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# Evaluation of two newborn resuscitation training strategies in regional hospitals in Ghana

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ABSTRACT

*Aim:* In Ghana, institutional delivery has been emphasized to improve maternal and newborn outcomes. The Making Every Baby Count Initiative, a large coordinated training effort, aimed to improve newborn outcomes through government engagement and provider training across four regions of Ghana. Two newborn resuscitation training and evaluation approaches are described for front line newborn care providers at five regional hospitals.
*Methods:* A modified newborn resuscitation program was taught at the Greater Accra Regional Hospital (GARH) and evaluated with real-time resuscitation observations. A programmatic shift, led to a different approach being utilized in Sunyani, Koforidua, Ho and Kumasi South Regional Hospitals. This included Helping Babies Breathe (HBB) and Essential Care for Every Baby (ECEB) training followed by objective structured clinical examinations (OSCE) with manikins at fixed intervals. Data was collected on training outcomes, fresh stillbirth and institutional newborn mortality rates.
*Results:* Training was conducted for 412 newborn care providers. For 120 staff trained at GARH, resuscitation observations and chart review found improvements in conducting positive pressure ventilation. For 292 providers that received HBB and ECEB training, OSCE pass rates exceeded 90%, but follow-up decreased from 98% to 84% over time. A decrease in fresh stillbirth and institutional newborn mortality occurred at GARH ($p < 0.05$), but not in the other four regional hospitals.
*Conclusion:* Newborn resuscitation training is warranted in low-resource settings; however, the optimal training, monitoring and evaluation approach remains unclear, particularly in referral hospitals. Although, mortality reductions were observed at GARH, this cannot be solely attributed to newborn resuscitation training.

## Introduction

In Ghana, significant reductions have occurred in infant and under-five mortality rates over the last two decades.[1] By contrast, neonatal mortality rates have shown slower decline and account for nearly 50% of deaths in children under the age of five.[1] Most neonatal deaths occur within the first week of life primarily due to intrapartum birth asphyxia, prematurity and sepsis.[2] This has led to recommendations that births should occur in health facilities where both mother and newborn can be attended by skilled providers.[2–4] As such, deliveries in health facilities in

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Ghana have increased from 54% to 79% in the last decade.[1] Unfortunately, however, the quality of care provided has been inadequate to prevent early neonatal deaths.[3,4]

Over 15 years, organizations such as the Church of Jesus Christ of Latter-Day Saints, United Nations (UNICEF), Kybele, and Project CURE, have taught newborn resuscitation in Ghana in efforts to reduce birth asphyxia.[4,5] Though potentially useful, these endeavors lacked central coordination, leading to fragmentation and the use of various curricula and tools.[4,5] In addition, insufficient mechanisms for ongoing training and follow-up resulted in knowledge gaps among healthcare workers.[6] The Making Every Baby Count Initiative (MEBCI) was launched in 2013 with support from the Children's Investment Fund Foundation (CIFF) to address these deficiencies and to improve newborn outcomes in line with the National Newborn Action Plan and Strategy.[7] As Ghana's largest coordinated neonatal training effort, MEBCI was a five-year partnership between the Ghana Health Service (GHS), PATH, Kybele, Inc. and CIFF. A key goal was to provide sustainable, high-quality newborn care to address asphyxia, infection, and prematurity. The project sought to strengthen national leadership to sustain newborn health best practices and to build the capacity of regional, district and selected lower level health facilities in four regions of Ghana to improve newborn care.

The primary training package included Helping Babies Breathe (HBB) and Essential Care for Every Baby (ECEB), programs developed by the American Academy of Pediatrics (AAP) in conjunction with other partners for resource-limited settings.[8–10] These programs focus on neonatal resuscitation and postnatal newborn care.[11] Initially, this training package was planned for district and lower level hospitals, while a broader, more advanced clinical skills training and mentoring program was designed for higher level regional hospitals. The advanced clinical skills training included obstetric triage, labor and delivery management, leadership development and quality improvement, in addition to newborn resuscitation, as has been described.[12] The neonatal resuscitation training component originally planned for regional hospitals was based on the Newborn Resuscitation Program (NRP) developed by the AAP and American Heart Association (AHA).[13] A program template was piloted at the Greater Accra Regional Hospital (GARH), the largest delivery facility in the GHS, with plans to scale it to the targeted regional hospitals. The plan was cancelled, however, when the funder altered the work scope whereby all facilities within the four regions would receive the basic HBB and ECEB training package, including the four regional hospitals, prior to incorporating an advanced resuscitation skillset.

The change in project direction provided the opportunity to evaluate the adoption of two neonatal resuscitation training approaches within regional hospitals in a low resource setting. Previous training programs conducted in low and middle-income countries (LMIC) have used either NRP or HBB, with varying levels of success.[14–17] We describe the two training and evaluation approaches and the associated outcomes in five regional hospitals in Ghana, with consideration that the report was not designed for statistical comparison.

## Methods

### *Program setting*

Ghana is a West African country with a health system comprised of community-based health centers at the lowest level, district hospitals at the intermediate level, and regional hospitals and teaching hospitals at the highest level. Neonatal resuscitation training was conducted in five regional hospitals for healthcare workers directly involved in childbirth and newborn care, primarily midwives, neonatal nurses, nurse anesthetists and doctors, using two methodologies described below.

### *NRP training site: The Greater Accra Regional Hospital*

Initially, structured observations of real-time midwife resuscitation practices were conducted using a modified AHA/AAP NRP integrated skills station performance checklist.[13] Observations were conducted six to nine months before and following training in the labor ward and obstetric theatre by NRP certified healthcare providers from the United States (US) familiar with the local setting. The training content, adapted from the NRP 6th Edition, included: Principles of Resuscitation, Initial Steps of Resuscitation, Use of Resuscitation devices for Positive-Pressure Ventilation (PPV), and Chest Compressions.[13,18] Six US based NRP instructors (one neonatologist, one neonatology fellow, one pediatrician, and three registered labor and delivery nurses) visited Ghana for 10–14 days at 3- to 4-month intervals to conduct observations, training, supportive supervision and bedside mentoring.

Each NRP training was a one-day, 4-h session at the GARH. A pilot course was delivered in September 2014 to determine appropriateness for this setting. In January 2015, seven training sessions were conducted over two weeks with one additional session in December 2015 for newly hired or previously untrained midwives. Training was context specific, addressing pre-training performance gaps identified through the structured observations. At the beginning and end of each session, participants completed a 20-question multiple choice examination provided in the NRP textbook.[13] During training, participants had opportunities to practice resuscitation techniques on mannequins including drying and stimulation, clearing the airway, providing PPV with a self-inflating bag, administering chest compressions, and coordinating chest compressions with PPV. Hands-on coaching was given to each participant to facilitate learning. In addition, two motivated labor ward midwives were trained to become neonatal resuscitation instructors at the GARH.

Data were collected on resuscitation provided for GARH delivered newborns with Apgar scores of 0–3 and neonatal intensive care unit (NICU) admissions for birth asphyxia. We concentrated on newborns with Apgar scores of 0–3, because these would have uniformly required PPV. Data were manually extracted from logbooks and patient folders or electronically extracted via a Microsoft Access database. Electronic data were inputted by local data collectors employed by the GHS, unaffiliated with the training program and validated.

### *HBB training sites: Kumasi South, Sunyani, Koforidua and Ho regional hospitals*

The MEBCI program targeted the Ashanti, Brong Ahafo, Eastern and Volta regions, which included the Kumasi South, Sunyani, Koforidua and Ho Regional Hospitals, respectively. A detailed assessment was conducted in each facility prior to training evaluating available equipment and medications, treatment protocols, laboratory services, staffing, infection prevention measures, waste management and delivery data. This information provided a baseline for facility readiness to implement training. Furthermore, training materials were provided to trainees for review.

Training in HBB, ECEB and infection prevention was conducted systematically in a conference center over five days according to the following schedule: HBB (1.5 day), ECEB (2 days), infection prevention (1 day) and implementation planning (0.5 days). A written pre- and post-test were administered including 17 questions for HBB, 25 for ECEB and 8 for infection prevention. Each training session included 24 multidisciplinary trainees divided into four groups with one trainer per group. The training team included five physicians, midwives and nurses from England and the US and six master trainer midwives from the GHS. Training sessions were conducted during May (two sessions), July (four sessions) and September (four sessions) 2016 and January (two sessions) 2017. Following short dedicative presentations, hands on practice with manikins and role playing were incorporated. Trainees were immediately evaluated with standardized OSCEs in HBB and ECEB and were re-tested with the same scenarios in their respective hospitals at 4–6 weeks, 5–6 months and 12–13 months following training. Follow-up assessments were done by individuals unaffiliated with the training but familiar with the training program. At each follow-up visit, equipment and supply availability, cleaning techniques, hand-washing capability and delivery

documentation were recorded and shared with hospital management. An allotment of resuscitation equipment was also dispensed at each regional hospital.

Course participant and assessment score data were maintained using Excel 2013 (Version 15) and results were grouped by hospital. An external evaluator collected information on institutional deliveries, newborn deaths, fresh and macerated still births through manual extraction from logbooks and patient folders. Results with each training approach were analyzed using Chi-squared, paired *t*-test or a test of binomial proportions, as appropriate, with $p < 0.05$ as significant. Institutional review board approval was granted by Cincinnati Children's Hospital Medical Center, Wake Forest University Health Sciences, and the GHS.

## Results

Four hundred twelve healthcare providers were trained in newborn resuscitation in Ghana including: Greater Accra (120), Kumasi South (72), Sunyani (73), Koforidua (77) and Ho (70) Regional Hospitals.

### *NRP training site: The Greater Accra Regional Hospital*

One hundred twenty healthcare personnel were trained (4 in September 2014, 103 in January 2015, and 13 in December 2015) including all 26 midwives providing delivery or operating room newborn care. Written examinations were completed by 79 participants pre-training and 72 post-training; 64 of these (53%) of participants completed both a pre- and post-training examination for paired analysis. After training, there was a 23% increase in mean ± standard deviation examination scores from 58 ± 14 to 81 ± 12% for all test takers ($p < 0.01$). Midwives had higher pre-and post-training examination scores (67 ± 6; 85 ± 8) than did non-midwives (55 ± 14; 80 ± 13); however, both groups improved significantly ($p < 0.01$).

Fifty-one real-time delivery room observations were performed pre-training and 60 post-training (Table 1). Of the pre-training assessments, two were excluded due to observer unavailability for part of the assessment. Of post-training assessments, 18 were excluded because observations were made on untrained midwives and in three, the observer was unavailable for the full assessment. In preparation for resuscitation, cleanliness of the resuscitation environment and equipment increased ($p < 0.01$) but glove availability for resuscitation decreased ($p = 0.04$). During resuscitation, newborn reassessment after 30 s and PPV as noted by chest rise improved ($p < 0.01$) but no improvement occurred in initiating PPV within 1 min in the absence of respiration. In addition, unnecessary suctioning during resuscitation decreased ($p < 0.01$).

In a baseline audit of 446 NICU admissions from November 2013 to May 2014, 155 (35%) newborns had 1-min Apgar scores ranging from 0 to 3 (Fig. 1). Of these, only 28 (18%) had PPV documented. During the 2015 training year, 323 (31%) of 1048 NICU admissions had 0 to 3 1-min Apgar scores; however, PPV increased to 61% ($p < 0.001$). In the post-training year, from January to June 2016, 158 (35%) of 450 NICU admissions had 0 to 3 1-min Apgar scores and documentation of PPV improved to 80% (Fig. 1; $p < 0.001$). Similarly, for 5-min Apgar scores of 0–3, PPV documentation improved from 19% to 90% post-training (Fig. 1; $p < 0.001$). Inborn NICU admissions for birth asphyxia decreased from 154/446 (35%) pre-training to 61/450 (14%) post-training ($p < 0.001$).

### *HBB training sites: Kumasi South, Sunyani, Koforidua and Ho regional hospitals*

For the hospitals where HBB and ECEB were taught, the number of providers trained and reevaluated are shown in Table 2. Trainees consisted of 151 (52%) midwives, 42 (14%) NICU nurses, 40 (14%) theatre and recovery room nurses, 28 (10%) nurse anesthetists, and 17 (6%) physicians. The remaining 14 (5%) were senior nurses and community health workers. The mean ± SD (range) pre-and post-test examination scores were 87 ± 7 (56–100) and 96 ± 4 (50–100), respectively ($p < 0.001$). The OSCE pass rates are shown in Table 3. The HBB OSCE questions most frequently missed were initiating PPV within 1 min when indicated (28%), changing wet linen during resuscitation (20%) and ventilating at the correct rate (19%).

The baseline facility assessment revealed a paucity of newborn resuscitation equipment. Equipment was unclean and poorly functioning including donated Ambu bags and suctions bulbs meant for single use. Many identified problems remained, such as space limitations, plumbing disrepair, rotation of trained staff to other hospital areas, poor provision for training new staff, inadequate assessment of clinical skills in practice, limited hand hygiene capability and disrepair of faulty equipment. There were improvements in delivery register completion, availability of essential newborn medications, preparation of sterilizing fluids and overall cleanliness.

**Table 1**
Observations of newborn resuscitation before and after newborn resuscitation program training.

| Measure | Skill Observed Pre-training (%) | Skill Observed Post-Training (%) | p-value |
|---|---|---|---|
| Preparation for Neonatal Resuscitation | | | |
| Resuscitation environment is clean | 36/49 (73) | 39/39 (100) | <0.01 |
| Resuscitation equipment is clean | 33/49 (67) | 38/39 (97) | <0.01 |
| Ensures that suction available for delivery | 31/48 (65) | 25/38 (66) | 0.94 |
| Checks that oxygen source is functioning | 21/48 (44) | 23/39 (59) | 0.17 |
| Ensures that appropriate sized bag and mask is present | 25/49 (51) | 24/40 (60) | 0.40 |
| Places gloves at resuscitation area | 45/49 (92) | 29/38 (76) | 0.04 |
| Ensures that towels are present at resuscitation area | 45/49 (92) | 34/38 (90) | 0.69 |
| Checks radiant warmer; turns it on | 25/49 (51) | 21/36 (58) | 0.51 |
| During resuscitation | | | |
| Stimulates baby appropriately (i.e. no slapping) | 47/49 (96) | 39/39 (100) | 0.21 |
| Assesses baby's condition after 30s (heart rate, apnea) | 25/38 (66) | 36/39 (92) | <0.01 |
| Unnecessary suctioning performed | 15/22 (68) | 3/33 (9) | <0.01 |
| Provides suctioning before stimulation in non-vigorous meconium baby | 0/4 (0) | 3/8 (38) | 0.18 |
| Effective spontaneous respirations achieved or PPV initiated within 1 min of life | 13/15 (87) | 24/35 (69) | 0.18 |
| Initiates positive pressure ventilation if baby is apneic | 7/11 (64) | 8/12 (67) | 0.89 |
| Gives effective PPV noted by chest rise | 2/8 (25) | 9/10 (90) | <0.01 |
| Gives PPV at acceptable rate | not measured | 8/10 (80) | – |
| Reassesses heart rate and breathing after 30s | 2/9 (22) | 6/10 (60) | 0.10 |
| Communicates with team member if condition poor | 1/4 (25) | 5/7 (71) | 0.16 |
| Performs corrective steps to ventilation if PPV is not effective and HR > 60 | 1/6 (17) | 1/2 (50) | 0.38 |
| Initiates cardiac compressions if HR < 60 | 2/3 (67) | 1/2 (50) | 0.73 |
| Correctly performs cardiac compression in 3:1 count | 0/3 (0) | 1/1 (100) | 0.08 |
| Uses the two thumb or 2 finger technique correctly | 0/3 (0) | 1/1 (100) | 0.08 |
| Reassesses heart rate after 30 s | 3/5 (60) | 1/1 (100) | 0.48 |
| Provides warmth, stimulation, suctioning, PPV, chest compressions in correct order | not measured | 24/28 (86) | – |

Data are presented as number (percent) of observations. PPV = positive pressure ventilation, HR = heart rate.

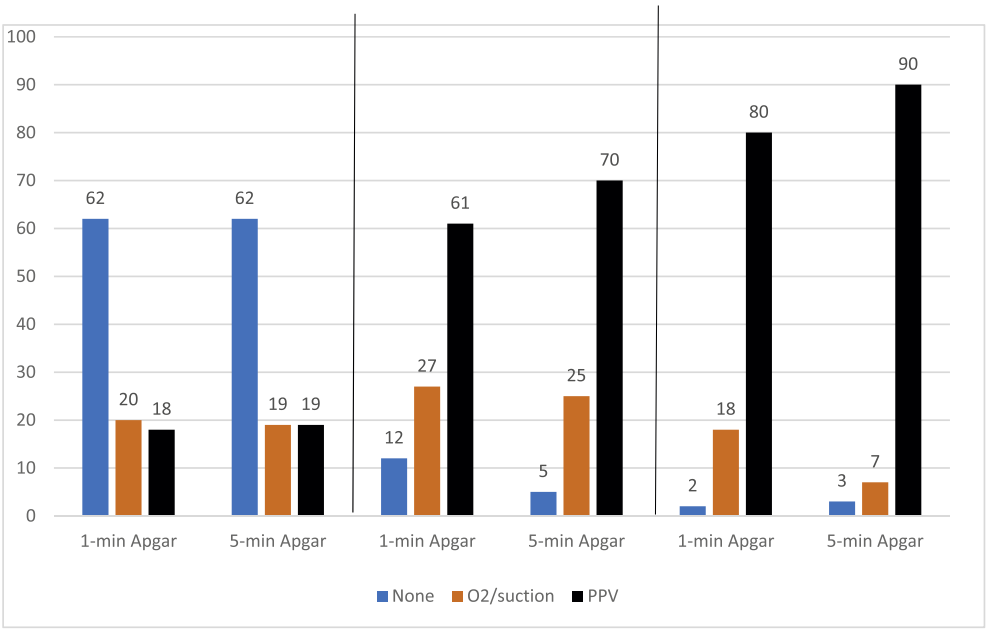


**Fig. 1.** Resuscitation Practices for Newborns with 1- and 5-min Apgar Scores of 0–3 during the Pre-training, Training and Post-training Periods.
A chart audit of newborn intensive care admissions was conducted for births occurring at the Greater Accra Regional Hospital. Resuscitation efforts documented for newborns having Apgar scores ranging from 0-3 included no resuscitation, oxygen and suction or positive pressure ventilation (PPV). In the pre-training period (left panel; November 2013 to May 2014) there were 446 admissions, of which 155 (35%) and 53 (12%) had 1- and 5-min Apgar scores from 0 to 3, respectfully. During the training year (middle panel; 2015), there were 1048 admissions for which 323 (31%) and 128 (12%) had 1- and 5-min Apgar scores ranging from 0 to 3. In the post-training period (right panel; January to June 2016), there were 450 admissions of which 158 (35%) and 68 (15%) had 1- and 5-min Apgar scores ranging from 0 to 3. A significant increase in the use of PPV occurred in the training year and post-training half year for newborns with 0–3 Apgar scores both at 1- and 5-min ($p < 0.001$; Chi-square).

**Table 2**
The number of providers trained and reassessed in HBB and ECEB at regional hospitals in Ghana.

| Region | Regional Hospital | Trained (n) | OSCE-1 (4–6 wk) | OSCE-2 (6 mo) | OSCE-3 (12 mo) |
|---|---|---|---|---|---|
| Eastern | Koforidua | 77 | 75 (97) | 67 (87) | 50 (65) |
| Volta | Ho | 70 | 68 (97) | 61 (87) | 62 (89) |
| Brong Ahafo | Sunyani | 73 | 72 (99) | 72 (99) | 68 (93) |
| Ashanti | Kumasi South | 72 | 71 (99) | 69 (96) | 65 (90) |
| Number (%) | | 292 | 286 (98) | 269 (92) | 245 (84) |

Data represent the number (%) of providers initially trained and reassessed at regional hospitals at 4–6 wk, 6-mo and 12-mo intervals following training using OSCE evaluations. Loss to follow-up was observed over time.

**Table 3**
Number and percent of providers passing OSCE evaluations for HBB and ECEB on first attempt.

| | Koforidua N (%) | Ho N (%) | Sunyani N (%) | Kumasi South N (%) | Total N (%) passing first attempt |
|---|---|---|---|---|---|
| **HBB OSCE** | | | | | |
| Training | 75/77 (97) | 68/70 (97) | 71/73 (97) | 71/72 (99) | 285/292 (98) |
| OSCE-1 | 73/75 (97) | 60/68 (88) | 66/72 (92) | 60/71 (85) | 259/286 (91) |
| OSCE-2 | 63/67 (94) | 53/61 (87) | 72/72 (100) | 68/69 (99) | 256/269 (95) |
| OSCE-3 | 47/50 (94) | 60/62 (97) | 64/68 (94) | 62/65 (62/65) | 233/245 (95) |
| **ECEB OSCE** | | | | | |
| Training | 72/77 (94) | 66/70 (94) | 71/73 (97) | 71/72 (99) | 280/292 (96) |
| OSCE-1 | 75/75 (100) | 63/68 (93) | 66/72 (92) | 67/71 (94) | 271/286 (95) |
| OSCE-2 | 67/67 (100) | 58/61 (95) | 69/72 (96) | 69/69 (100) | 263/269 (98) |
| OSCE-3 | 50/50 (100) | 62/62 (100) | 68/68 (100) | 63/65 (97) | 243/245 (99) |

Participants were given standardized OSCE assessments for HBB and ECEB. The minimum passing score for the OCSEs were 16/23 for HBB and 20/28 for ECEB. Data are shown for the number (%) passing on the first attempt. No one required more than 3 attempts.

Fresh stillbirth and institutional newborn death rates for the regional hospitals are shown in Fig. 2. Fresh stillbirth and the institutional newborn death rates significantly decreased at the GARH ($p < 0.05$) but improvements were not observed at the other regional hospitals.

## Discussion

We describe two neonatal resuscitation training and evaluation approaches for 412 front-line healthcare workers in five regional hospitals in Ghana. From 2013 to 2015, one training approach utilized NRP, modified to the hospital context through structured, real-time clinical observation and evaluated by review of resuscitation documentation and NICU admission for asphyxia. From 2016 to 2018, a separate approach conducted HBB and ECEB training in nonclinical settings with manikin based OSCE simulations given at three specific follow-up intervals. While there is little debate that newborn resuscitation training is needed in low resource settings, the optimal training, monitoring and evaluation approach remains unclear, particularly for referral and teaching facilities.

Initially, the AAP/AHA NRP training course was selected, given that regional hospitals receive high risk referrals and personnel may require skills more advanced than HBB and ECEB. Advanced neonatal resuscitation, the standard of care for high-income countries (HIC), includes chest compressions, endotracheal intubation, and medication administration for full cardiopulmonary resuscitation. Training efforts, even in low resource settings, should endeavor to reach to the highest capabilities of regional and teaching hospitals. The results from GARH support previous findings that NRP can be modified for use in low-recourse hospitals to improve the knowledge and skills of health professionals in neonatal resuscitation.[5,15,18] Not only did documentation of PPV improve for severely depressed newborns, fresh stillbirth rates and NICU admissions for asphyxia decreased, as similarly shown.[19,20] Babies born without respiratory effort can be misclassified as stillbirth and may not be resuscitated.[17] Our data support that respiratory assistance was progressively provided to babies that previously may have been considered

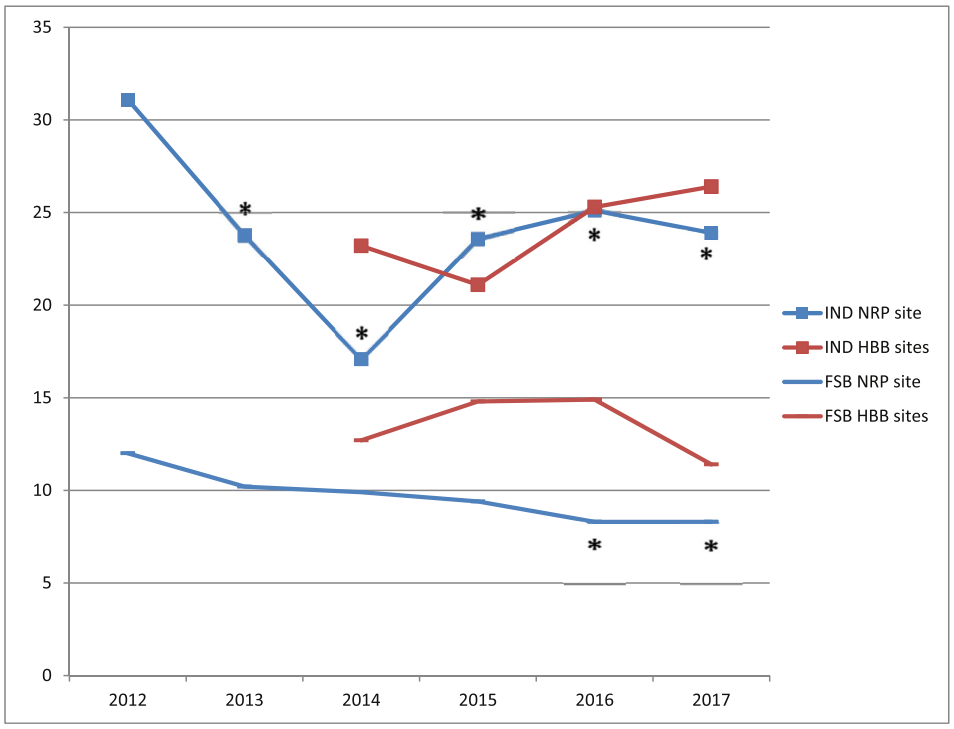


**Fig. 2.** Institutional Newborn Death and Fresh Stillbirth Rates.
Institutional newborn death (IND) and fresh still birth (FSB) rates are shown for the Greater Accra Regional Hospital (NRP site; blue lines) and three other regional hospitals (HBB sites; red lines) combined (Koforidua, Ho and Sunyani Regional Hospital). Data for HBB sites were pooled or excluded (Kumasi South) due to missing data and frequent newborn referral to a higher-level facility. The IND and FSB rates were calculated each year as the number of IND or FSB/total live births $\times$ 1000. The NRP site had an average of 8329 live births per year compared to 9659 to the combined HBB sites. At the NRP site, there was a decrease in IND ($p < 0.05$) each year and a decrease in FSB for 2016 and 2017 compared to baseline ($p < 0.05$). Significant improvements were not observed at the other regional hospitals. NRP = newborn resuscitation program; HBB=Helping Babies Breath. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

dead. In this setting, intubation skills were not taught as part of NRP because mechanical ventilation was unavailable. Therefore, which program was taught was probably irrelevant, given that both approaches emphasized the basic skills of prompt bag-mask ventilation in a non-breathing baby. The differences were more likely related to the manner in which performance was evaluated and how on-site observations and coaching were utilized.

Evaluating and maintaining resuscitation knowledge and skills following training is challenging.[15,17,21] Both approaches evaluated performance over time, one using direct clinical observation and analysis of NICU data and the other OSCE simulation. The pros and cons of real-time observations vs OSCE assessments to evaluate resuscitation skills are summarized in Table 4. At GARH, the initial clinical observations revealed that many providers could not operate the radiant warmer or correctly perform PPV. These observations led to adjustments in the training content to address specific knowledge and skill gaps. Furthermore, unnecessary and aggressive suctioning was frequently administered with unclean and inappropriately sized tubing, as has been reported.[22,23] This widespread, culturally entrenched practice can be harmful, causing infection, trauma, and bradycardia.[24] Fortunately, post training observations demonstrated a decreased use of wall suction and improved PPV competency, but initiating PPV within 1 min when indicated remained inadequate, as similarly shown.[25] The disadvantage of observational assessments are the unpredictability in knowing how many newborns will require resuscitation during the audit period and the subsequent difficulty in evaluating all trained staff. We sought to overcome this limitation by reviewing resuscitation data over two years surrounding training. We analyzed resuscitation documentation in neonates with Apgar scores <3 and found significant increases in PPV after training, both at one and 5 min; however, a gap remained in initiating PPV at 1 min compared to 5 min, consistent with direct observation. While the improved documentation of PPV does not confirm correct administration, the reduction in asphyxia related NICU admissions and in fresh stillbirth rates is compelling.

Conversely, the use of OSCE has been promoted to systematically assess HBB knowledge and manual skills according to clinical scenarios, but simulations do not consistently translate into bedside performance

**Table 4**
Real-time clinical observations vs. OSCE evaluations.

| Real-time observations | OSCE |
|---|---|
| Pros:<br>• Evaluates real performance<br>• Allows for better understanding of know-do gaps | Pros:<br>• Providers take testing seriously<br>• More providers can be tested<br>• Providers can be re-tested at intervals to assess knowledge retention |
| Cons:<br>• Can't predict the number of deliveries or resuscitations that will occur | Cons:<br>• Simulated environment<br>• Simulations can be memorized if reused<br>• Performance may not correlate with clinical practice |

improvements.[24–26] Work in Tanzania found that HBB training sufficiently maintained resuscitation skills during simulation, but outcomes did not improve.[25] Similarly, the MEBCI program revealed that while healthcare personnel gained and retained knowledge and skills during simulations conducted over a year, fresh stillbirth and institutional newborn death rates did not improve. These results reflect the complex nature of healthcare systems, which require more than facility assessments and provider training to support change. Recent studies demonstrate improvement when training is combined with frequent, on-site simulation, coupled with coaching, mentoring and reinforcement by facility-based champions.[4,24,27–29] Frontline users also report that OSCE simulations are cumbersome, confusing and may not enhance a learner's experience.[29] Indeed, the HBB training materials have recently undergone revision to address these considerations.[29,30]

While GARH showed decreases in stillbirth rates, NICU admissions for birth asphyxia, and newborn mortality, the results cannot be solely causally linked to NRP training alone because other concerted capacity building efforts were simultaneously made to reinforce maternal and neonatal care, including maternal triage, intrapartum care, leadership development and quality improvement.[31–33] Others have similarly shown reductions in stillbirth and newborn mortality when resuscitation training was paired with ongoing quality improvement, implementation

methodology and leadership development.[34,35] The critical condition of mothers and neonates cared for in referral hospitals require that motivated and trained staff recognize and provide timely and correct interventions. A challenge identified with both training approaches was the high turnover and rotation of staff, hindering the achievement of having fully trained provider coverage within the regional hospitals. The onus is upon the GHS and other partners to influence policy to initiate pre-service and in-service training to maintain knowledge and skills.

## Conclusions

National programs to provide newborn resuscitation training should ensure that training is appropriate for the facility level. During the period studied, neonatal outcomes at GARH improved, likely owing to a combination of capacity building activities and better execution of neonatal resuscitation. A multidisciplinary implementation approach is warranted for building and maintaining high level healthcare delivery systems in the global setting. Advanced care facilities must have capabilities for caring for sick newborns beyond basic neonatal resuscitation.

## Declaration competing of interest

Fiona Bryce, Cyril Engmann, Nana A. Y. Twum-Danso, Emmanuel K. Srofenyoh, Sebnem Ucer, Richard O. Boadu, and Medge Owen report a grant from the Children's Investment Fund Foundation for the "Making Every Baby Count Initiative". The funder was uninvolved in the training, collection of data, analysis of results or preparation of the manuscript.

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