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ORIGINAL ARTICLE

Knowledge acquisition after Helping Babies Survive training in rural Tanzania

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Background: While the effectiveness of Helping Babies Breathe (HBB) training in Tanzania has been reported, no published studies of Essential Care for Every Baby (ECEB) and Essential Care for Small Babies (ECSB) in this setting have been found. This study compared knowledge before and after HBB, ECEB and ECSB training in Tanzania.

Methods: Training was provided to future facilitators (n=16) and learners (n=24) in Tanzania. Using standardized multiple-choice questions, knowledge was assessed pre- and post-HBB and ECEB courses for both learners and facilitators, while ECSB assessment was conducted with facilitators only. A >80% score was considered to be a pass. Paired t-tests were used for hypothesis testing.

Results: Knowledge significantly improved for both facilitators and learners on HBB and ECEB ($p<0.001$) and for facilitators on ECSB ($p<0.001$). After training, learners had difficulty identifying correct responses on one HBB item (21% incorrect) and three ECEB items (25–29% incorrect). After training, facilitators had difficulty identifying correct responses on five ECSB items (22–44% incorrect).

Conclusions: Training improved knowledge in Tanzania, but not sufficiently for feeding, especially for low birthweight babies. Targeted training on feeding is warranted both within the Helping Babies Survive program and in preclinical training to improve knowledge and skill to enhance essential newborn care.

Keywords: essential newborn care, health personnel, Helping Babies Survive, infant, knowledge, Tanzania

Introduction

Nearly 3 million babies die worldwide within the first month, with prematurity, infection and birth asphyxia as the leading causes.[1] Many neonatal deaths could be prevented through low-cost, highly effective interventions addressing essential newborn needs.[2] In response to the large number of neonatal deaths in low resource areas, there has been a push to improve the ability of healthcare providers to provide essential care for newborns in low resource areas where the majority of deaths occur.[3,4] Key interventions that have been promoted include having a skilled birth attendant present at birth, provision of emergency care at birth, such as resuscitation, and ongoing newborn care.[5] One training program that addresses these needs is the Helping Babies Survive (HBS) suite of programs, which are intensive, structured 1- or 2-d courses developed by the American Academy of Pediatrics and its partners.[6,7]

Helping Babies Survive consists of Helping Babies Breathe (HBB), Essential Care for Every Baby (ECEB) and Essential Care for Small Babies (ECSB).[8–10] All programs are based the WHO guidelines and recommendations.[11] Helping Babies Breathe was developed and launched in 2009 to give birth attendants in low resource areas skills in basic newborn resuscitation, including maintaining temperature, safe cutting of the umbilical cord, assessing respiration and responsiveness, clearing the airway, and providing bag and mask ventilation if necessary.[12] The cornerstone of the HBB module is the 'Golden Minute', where, if an infant

is born not breathing, the birth attendant provides stimulation, suction and resuscitation within the first 60 s after birth.[8] Tanzania has embraced HBB as a means to address the inadequate access to obstetrical and neonatal care in health facilities, with the goal of reaching much of its population.[13,14] In an attempt to reduce the number of newborn deaths, Tanzania has implemented HBB training across the country, with several studies reporting a positive impact on neonatal mortality and fresh stillbirths,[13–15] as well as knowledge and skills.[16,17] Helping Babies Breathe training in Tanzania has also been found to be cost-effective, estimated at US $233 per life saved and US $4.21 per life-year gained based on initial training alone and US $80 per life saved and US $1.44 per life-year gained for program maintenance.[18,19] Tanzania is routinely held up as an example of how HBB can reduce neonatal mortality in low resource countries through in-service training of healthcare providers, with Perlman et al. reporting a 47% reduction in first-day mortality and 24% reduction in fresh stillbirth.[13]

Following the success of HBB and implementation in over 80 countries, ECEB was launched in 2014 to cover the period immediately after birth throughout the first day of life or until the time of discharge.[9] Essential Care for Every Baby focuses on maintaining infant warmth, immediate skin-to-skin care, early breastfeeding, umbilical cord care, eye care, vitamin K injections, and immunization.[9] Essential Care for Small Babies was launched in 2015 to address deaths related to prematurity and focuses on interventions that support the needs of well, late preterm and low birthweight babies (under 2000 g) after birth until discharge or transfer to another facility.[10] Essential Care for Small Babies teaches temperature control of well, low birthweight or late premature infants through skin-to-skin contact and feeding that is appropriate to gestational age, including proper breastfeeding and training in alternative feeding methods, such as feeding using a spoon and cup or via nasogastric tube.[10] Newer programs, such as ECEB and ECSB are expected to further reduce the mortality risk beyond the first 60 s for newborns and well, small-for-gestational-age babies. However, ECEB and ECSB have yet to be evaluated for effectiveness and implementation to the same extent as HBB, even in countries such as Tanzania, where strong evidence of success for HBB has been shown. To date, there have been only two published studies about ECEB training.[20,21] They showed a significant improvement in immediate knowledge after training in Kenyan and Indian trainees, as well as satisfactory skills measured through observed structured clinical evaluations. No studies to date have reported on ECSB training.

The current study was embedded within a larger project called 'Accessing Safe Deliveries in Tanzania' (ASDIT), which aims to scale up comprehensive emergency obstetric and newborn care in Tanzania through training a broad cadre of healthcare providers. As the primary purpose of the larger study was targeting safe deliveries and newborn care, the HBS modules of HBB and ECEB were prioritized for training facilitators and learners. However, as identified in a recent systematic review of the HBS program, there is a need for greater reporting on ECEB and ECSB to evaluate their effectiveness due to a dearth of evidence on these newer modules.[22] Therefore, additional training of the ECSB module was provided to facilitators to evaluate readiness for ECSB training in Tanzania. The primary objective of this study was to compare the knowledge obtained immediately after training on HBB and ECEB among facilitators and learners in a rural hospital in Tanzania. A secondary objective was to compare the knowledge obtained immediately after training on ECSB among facilitators.

Methods

Setting

As part of a larger initiative, HBS training was provided at St Francis Hospital, Ifakara, Tanzania in February 2016. Ifakara is in the Morogoro region, which has 15 health centers, made up of publicly funded health centers, non-government organizational hospitals and faith-based hospitals. The Morogoro region has two regional referral hospitals, including St Francis Hospital and Morogoro Regional Hospital, as well as four district hospitals. St Francis Hospital, the regional referral hospital of the Kilombero, Malinyi and Ulanga districts, serves a catchment area of approximately 750 000 people and averages 5000 births per year.[23]

Implementation of Helping Babies Survive

Using a 'train-the-trainer' model, two of the authors (DM, MCY), master trainers in HBS, trained future facilitators (n=16) during a 3-d workshop. During the workshops, discussion, practice and simulation occur in a 6:1 ratio of learners to teachers using HBB (first edition), ECEB and ECSB learner workbooks, flipcharts, and the 'NeoNatalie' and 'PremieNatalie' simulators.[8–10] Following this initial training of facilitators, some of the trained facilitators and the master trainers provided training to learners (n=24) in a 2-d workshop for HBB and ECEB. All training and tests for future facilitators were provided in English, as all healthcare providers could speak and read English. In addition, training materials and instructions for the learner sessions were translated into Swahili by assistants fluent in both languages.

Sample

Facilitators (n=16) were doctors and nurses from St Francis Hospital who had responsibility for overseeing deliveries and leadership positions, and who had previous knowledge, experience and/or training in essential newborn care. Learners (n=24) were nurse midwives and assistant medical officers from five ASDIT-supported health centers who attended deliveries for newborns.

Data collection

Data were collected from both the facilitators and learners using the HBS standardized pre-post knowledge test for HBB and ECEB, and from facilitators alone for ECSB.[7] The HBB multiple choice questionnaire (MCQ) consists of 17 items, the ECEB MCQ consists of 25 items and the ECEB MCQ consists of 30 items. A passing grade for each questionnaire required answering 80% or more of items correctly (MCQs freely available on the Helping Babies Survive website).[7] The MCQs were given to

participants immediately before and immediately after each training session.

Data analysis

Data from MCQs were analyzed using SPSS version 24.0 software to determine whether facilitators and learners achieved adequate knowledge after HBS training on each of the modules. Data were collected from each participant individually and descriptive statistics (mean, SD, range) were calculated per item, as well as an overall score calculated as the sum of correct answers and percentage correct. The two-sided paired t-test was used to determine the difference between participants on their pre- and post-test scores. A p-value of <0.05 was considered statistically significant.

Ethical considerations

Ethics for the larger study, in which this was embedded, was received by Dalhousie University in Canada and the National Institute of Medical Research in Tanzania. As participants were involved as part of a quality improvement initiative focused on training, individual written consent was not obtained. All responses were de-identified during analysis using unique numerical codes and no individual data is reported to respect confidentiality.

Results

Overall, knowledge significantly improved for both facilitators and learners after the course on HBB and ECEB, as well as for facilitators on ECSB (p<0.001) as seen in Table 1.

Helping Babies Breathe

For facilitators, the largest improvement occurred for item 7 (recognizing a non-breathing baby; Table 2). Eight of the 17 items received a perfect score on both the pre- and post-MCQ. All facilitators received a passing score after HBB training.

For learners, improvement occurred for items 4 (identifying need for routine care), 6 (umbilical cord management), 7 (recognizing a non-breathing baby), and 8 (care with meconium-stained amniotic fluid). Even though there was a significant improvement compared with their pre-training scores, learners still had difficulty identifying the correct response on item 8 after training—care for an infant born with meconium-stained amniotic fluid—with 21% incorrect. Six items received a perfect score on both the pre- and post-MCQ, and 91.7% of learners received a passing score after HBB training.

Essential Care for Every Baby

For facilitators, per item improvement occurred for items 2 (monitoring breathing within first hour after birth), 4 (exclusive breastfeeding), 10 (vitamin K), 17 (how to cup feed) and 21 (recognizing jaundice), as seen in Table 3. Six items received a perfect score on both the pre- and post-MCQ, and all facilitators received a passing score after HBB training.

For learners, per item improvement of between 21% and 58% occurred on ECEB for items 2 (monitoring breathing within first hour after birth), 3 (breastfeeding), 10 (vitamin K), 14 (breast engorgement), 17 (how to cup feed) and 21 (recognizing jaundice). Learners had difficulty identifying correct responses on three ECEB items after training—16 (benefits of cup feeding), 23 (classifying a non-feeding infant) and 24 (recognizing adequate breastfeeding). Only one of the 25 items received a perfect score on both the pre- and post-MCQ, and 95.8% of learners received a passing score after ECEB training.

Essential Care for Small Babies

For facilitators, the per item improvement occurred for items 9 (skin temperature of a well, small baby) and 17 (proper placement of the nasogastric tube), as seen in Table 4. Facilitators had difficulty identifying correct responses on five ECSB items after training: 15 (recognizing babies who need nasogastric tube feeding), 19 (average daily weight gain), 21 (daily increase of feeding volume), 25 (cues for readiness for breastfeeding) and 27 (timing of ongoing assessments). Four items received a perfect score on both the pre- and post-MCQ, and all facilitators received a passing score after ECSB training.

Discussion

Overall, knowledge significantly improved for both facilitators and learners on neonatal resuscitation, and early newborn care for full-term infants after HBB and ECEB training. Facilitators also benefited from training about low birthweight infants.

Table 1. Helping Babies Survive multiple choice questionnaire

	Pre-		Post-		SD	2-Sided p-value
	Mean score	% passed	Mean score	% passed		
HBB—facilitators (n=16)	15.3	93.8%	16.6	100%	1.1	0.001
HBB—learners (n=24)	14.5	75.0%	16.3	91.7%	1.6	0.001
ECEB—facilitators (n=16)	20.9	81.3%	24.3	100%	2.3	0.001
ECEB—learners (n=24)	20.3	66.7%	23.5	95.8%	2.0	0.001
ECSB—facilitators (n=16)	23.8	56.2%	27.9	100%	2.3	0.001

Table 2. Helping Babies Breathe multiple choice responses

Item	Learners		Facilitators	
	Pre-	Post-	Pre-	Post-
1	92%	100%	100%	100%
2	83%	96%	100%	100%
3	100%	100%	87%	100%
4	67%	96%*	81%	94%
5	100%	100%	100%	100%
6	46%	100%*	69%	87%
7	63%	96%*	56%	94%*
8	46%	79%*	75%	100%
9	96%	87%	100%	100%
10	92%	100%	100%	100%
11	83%	83%	94%	94%
12	92%	100%	94%	100%
13	100%	100%	94%	100%
14	87%	92%	81%	94%
15	100%	100%	100%	100%
16	100%	100%	100%	100%
17	100%	100%	100%	100%

*p<0.05.

Table 3. Essential Care for Every Baby multiple choice responses

Item	Learners		Facilitators	
	Pre-	Post-	Pre-	Post-
1	83%	92%	69%	81%
2	63%	96%*	50%	100%*
3	67%	96%*	69%	94%
4	92%	100%	63%	100%*
5	96%	96%	94%	100%
6	96%	100%	87%	100%
7	100%	96%	100%	100%
8	96%	96%	94%	100%
9	83%	100%	87%	100%
10	42%	100%*	63%	94%*
11	100%	96%	100%	100%
12	87%	100%	94%	100%
13	83%	100%	94%	100%
14	79%	100%*	94%	100%
15	71%	75%	81%	87%
16	96%	83%	100%	100%
17	42%	87%	56%	100%*
18	83%	96%	87%	100%
19	96%	100%	100%	100%
20	96%	100%	94%	100%
21	50%	96%*	56%	100%*
22	83%	100%	81%	87%
23	83%	71%	100%	100%
24	75%	75%	75%	87%
25	96%	100%	100%	100%

*p<0.05.

However, when examining on a per-item level, some areas were well understood prior to training and others were not. While most facilitators correctly answered all items after training on HBB and ECEB, a quarter of learners failed to identify the correct response to three items on ECEB, mostly related to feeding, and one-fifth failed to identify the correct response to the HBB item, related to meconium-stained amniotic fluid. With ECSB, facilitators demonstrated less knowledge prior to the course, suggesting less prior training and/or experience in the care of well, small infants. Despite all participants receiving a passing score post-training, five items on ECSB (mostly related to feeding) remained incorrectly identified by a minimum of a quarter of facilitators.

Given that HBB has been implemented across Tanzania, it is not a surprise that both learners and facilitators had high initial pre-training knowledge scores, at 93% and 75%, respectively, and near perfect post-training scores. The item that gave learners the most trouble was related to the care for an infant born with meconium-stained amniotic fluid. In the first edition of HBB, used in the current study, the removal of meconium before drying was stated in the action plan.[8] However, the second edition of HBB (2017) removed 'if meconium, clear the airway' before the action step, 'dry thoroughly' and changed the instructions to perform suctioning only 'if meconium is in the amniotic fluid *and* the baby is not crying after thorough drying'. This change is in the WHO guideline on newborn resuscitation published in 2012, which recommends that 'in neonates born through meconium-stained amniotic fluid who do not start breathing on their own, suctioning of the mouth and nose should be done before initiating positive-pressure ventilation' (p. 8).[11] This reflects a larger cultural shift to encourage simulation and discourage suctioning unless the infant is not breathing or if there are secretions of meconium in the airways.[8,11] The changes in recommendations for this item as part of the HBB program could be related to this divergent response if learners were trained differently than as provided through HBB training, indicating a potential training difference, rather than a lack of knowledge. Given the high scores on the HBB modules overall and per item, this may suggest the effectiveness of HBB having been incorporated into in-course and on-site neonatal resuscitation training across the country.

For ECEB, over 20% of learners had difficulty identifying the correct response on some items even after training, including the benefits of cup feeding, the ability to classify a non-feeding infant and how to recognize adequate breastfeeding. This differs from the first reported evaluation of ECEB, where Thukral et al.[20] found that over 90% of both learners and facilitators in India and Kenya were able to correctly identify the responses for the benefits of cup feeding and recognize adequate breastfeeding. The question related to classifying a non-feeding baby, that is, 'a 3000-gram baby is unable to suck or swallow during the first 6 hours after birth. How would you classify this baby and what should you do?' was not asked in the initial evaluation and was

Table 4. Essential Care for Small Babies multiple choice responses

Item	Facilitators	
	Pre-	Post-
1	75%	100%
2	100%	100%
3	94%	94%
4	87%	100%
5	94%	100%
6	75%	100%
7	94%	100%
8	94%	100%
9	63%	100%*
10	100%	100%
11	94%	100%
12	100%	100%
13	81%	100%
14	94%	100%
15	56%	63%
16	81%	100%
17	44%	100%*
18	81%	94%
19	75%	69%
20	50%	94%
21	56%	75%
22	75%	100%
23	87%	94%
24	94%	100%
25	50%	69%
26	94%	100%
27	31%	56%
28	100%	100%
29	63%	81%
30	94%	100%

*$p<0.05$.

modified after the Thukral et al. study.[20] Thukral et al.[20] noted that, while significant improvements occurred overall, some items remained incorrectly identified by learners. Thukral et al.[20] offers two suggestions of this uncertainty: these content areas may not have been adequately addressed in the training or the content provided may have been misunderstood or was not used in practice, such as provision of vitamin K in Kenya or cup feeding in India. These considerations may also have affected the findings here.

To the authors' knowledge, this is the first study to report findings on ECSB knowledge assessment following training. One explorative study conducted in Rwanda reported on healthcare provider readiness for small baby training.[24] Similar to the finding that learners struggled to identify the frequency of nasogastric tube feeding, most nurses and midwives interviewed stated that they had never placed a nasogastric tube and most felt uncomfortable placing and maintaining it.[24] From the current study, other educational challenges included average daily weight gain, daily increase of feeding volume, cues for readiness for breastfeeding, and timing of ongoing assessments. Based on the initial findings with a small groups of educated healthcare providers, focus on key topic areas may require additional training to ensure successful implementation.

An area where healthcare providers in Tanzania would benefit from additional training is breastfeeding and alternative feeding techniques, for both full-term and well, preterm infants. Both ECEB and ECSB knowledge scores identified gaps in knowledge related to recognizing adequate and normal breastfeeding, and use of alternative feeding methods, including cup and spoon feeding and nasogastric tube usage. In a qualitative study conducted in Western Tanzania with mothers of preterm and low birthweight infants in a neonatal ward, it was found that mothers had difficulty with breastfeeding their premature infant and often needed additional support from nursing staff.[25] The Tanzanian Ministry of Health and Social Welfare found that, in the national referral hospital in Dar es Salaam, 2.4% of infants—both full and preterm—experienced a failure to thrive due to poor breastfeeding technique and lack of breastfeeding support.[26] To improve essential newborn care for premature and small-for-gestational-age infants, mothers must be supported by knowledgeable healthcare providers on breastfeeding and feeding during antenatal, postnatal and prior to discharge care.[27] Targeted training on breastfeeding may be warranted both within the HBS program and in pre-clinical training to improve knowledge.[28]

Limitations

While this study provides the first reported findings related to healthcare provider knowledge acquisition following ECSB training, the authors acknowledge that the small and selective sample of participants is a significant limitation. The authors were unable to collect details on the learners (e.g., previous experience with HBS topic areas, length of time employed on the labor/postnatal ward), limiting the ability to determine if the sample was reflective of other healthcare providers in the area. As part of a larger study, the authors sought to explore the knowledge uptake of training on facilitators and learners. Based on the findings, future training will focus on obtaining data on the long-term knowledge and use of clinical skill in practice outcomes. These findings suggest that additional time may be required to optimally teach the HBS program, especially the ECSB module, to ensure all levels of healthcare providers will be able to gain the knowledge and skills to adequately care for late preterm infants. Training in HBS could also be tailored if learners undertook pre-training evaluation to identify areas where less time could be spent on content that learners already know and more time on content poorly understood.

In practice, any additional time for training may be a barrier, as adding additional training days increases the cost to the hospitals that pay the salaries and this may limit healthcare providers available to provide patient care in a setting with staff shortages. Training provided in ECSB may require additional time and targeted education to ensure adequate knowledge uptake, which is a prerequisite to change in behaviors

and clinical skills, especially for frontline workers who may not have previous experience in or knowledge of neonatal nursing for premature infants. Inclusion of HBS in preservice training may allow for less time to be spent on subsequent training with less time spent away from clinical practice, but this remains to be assessed.

Another limitation of this study is the focus only on knowledge, excluding assessment of healthcare provider practical skills (measured through standardized Observed Structured Clinical Evaluations, OSCEs) and the ability to translate knowledge into effective care. This study did not determine the long-term impact of the training, both on healthcare providers and newborn outcomes, nor has the potential effects of knowledge and skills consolidation through coached practice and mentoring been measured. In the systematic review conducted by some of the authors on the HBS program, it was found that despite knowledge uptake, this did not impact observed clinical behaviour.[22] There is evidence that problem-based learning (similar to that used with this training) results in better retention and utilization in patient care.[29] Thus, while the current study offers preliminary insight into the impact of knowledge uptake when all HBS modules are provided in one training period, it will be essential to continue to monitor knowledge and skill to determine long-term behavior change and to identify barriers to use in clinical practice.

As the first published analysis on knowledge acquisition with all three modules of HBS over 3 d, this study provides insight into areas that may need to be improved during training in order to positively enhance healthcare provider skill and, in turn, neonatal outcomes. A potential direction for future research is to determine whether there should be HBS essential knowledge items (similar to the structure of the OSCEs), with certain items required to be correctly answered for a learner to pass the knowledge assessment. By linking essential knowledge items with essential clinical skill items, additional targeted training can be provided to healthcare providers who demonstrate a gap in either knowledge or skill as a means to enhance ongoing learning and continue to improve essential newborn care. Additionally, further considerations of specific questionnaire items may be required to ensure they reflect the desired knowledge and are appropriate when translated into other languages for those whose first language is not English.

Conclusion

Helping Babies Survive training improved the knowledge of healthcare providers in HBB, ECEB and ESCB. However, within ECEB and ECSB, knowledge of breastfeeding and alternative feeding techniques in both full-term and preterm infants was inadequate before and after training. While approved and tested courses, such as HBS modules, should be used, there may be benefit in modifying presentation time and content areas, limiting areas where learners already have knowledge and identifying areas where more time would be beneficial. Due to the limitations of the current study, further research is needed to evaluate the impact of HBS on healthcare providers' knowledge maintenance, effective implementation and potential benefits to newborn babies.

Authors' contributions: DM and MCY provided initial training and data collection; JD was responsible for data cleaning, data analysis and initial drafting of the manuscript; JCL provided statistical guidance and helped revise the manuscript. All authors were involved in revising and approving the final manuscript.

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