBJECT ID: |___|___|- |___|___|___|___|-|___|___|	Version 1.2 02/26/2015

This form is to be completed at Home Visits at 1 month of age and 2 months of age by the Community Health Promoter.

SECTION A. MORTALITY

1.Is the child still alive?

1☐ No

2☐ Yes → SKIP to **QUESTION 3**

2. Date that the child died:

|__|__| - |__|__| - |__|__|__|__| ☐ DON'T KNOW

dd mm yyyy

3. Is mother still alive?

1☐ No → Answer **QUESTION 4**, then SKIP to **SECTION C**

2☐ Yes → SKIP to **SECTION B**

4. Date that mother died:

|__|__| - |__|__| - |__|__|__|__| ☐ DON'T KNOW

dd mm yyyy

SECTION B. BREASTFEEDING HABITS

1. How many times per day does your child breastfeed?

|__|__| times

2. Are there ever any times when mom is unavailable to feed her child?

1☐ Yes 2☐ Never→ SKIP TO **SECTION C**

3. Who feeds the baby at those times?

SELECT ALL THAT APPLY:

1☐ Grandmother

2☐ Father

3☐ Other child

4☐ Friend/Neighbor

5☐ Other family member

4. What does your child eat or drink when fed by someone else?

SELECT ALL THAT APPLY:

1☐ Pumped breastmilk from mother

2☐ Breastfed/breastmilk from another mother

3☐ Formula

4☐ Solid Foods

5☐ Water

6☐ Sugar water/Juice

7☐ Porridge/Cereal

8☐ Other→(Specify) _____

_____

SECTION C. OTHER FOODS

1. Has the child consumed any foods other than mom's breast milk since our last visit?

1☐ Yes 2☐ No → SKIP to **SECTION D**

2. What other liquids has the child consumed?

SELECT ALL THAT APPLY:

a☐ Water

b☐ Animal Milk

c☐ Formula

d☐ Sugar Water

e☐ Porridge/Rice Water

f☐ Oral Rehydration Solution

g☐ Other →(Specify) _____

h☐ None

Section D. Completion of Form

Q.1a ID of person completing this form:

|___|___|___|

Q.1b Date form completed:

|__|__| - |__|__| - |__|__|__|__|

dd mm yyyy

Q.2a ID of person reviewing this form:

|___|___|___|

Q.2b Date form reviewed:

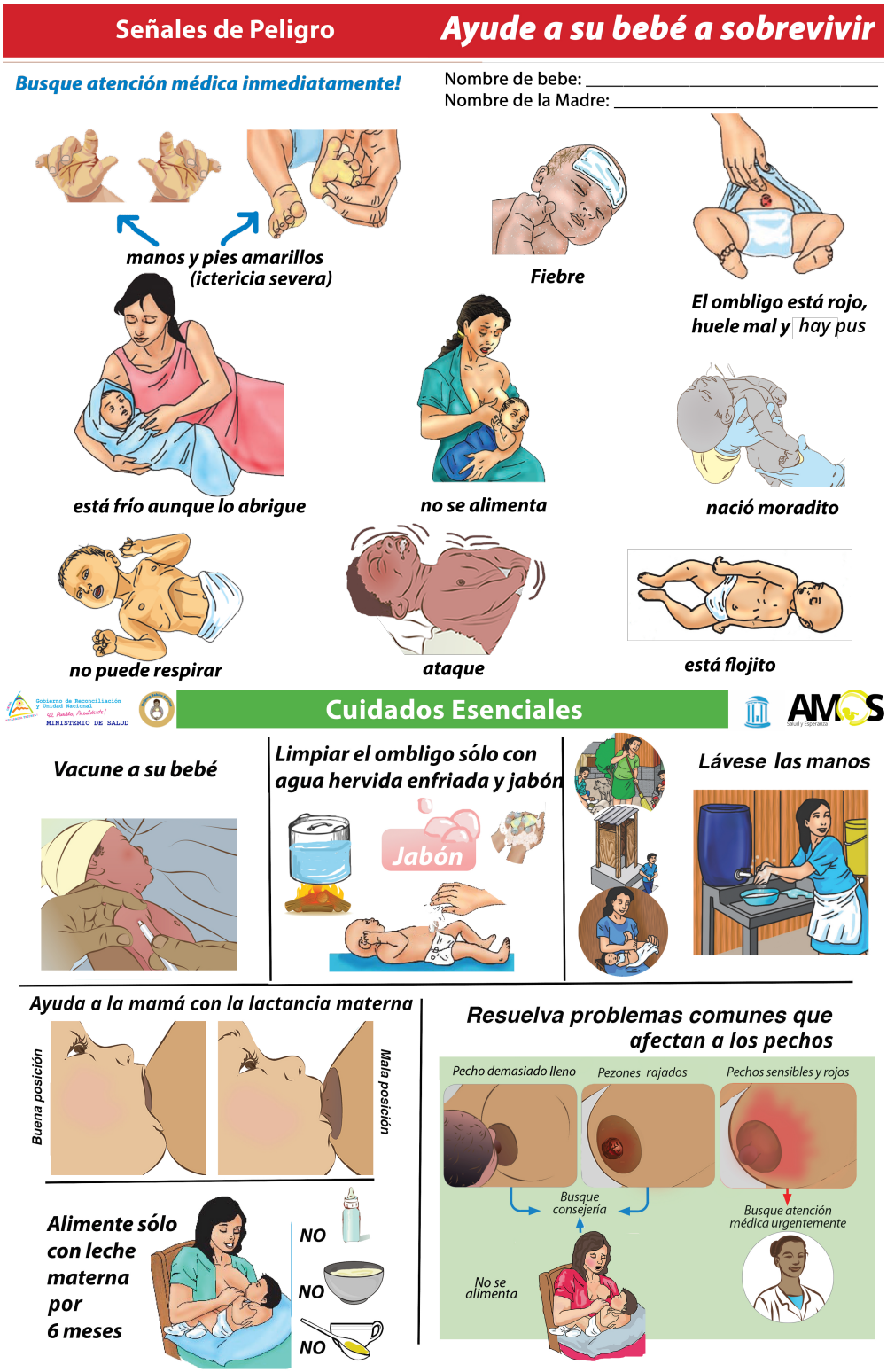
|__|__| - |__|__| - |__|__|__|__|

dd mm yyyy

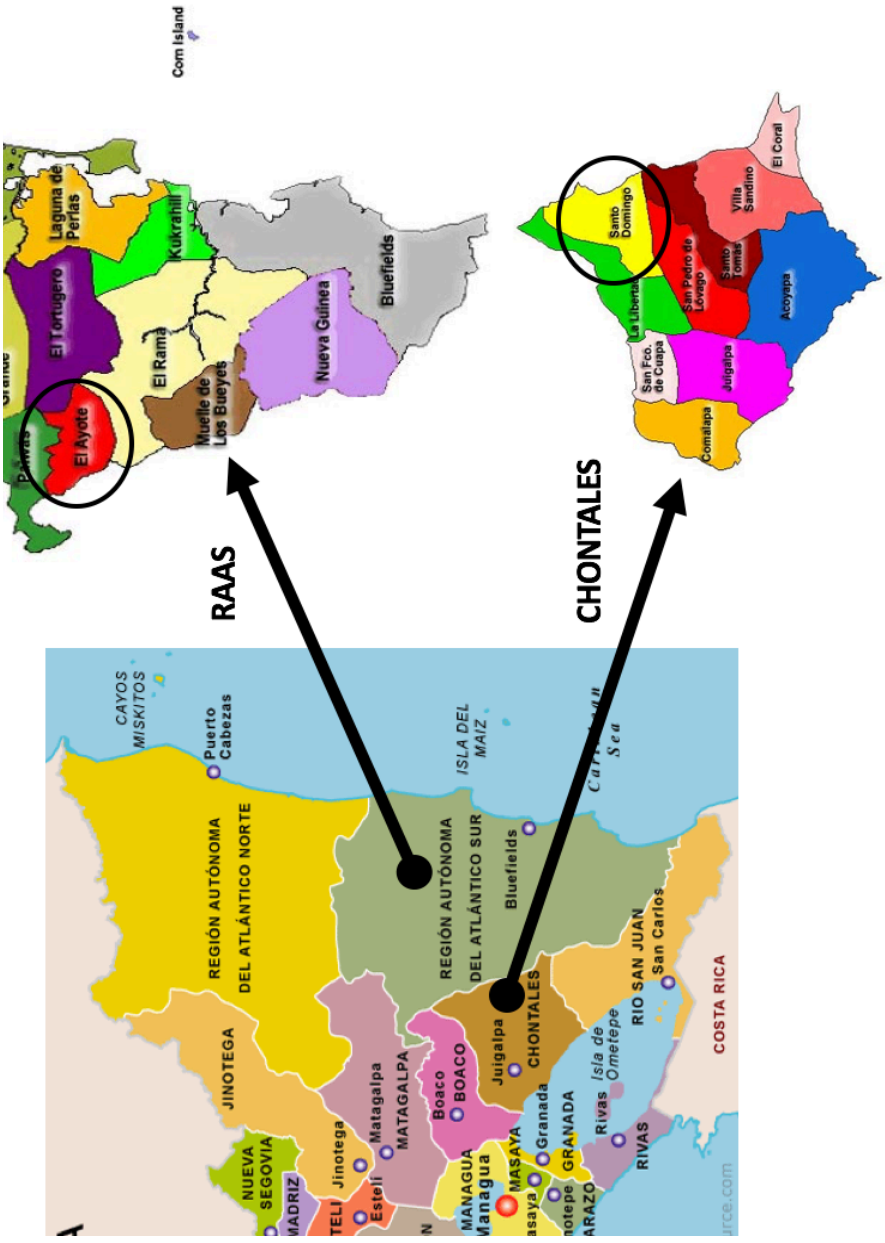
APPENDIX 5: Table of Subsequent HBB-ECEB Trainings

Municipality	Dates	Total people trained	Health Center Staff	Type of Provider	Health Posts Staff	Type of Provider	Training Facilitator
El Ayote (1 Health Center & 3 Health Posts)	10/18 – 10/21/15	16	9	3 doctors 6 nurses	7	2 doctors 5 nurses	4 AMOS staff 2 MINSA staff (nurses)
	10/29 – 10/30/15	3	-	-	3	2 doctors 1 nurse	1 AMOS staff
Santo Domingo (1 Health Center & 2 Health Posts)	8/25 – 8/28/15	14	6	3 doctors 3 nurses	8	2 doctors 6 nurses	4 AMOS staff 2 MINSA staff (nurses)

APPENDIX 6: Parent Guide



APPENDIX 7: Map of the Catchment Areas within Nicaragua



APPENDIX 8: Systematic Review

INTRODUCTION

Neonatal mortality is the main contributor to childhood mortality in the developing world (Liu, et. al 2012; Blencowe et al. 2013). It is defined as death within the first 28-day of life and is expressed as the number of deaths per 1,000 live births. Nearly all neonatal deaths are attributable to three main causes: complications of premature birth, birth asphyxia, and infection (Oza, et al. 2015). Training in neonatal resuscitation and other elements of basic newborn care may effectively reduce deaths from these causes. However, educational program implementation and assessment can be challenging, especially in rural communities where complications of birth leading to neonatal deaths are most likely to occur.

The interventions most likely to improve neonatal mortality revolve around the education and training of families and providers. Additionally, the greatest reduction in neonatal mortality is likely to be appreciated by the integration of resuscitation training into training in other aspects of basic newborn care. The introduction of such interventions as a comprehensive package might decrease neonatal deaths significantly.

Trials assessing the efficacy of educational programs are challenging. Educational programs are often complex with important variations in implementation strategies (including train-the-trainer strategies), persons being trained (medical professional, birth attendants, or families) and content of materials, amongst other things. Additionally, assessment in the areas where most deaths are likely occurring, e.g. rural communities, can be topographically and fiscally challenging. Due to such complexities, systematic studies assessing the effect of community-based educational programs on neonatal and infant health are few, and the ideal mechanism for implementation of such programs remains ill-defined.

Latin America and the Caribbean offer a unique setting to trial such educational programs. Although national neonatal and infant mortality rates demonstrate significant improvements compared to other LICs or LMICs in other parts of the world, significant

disparities persist between urban and rural areas (Casas, Dachs & Bambas 2001). Rural areas are often isolated and neonatal deaths are most likely in these areas (Lawn, Gravett, Nunes & Rubens 2010). Fortunately, the infrastructure of many Latin American and Caribbean countries offer the support of health interventions, including educational programs.

In this systematic review, I will review existing evidence for the implementation of community-based educational programs in Latin American and Caribbean countries as a mechanism to improved neonatal and infant mortality. We investigated outcomes including neonatal or infant death, infection, hypothermia, or other morbidities. Secondary outcomes, such as breastfeeding rates or educational outcomes, were not included as their relation to ultimate outcomes of the neonates and infants was undetermined.

METHODS:

Research question

The primary question of this review was: What are the effects of implementing community-based educational and/or training programs on Latin American and Caribbean neonatal and/or infant mortality?

Criteria for selection of studies

I included original trials, including randomized and nonrandomized trials irrespective of year of publication, with sufficient data published in English or Spanish for inclusion eligibility. We included studies whose subjects included live born infants up to 1 year-of-age born in the community or basic health facilities. Infants born in tertiary care facilities such as neonatal intensive care units were excluded.

We included studies evaluating educational or training programs compared to other standard of care as determined by historical context or current national standard. We excluded studies with other comparators, such as experimental therapies or interventions such as the use

of prophylactic systemic antibiotics. We also excluded studies without any educational or training component to the intervention for patients, patients' families and/or for providers.

Outcome measures of interest included neonatal mortality or infant mortality. We excluded studies whose outcomes were limited to the educational attainment of trainees, such as pre- and post-training assessments. We also excluded studies exclusively reported secondary outcomes such as exclusive breastfeeding rates, anthropometrics such as low birth weight, or other morbidities. We excluded these studies as such secondary outcomes cannot be linked to the primary outcome of death.

We included studies that evaluated stillbirths, neonatal mortality or infant mortality in the community or primary health facilities in Latin America and/or the Caribbean. We excluded studies evaluating outcomes in tertiary care or referral centers such as neonatal intensive care units.

Search methods for identification of studies

I performed a systematic search of the literature using Pubmed, EMBASE, and EBSCO (global health) from their establishment through March 15th, 2015. Filters were used to maximize original research with limitations set to exclude reviews, editorials, or erratums as possible. A medical librarian helped to develop a search strategy using appropriate search terms. The search used the following combination of keywords: *("neonatal health" OR "infant health" OR "newborn health" OR newborn infant [MeSH]) AND (Developing countries OR Global Health) AND (Latin America OR Caribbean Region OR West Indies OR Antigua and Barbuda OR Bahamas OR Barbados OR British Virgin Islands OR Cuba OR Dominica OR Dominican Republic OR Grenada OR Guadeloupe OR Haiti OR Jamaica OR Martinique OR Netherlands Antilles OR Puerto Rico OR Saint Kitts and Nevis OR Saint Lucia OR Saint Vincent and the Grenadines OR Trinidad and Tobago OR United States Virgin Islands OR Central America OR Belize OR Costa Rica OR El Salvador OR Guatemala OR Honduras OR Nicaragua OR*

Panama OR Panama Canal Zone OR South America OR Argentina OR Bolivia OR Brazil OR Chile OR Colombia OR Ecuador OR French Guiana OR Guyana OR Paraguay OR Peru OR Suriname OR Uruguay OR Venezuela) AND (program OR implement* OR program evaluation [MeSH]).* I used broad search terms to maximize results as a limited number of studies were expected. Individual country names were included in the search as broader terms such as "Latin America" and "Caribbean" had limited results. Language was restricted to English or Spanish. No date limits were applied to the search.

Study selection and analysis

One reviewer (Dr. Perez) determined inclusion for full text review of abstracts and titles obtained by the search. Although two reviewers would be ideal, I performed this review solitarily as part of my research project. Eligible studies as determined by full text review were included in the systematic review. The quality of the study, research design, analysis and results were abstracted from included studies.

RESULTS:

Study Characteristics

After removal of duplicate studies, I found 631 articles from the search. From the 631 articles screened, 548 citations were determined to be irrelevant due to reasons including wrong patient population, wrong study design, wrong setting, wrong country, and wrong intervention(s) reported within the abstract. In total, we reviewed 84 full-text articles for eligibility. Of these, 80 articles did not meet eligibility criteria for inclusion in the systematic review. In total, we identified 4 full-text articles for inclusion in this systematic review (Appendix 9). One of the studies was a multi-country pre-/post- design study with cluster randomization, including sites in Guatemala and Argentina (Carlo et al. 2010). Another study described numerous interventions in different countries, including Bolivia and Guatemala (Kwast 1996). The other 2 studies used a pre-/post-

design to evaluate the intervention in Guatemala and Brazil (Garces et al. 2012; Edmond, Pollock, da Costa, Maranhao, & Macedo 2002). Of note, the study in Guatemala was part of the larger multi-country, study but was published separately. There were no additional trials identified through bibliographic citations or other references. See Appendix 10 for a summary of included studies.

Intervention Characteristics

Interventions varied between studies. Two of the studies, noting 1 was a part of the other, evaluated outcomes after training local birth attendants from rural areas in Guatemala and Argentina in the WHO ENC course using a train-the-trainer model (Carlo et al. 2010; Garces et al. 2012). The WHO ENC course teaches basic newborn resuscitation, routine care of the newborn and care of common newborn illnesses. One study described "MotherCare" demonstration projects in Bolivia and Guatemala, noting these projects vary in each location and are broadly described in the study (Kwast 1996). In Bolivia, the project focused on the empowerment of women, improvement of perinatal care and family planning, as well as the training of birth attendants, women and husbands "on safe birth practices" (Kwast 1996, p. 49). In Guatemala, the MotherCare project aimed to improve quality of perinatal care through standards and protocols, train 400 traditional birth attendants to recognize perinatal complications and to make appropriate referrals, and encourage compassionate treatment for birth attendants and women referred to health facilities (Kwast 1996). There was no detailed description on the specifics of how these programs were implemented or how the training occurred. Another study evaluated a "ProNatal" program, a complex program with numerous interventions mostly focused on the improvement in access and quality of health facilities, though also included a segment for the education of nursing and medical students in the pediatric community clinics (Edmond et al. 2002). The content of this education was not further

described, and the amount of content, if any, on neonatal care, was unknown. Thus, only 2 of the 4 included studies described the details of the training.

Participant Characteristics

The two studies evaluating the effects of the WHO ENC program included neonates with birthweight ≥ 1500 grams, both stillbirths and live born infants (Carlo et al. 2010; Garces et al. 2012). Participant characteristics were poorly described or not described in the remaining 2 studies (Edmond et al. 2002; Kwast 1996).

Reported Outcome Measures

There was significant variation in reported outcomes, though all 4 included studies reported mortality outcomes such as stillbirths, early neonatal mortality, perinatal mortality, or infant mortality. Outcomes described in the 2 studies evaluating MotherCare projects and the ProNatal program had incomplete data (Edmond et al. 2002; Kwast 1996). The large, multi-country study evaluating the ENC program did not separate reported outcomes by country, thus reported outcomes were an average from the 6 included countries, including Argentina and Guatemala as well as the Democratic Republic of the Congo, India, Pakistan, and Zambia (Carlo et al. 2010). The study derived from the multi-country study describes outcomes from Guatemala only (Garces et al. 2012).

Three studies reported the outcome of stillbirth and/or perinatal death, defined as stillbirths plus early neonatal deaths (Carlo et al. 2010; Garces et al. 2012; Edmond et al. 2002). In 2 studies, stillbirths declined significantly after the intervention (Carlo et al. 2010; Garces et al. 2012). Perinatal deaths declined in 2 of the 3 studies (Garces et al. 2012; Kwast 1996), noting 1 of these did not detail the number of stillbirths contributing to the perinatal mortality rate and the decline was only described among the referred mothers during delivery (Kwast 1996).

The other study attributed the reduction in perinatal mortality largely to the decline in stillbirths (Garces et al. 2012).

Early neonatal mortality, defined as death within the first 7 days of life, was reported in 2 of the studies, noting one was derived from the other (Carlo et al. 2010; Garces et al. 2012). Early neonatal mortality was unchanged compared to baseline in both studies. A third study refers to a decline in early neonatal death among infants born to women referred to health facilities, though fails to provide data (Kwast 1996). The ProNatal study reported infant mortality as the primary neonatal outcome, with data derived from national the national registry (Edmond et al. 2002). As a result, infant mortality estimations were reported to be unreliable due to underregistration of infant deaths, though rates were suspected to be improved post-intervention after a later period of more accurate reporting.

Overall, 2 of the 4 included studies had significant limitations in outcome reporting. The 2 studies with more complete data reporting were related, with 1 being a parent study of the other.

DISCUSSION

I evaluated published studies looking at the effects of educational or training programs on neonatal and infant mortality outcomes in Latin American and Caribbean countries. I identified that education of providers on neonatal care appears to result in a reduction in stillbirths, though does not appear to affect perinatal or early neonatal mortality within the first 7 days. Although other educational programs may exist, training in newborn resuscitation and care, such as through WHO ENC program or HBB, appears a critical component in improving stillbirths. The descriptions of the training component of the programs were severely limited in 2 of the 4 studies. There were no studies evaluating long-term sustainability of the educational programs. Unfortunately, there are little data to guide specific implementation strategies.

Stillbirths make up a significant number of perinatal deaths in LICs and LMICs (Lawn, Gravett, Nunes, & Rubens 2010). However, reporting of stillbirths remains a challenge. The

reduction in stillbirths was demonstrated after training in the WHO ENC program in 2 of the studies (Carlo et al. 2010, Garces et al. 2012). Unfortunately, the decline in stillbirths did not translate to a reduction in later neonatal death in these studies. This is consistent with a subsequent study of HBB in Tanzania and India, noting a reduction in stillbirths and/or early neonatal death within 24 hours without a reduction in neonatal mortality rates (Msemo et al. 2013; Goudar et al. 2013). Content of HBB and ENC is very similar, and both programs use a train-the-trainer model. However, there appears to be another component to training and implementation that is crucial for improvements in neonatal mortality or longer-term outcomes.

Some temperance is justified given possible underreporting of deaths, a common concern in rural communities in LICs and LMICs. As a result, many studies rely on survey data rather than vital registration data to capture deaths (Lawn et al. 2010). Training programs may improve reporting of deaths, and baseline data collection prior to the intervention may reduce the variation in reporting of deaths. Two of the included studies collected baseline data and post-intervention data (Carlo et al. 2010; Garces et al. 2012). However, the remaining 2 studies relied heavily on national registries for determining mortality outcomes, making interpretation of their findings more challenging (Edmond et al. 2002; Kwast 1996).

The ideal strategy for training and implementation remains unknown. As previously stated, the 2 included studies demonstrating improvement in stillbirths utilized a train-the-trainer model. This strategy may offer the additional advantage of leaving local trainers to propagate the program and, ideally, continue training. In this way, a train-the-trainer model may improve sustainability. However, specific advantages to a train-the-trainer model on the sustainability of outcome improvements are lacking in the literature. Training is likely only a fraction of what leads to improvement, and evidence suggests that continued monitoring and evaluation, maintenance of knowledge, CQI training, and supportive supervision are additional critical elements to training (NASEM 2015; Rowe, de Savigny, Lanata, & Victoria 2005). It is possible

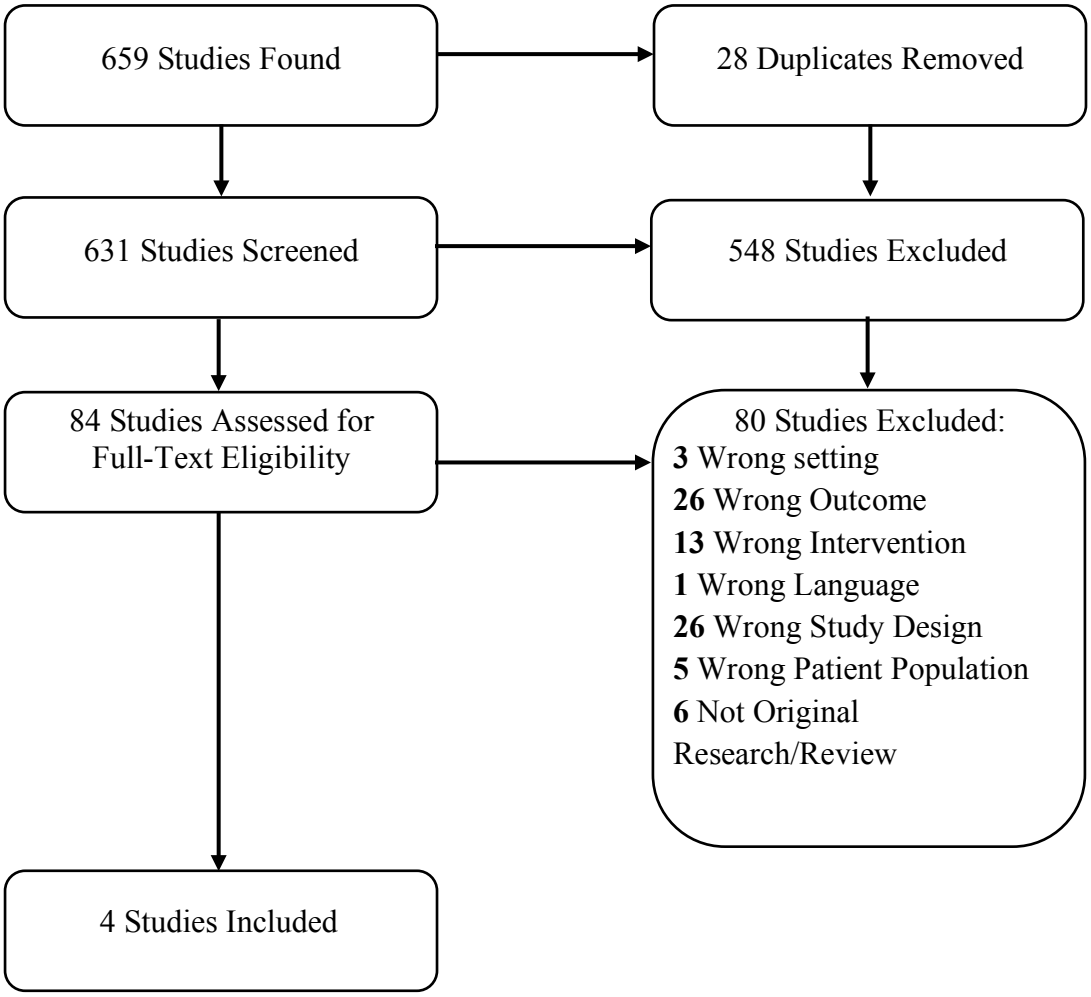
that with the addition of such elements, neonatal and infant mortality may improve beyond perinatal outcomes such as stillbirth.

In summary, although there is limited data in regards to educational programs' effects on neonatal outcomes in Latin America, training in neonatal resuscitation and basic care using a train-the-trainer model may decrease stillbirths in Latin America. Such training has not been shown to improve neonatal mortality, however. More information regarding the effects of CQI and education on CQI in conjunction with ENC training will be available soon. Investigators are conducting demonstration trials using a novel QI workbook to be used in conjunction with HBB and ECEB training. Data obtained from these trials in conjunction with similar ongoing studies on training programs, such as HBB and ECEB, will help guide appropriate implementation strategies for the continued improvement of neonatal and infant outcomes.

CONCLUSIONS

In resource-limited settings in Latin America, training in neonatal resuscitation and basic newborn care may offer a mechanism to reduce stillbirths. Currently, there is no evidence to support such programs reducing overall neonatal or infant mortality. Additionally, there is little evidence on ideal mechanisms for long-term sustainability. Although evidence-based interventions exist, namely as they pertain to basic newborn care, it is unclear which programs, if any, are most effective in Latin America and the Caribbean. Future areas of research could include effectiveness studies to determine implementation strategies, target population to be trained, and mechanisms for sustainability.

Appendix 9: PRISMA Diagram



APPENDIX 10: Table of Included Studies

Source	Patient Population/ Countries	Intervention	Trial Design	Outcomes	Results
Carlo WA, et al. 2010	**ENC: 57,643** infants **NRP: 62,366** infants Infants ≥1500 grams & ≥ 28 weeks gestation Rural areas of Argentina, Democratic Republic of Congo, Guatemala, India, Pakistan & Zambia)	*Train-the-Trainer model* 1.WHO ENC program 2.NRP training (except in Argentina) **Physicians, nurses, birth attendants, and mothers** trained	Pre-/Post- design, cluster-randomized controlled triali	Primary- Early neonatal death, all causes (within 7 days) Secondary- Stillbirths & perinatal mortality	After ENC: Decreased stillbirths (RR 0.69; 95% CI 0.54, 0.88, p=0.003) No change in early neonatal deaths (RR 0.99; 95% CI 0.81, 1.22) No change in perinatal mortality (RR 0.85; 95% CI 0.70, 1.02) After NRP: No change in stillbirths, early neonatal death or perinatal mortalty
Garces A, et al. 2012 (Guatemala) *Part of Carlo WA, et.al trial above)	**4798** infants Infants ≥1500 grams Rural Guatemala	*Train-the-Trainer model* 1.WHO ENC program **Physicians, nurses, & birth attendants**	Pre-/Post- design, prospective trial	Primary- Early neonatal death, all causes (within 7 days) Secondary- Stillbirths & perinatal mortality	Decreased stillbirths (RR 0.40; 95% CI 0.25, 0.64) No change in early neonatal deaths (RR 1.05; 95% CI 0.7, 1.57) Decrease in perinatal mortality (RR 0.72; 95% CI 0.54, 0.97)
Edmond A, et al. 2002 (Brazil)	**Number not reported**, though national birth registration with 2420 births in the area Rural Brazil	ProNatal project: Open antenatal clincs, maternity facilities, family planning clinic, breastfeeding clinic, improvement of children's services and clinics, introduction of community health agents, & **teaching in public health & pediatrics to nursing and medical students in the community**	Pre-/Post-design, prospective trail	Undefined, though data reported for maternal, infant and child mortality and morbidities as well as demographics	Changes in infant mortality initially reported as inaccurate for "underregistration" Later data collection with improvent in infant mortality without any data reported
Kwast B. 1996 (Bolivia & Guatemala)	**Number not reported** Rural Bolivia & Guatemala	MotherCare project Bolivia: Development of women's groups, & perinatal action protocols for birth attendants and women, **training of birth attendants, women and husbands**, & strengthening of referral resources MotherCare project Guatemala: **Train 400 birth attendants**, implementation of protocols for perinatal complications, and sensitization of providers to women and birth attendants	Non-randomized trial (Guatemala) Ongoing prospective trial (Bolivia)	Undefined, though outcomes reported for perinatal mortality (Bolivia & Guatemala) & early neonatal deaths (Guatemala)	Improvement in perinatal mortality from 105 to 38 per 1000 deaths (Bolivia) Improvement in perinatal mortality **in the referrals** from 22 to 12.% No improvement in early neonatal deaths.

ABBREVIATIONS

LIC – Low income countries

LMIC - Low-middle income countries

AAP – American Academy of Pediatrics

HBB – Helping Babies Breathe

ECEB – Essential Care for Every Baby

WHO – World Health Organization

ENC – Essential Newborn Care

MINSA – Ministry of Health

QI – Quality Improvement

CQI – Continuous Quality Improvement

SILAIS – Local Health System in Nicaragua

NRP – Neonatal Resuscitation Program

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