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Simulation and education

Helping Babies Breathe: Global neonatal resuscitation program development and formative educational evaluation☆

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ABSTRACT

Objectives: To develop an educational program designed to train health care providers in resource limited settings to carry out neonatal resuscitation. We analyzed facilitator and learner perceptions about the course, examined skill performance, and assessed the quality of instruments used for learner evaluation as part of the formative evaluation of the educational program Helping Babies Breathe.
Methods: Multiple stakeholders and a Delphi panel contributed to program development. Training of facilitators and learners occurred in global field test sites. Course evaluations and focus groups provided data on facilitator and learner perceptions. Knowledge and skill assessments included pre/post scores from multiple choice questions (MCQ) and post-training assessment of bag and mask skills, as well as 2 objective structured clinical evaluations (OSCE).
Results: Two sites (Kenya and Pakistan) trained 31 facilitators and 102 learners. Participants expressed high satisfaction with the program and high self-efficacy with respect to neonatal resuscitation. Assessment of participant knowledge and skills pre/post-program demonstrated significant gains; however, the majority of participants could not demonstrate mastery of bag and mask ventilation on the post-training assessment without additional practice.
Conclusions: Participants in a program for neonatal resuscitation in resource-limited settings demonstrated high satisfaction, high self-efficacy and gains in knowledge and skills. Mastery of ventilation skills and integration of skills into case management may not be achievable in the classroom setting without additional practice, continued learning, and active mentoring in the workplace. These findings were used to revise program structure, materials and assessment tools.

1. Background

Of the 7.7 million deaths of children under age 5 years worldwide, 3.1 million are neonatal deaths.[1] Intrapartum-related hypoxic events ("asphyxia") result in an estimated 814,000 neonatal deaths[2] and 1.02 million stillbirths annually.[3] More than 98% of these deaths occur in low- and middle-income countries. If targets for Millennium Development Goal 4 (reducing under-5 child deaths by 2/3 from 1990 levels by the year 2015)[4] are to be met, neonatal deaths from intrapartum-related hypoxic events, prematurity, and infection must be reduced.

Life support programs in developed countries have shown post-course improvement but have demonstrated variable retention of knowledge and skills.[5–9] Helping Babies Breathe® (HBB), developed with the American Academy of Pediatrics, is designed to train birth attendants in developing countries in the essential skills of newborn resuscitation. It is based on the neonatal evidence evaluation of ILCOR (International Liaison Committee on Resuscitation) and recognizes that in many countries only one birth attendant must provide care to both mother and newborn.

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Table 1
Skills taught in Helping Babies Breathe®.

Preparation for birth
Identifying a helper and reviewing the emergency plan
Preparing the area for delivery
Hand washing
Preparing an area for ventilation and checking equipment
Routine care
Drying thoroughly
Keeping warm
Evaluating crying
Checking breathing
Clamping or typing and cutting the cord
The Golden Minute®
Positioning the head
Clearing the airway
Providing stimulation to breathe
Evaluating breathing
Initiating ventilation
Ventilating with bag and mask
Continued ventilation with normal or slow heart rate
Improving ventilation
Evaluating heart rate
Activating the emergency plan
Supporting the family

Formative evaluation of HBB focused on the first steps of a 7-stage hierarchy proposed for comprehensive assessment of educational outcomes: participant numbers, satisfaction, learning, competence and performance; patient health; and community health.[10]

The evaluation, conducted independently at two international field testing sites, addressed: (1) How do facilitators and learners perceive the course structure, learning materials, and assessment tools? (2) Do learners achieve acceptable levels of knowledge and/or performance of skills? (3) What is the quality of the assessment tools used to evaluate learner knowledge and skills performance? The information from these analyses was used to guide the refinement of course materials and participant assessment.

2. Methods

2.1. The educational program

2.1.1. General description

The HBB educational program is described at (http://www.helpingbabiesbreathe.org/about.html) and (http://www.helpingbabiesbreathe.org/docs/HBB%20Brochure.pdf). The course structure reflects contemporary educational theory and research and includes evidence-informed content, active learning, skill practice with feedback, case scenarios, self-reflection, group discussion, and structured assessment of knowledge, skills and performance.[11–14] HBB emphasizes assessment at birth, stimulation to breathe, and assisted ventilation for all newborns who are not breathing well by 1 min after birth (The Golden Minute®). Of all the skills taught (Table 1), the central life-saving skill is ventilation with a bag and mask.

The program was developed by the Global Implementation Task Force of the American Academy of Pediatrics (AAP). Prior to field testing, complete course materials underwent two rounds of review by a Delphi panel of experts in global child health and neonatal resuscitation and a regional technical expert review conducted at the World Health Organization.

2.1.2. Learning materials

The following tools were developed to facilitate learning:

- Action plan – a pictorial representation of the resuscitation algorithm (see: http://www.helpingbabiesbreathe.org/docs/HBBBrochure.pdf).
- Learner workbook – pocket-sized booklet to prepare learners with knowledge, guide practice during the course, and support continued learning after training.
- Facilitator flip chart – table-top sized pictorial flip chart to guide facilitator presentations.
- Neonatal simulator – an optional purpose-built, low-cost neonatal simulator which can be filled with 2 l of water or air. The simulator's features include crying, spontaneous breathing, chest wall movement with bag-and-mask ventilation, and umbilical cord pulse.
- Equipment – reusable ventilation bag masks, and bulb suction device.

2.2. Training

HBB utilizes a train-the-trainer model[7–9] in which potential facilitators are selected, trained to deliver a standardized educational program, and then assume responsibility for training facilitators and health care professionals within their medical facility or community. The program trains master trainers, facilitators, and learners and uses one simulator for each pair of trainees so that each participant takes turns being the learner (performing resuscitation actions/assessments of the baby) and teacher (providing responses with the simulator and verbal feedback on technique).

2.3. Selection of test sites

Two test sites were selected on the basis of responses to a competitive Request for Applications from AAP, their experience in delivery of educational programs, ability to collect data and willingness to train facilitators and learners. The principal investigator at each site was responsible for selecting and training facilitators and learners; planning, directing and executing the project; overseeing central data collection, data quality assurance, data management, and submission of data for analysis.

Facilitators were selected on the basis of their experience in labor and delivery or neonatology as well as for their experience as teachers of other courses. Each facilitator agreed to offer the program on 1–2 occasions. Members of the HBB editorial board oriented the principal investigators to the course design, content, curriculum and teaching design, and evaluation procedures.

2.4. Program evaluation and learner assessment tools

Satisfaction or a level 2 outcome[10] was measured by:

- Facilitators and learners recorded their perceptions of the course and its teachers on a course evaluation form (1–5 Likert scale, strongly disagree–strongly agree) as shown in Tables 2–4. Participants were invited to provide written suggestions for improvement in a comments section. Facilitators completed evaluation forms immediately after they were trained and also after leading the course at least once.
- Separate focus groups with facilitators and learners registered perceptions of program acceptability and ease of teaching. A semi-structured interview guide asked participants to discuss the learning and assessment tools. Focus groups were audio taped (with the participants' consent) and transcribed verbatim.

The assessment of declarative and procedural learning or knowing (level 3 outcome)[10] utilized a 16 item set of written/verbal

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Table 2
Facilitator course evaluation survey (Kenya and Pakistan).

	Kenya		Pakistan	
	N[a]	M[b] (SD)[c]	N[a]	M[b] (SD)[c]
1. Organization of train the trainer course				
1a. The course was well organized (adequate time for practice)	20	4.55 (.51)	11	4.27 (.65)
1b. I had enough time to learn how to lead the course	19	4.47 (.51)	11	4.27 (.65)
1c. We completed the course in the time we had	19	4.37 (.60)	11	4.45 (.69)
2. Teacher				
2a. The teacher had time for my questions	20	4.70 (.47)	11	4.55 (.69)
2b. The teacher listened to my questions	20	4.80 (.41)	11	4.45 (.69)
2c. The teacher gave me answers	20	4.70 (.92)	11	4.64 (.68)
3. Teacher efficacy				
3a. I can explain the Golden Minute	20	4.75 (.44)	11	4.18 (.60)
3b. I can explain the action plan	20	4.80 (.41)	11	4.00 (.45)
3c. I have enough information to lead the course	20	4.75 (.44)	11	4.27 (.65)
4. Course materials				
The following course materials will help my learners:				
4a. Learner workbook	20	4.90 (.31)	11	4.27 (.65)
4b. Mannequin, bag, and mask	20	4.90 (.31)	11	4.27 (.65)
4c. Flip chart	20	4.90 (.31)	11	4.27 (.65)
4d. Action plan	19	4.89 (.32)	11	4.18 (.75)
4e. The pictures presented in the workbook and flip charts are appropriate	20	4.80 (.52)	11	4.18 (.75)
4f. The pictures in the workbook and flip charts will help me explain the action plan	20	4.85 (.37)	9	4.33 (.71)
4g. Group discussions were helpful	19	4.84 (.38)		
4h. Self-check lists were helpful	19	4.63 (.50)		
5. Overall				
5a. I can help a baby breathe	20	4.85 (.37)	11	4.55 (.69)
5b. I want to help people learn how to help babies breathe	20	4.90 (.31)	11	4.55 (.82)

[a] Number of people who responded.
[b] Mean agreement score.
[c] Standard deviation.

multiple choice questions (MCQ), with one or two possible correct responses. Successful completion required 80% total correct responses.

Competence or a level 4 outcome[10] was measured by:

- Bag and mask skill checklist of 12 steps to establish and improve bag and mask ventilation. Successful completion required that all 12 steps be demonstrated correctly to signify mastery of this critical skill.

Table 3
Facilitator evaluation after leading a course (Kenya and Pakistan).

	Kenya		Pakistan	
	N[a]	M[b] (SD)[c]	N[a]	M[b] (SD)[c]
Organization of course				
I had enough training to lead the course	4	4.50 (.58)	11	4.73 (.47)
I could lead the course as I was taught	4	4.75 (.50)	11	4.82 (.41)
I had adequate time for discussion and hands-on demonstration	4	3.75 (1.26)	11	4.82 (.41)
I had enough time for questions	4	4.50 (.58)	11	4.82 (.41)
I was able to answer the questions	4	4.75 (.50)	11	4.64 (.51)
I could explain the action plan	4	5.00 (.00)	11	4.91 (.30)
I could explain the Golden Minute	4	5.00 (.00)	11	4.91 (.30)
I can train others to teach the course	4	5.00 (.00)	11	4.73 (.47)
I can train others to act in the Golden Minute	4	5.00 (.00)	11	5.00 (.00)
Course material				
The following course materials helped my learners:				
Learner workbook	4	4.75 (.50)	11	4.73 (.47)
Mannequin, bag, and mask	4	5.00 (.00)	11	4.82 (.41)
Flip chart	4	4.25 (1.50)	11	4.91 (.30)
Action plan	4	4.75 (.50)	11	4.91 (.30)
The pictures in the workbook and flip chart helped me explain the action plan	4	5.00 (.00)	11	4.82 (.41)
Group discussions were helpful	4	4.50 (1.00)	11	4.64 (.51)
Check yourself questions were helpful	4	5.00 (.00)	11	4.91 (.30)
Course assessment				
My group could understand the questions on the multiple choice test	4	4.25 (.50)	11	4.55 (.52)
I could assess whether people could help babies breathe using the check-list and mannequin, bag and mask test	4	4.75 (.50)	11	4.73 (.47)
I had enough time to test my group	4	4.00 (.82)	11	4.82 (.41)
Overall				
The group will use the action plan to help babies breathe	4	4.75 (.50)	11	4.55 (.52)
The group will be able to help babies breathe	4	4.75 (.50)	11	4.91 (.30)

[a] Number of people who responded.
[b] Mean agreement score.
[c] Standard deviation.

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Table 4
Learner course evaluation survey (Kenya and Pakistan).

	Kenya		Pakistan	
	N[a]	M[b] (SD)[c]	N[a]	M[b] (SD)[c]
1. Organization of train the trainer course				
1a. I had enough time to learn how to help babies breathe	47	4.15 (1.08)	50	4.26 (.83)
1b. I could ask questions	47	4.26 (.64)	50	4.36 (.72)
1c. The teacher listened to my questions	47	4.51 (.62)	50	4.52 (.71)
1d. The teacher answered my questions	47	4.45 (.69)	50	4.56 (.71)
1e. I had enough time to practice helping babies breathe	48	4.50 (.62)	50	4.40 (.88)
2. Course content				
2a. I understand why the Golden Minute is important	47	4.45 (.62)	50	4.80 (.40)
2b. I can use the action plan to help babies breathe	44	4.18 (.92)	50	4.62 (.49)
3. Course materials				
3a. The following course materials helped me to learn				
3a1. Learner workbook	47	4.23 (.76)	50	4.52 (.65)
3a2. Mannequin, bag, and mask	45	4.29 (.76)	50	4.56 (.71)
3a3. Flip chart	40	3.75 (1.08)	50	4.56 (.64)
3a4. Action plan	42	4.33 (.79)	50	4.59 (.50)
3b. The pictures in the workbook and flip chart tell me how to help babies breathe	44	4.59 (.50)	50	4.50 (.71)
3c. Group discussions were helpful	46	4.48 (.55)	50	4.36 (.78)
3d. Check yourself questions were helpful	41	3.83 (.89)	50	4.51 (.55)
3e. The mix of flip chart teaching, discussion, and practice was appropriate	44	4.34 (.75)	50	4.57 (.50)
4. Course assessment				
4a. I could understand the questions on the multiple choice test	46	4.26 (.54)	50	4.50 (.74)
4b. I could understand what I needed to do for the baby, bag and mask test	47	4.43 (.58)	50	4.57 (.50)
4c. The course helped me to answer the questions on the multiple choice test	46	4.46 (.50)	50	4.47 (.50)
4d. The course helped me to do the practical baby, bag and mask test	47	4.55 (.54)	50	4.48 (.50)
5. Overall				
5a. I can use the action plan	44	4.43 (.76)	50	4.64 (.60)
5b. I can help babies breathe	48	4.58 (.54)	50	4.70 (.51)

[a] Number of people who responded.
[b] Mean agreement score.
[c] Standard deviation.

- Two objective structured clinical examinations (OSCEs) tested ability to prepare for, assess and act in a scenario of routine newborn care (OSCE A) and a scenario requiring bag and mask ventilation (OSCE B). Successful completion required correct overall 80% performance as well as key assessments and interventions such as "*recognizes baby not breathing/crying*" and "*provides bag and mask ventilation*".

2.5. Data analysis

Data for each site were analyzed independently. Data from the facilitator/learner course evaluations and focus groups were used to determine perceptions about the course. Data from the MCQ, bag and mask skill checklist, and OSCEs were used to investigate whether learners reached acceptable levels of knowledge and performance of simulated neonatal resuscitation, as well as to determine the psychometric quality of the evaluation instruments.

Descriptive statistics (e.g., mean, SD, range) were calculated for each item of the course evaluations. For knowledge, skill, and performance tests, the scores represent the sum of the number of correct answers and a comparison to the 'minimum pass level' scores. Analysis of change in pre/post data for the MCQ and bag and mask skill checklist utilized the Student *t*-test for paired samples coupled with an effect size calculation to determine the strength of the differences between means (an assessment of the impact of the course and the psychometric quality of the instruments).

The thematic analysis incorporated data from comments on course evaluations and focus group discussions. Data were categorized around perceptions about course structure, course content, course material/equipment, the evaluation surveys, and the assessment tools using QSR-NVIVO 8 software which facilitates coding and data comparisons.

The study received approval from the University of Calgary, Moi University in Kenya, Indiana University, and the Aga Khan University in Pakistan.

3. Results

Two sites in Kenya and Pakistan were selected for the study. Kenya has a population of 40 million, a birthrate of 35.1/1000 inhabitants, and an infant mortality estimated at 53.5/1000 live births. Pakistan has a population of over 184 million, a birthrate of 25.3/1000 inhabitants, and an infant mortality estimated at 65.3/1000 live births.[15] Both sites were university hospitals with a strong rural outreach program. Learners had not been formally trained in neonatal resuscitation.

In Kenya, the investigators trained 4 master trainers, who trained 16 facilitators and 48 learners. Learners were pediatricians, obstetricians, medical officers, nurse midwives, nurses from district hospitals and primary health centers and community birth attendants. Learner training sessions were conducted over 1.5 days (10 total hours, 6 h instruction, 4 h pre/post evaluation) for learners. Facilitator: learner ratios for the master trainer, facilitator, and learner courses were 1:2, 1:3, and 1:4 respectively. Learner: simulator ratios were 1:1 (master trainer course) and 2:1 (facilitator and learner courses). In Pakistan, the principal investigators trained 11 facilitators and 54 learners who included a pediatrician, medical officers, registered nurses, lady health workers and lady health visitors. Learner training sessions were conducted in community hospitals and rural centers over 1 day (7 h total, 6 h instruction, and 1 h post testing) for learners.

3.1. Course evaluation data

HBB was highly rated. Facilitators in both sites evaluated their training to lead a course >4 on all items (Table 2). After the first teaching session, the facilitators for both sites recorded scores ≥4

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Table 5
Main points from course evaluations and focus groups by theme.

Theme	Affirmations	Suggestions
Program structure	Graphic linkage among materials Hands-on learning	Additional time for hands-on learning and skills practice
Course content	Importance and understandability of the concept of The Golden Minute®	Incorporation of experience in actual resuscitations Practice opportunities after course
Program materials	Superior functionality of neonatal simulator Utility of cleanable, reusable bag-and-mask and suction devices	Video demonstration of skills and patient assessments Larger illustrations in print materials Translation of print materials into local languages
Assessment tools	Relevant and acceptable assessments Verbal presentation of MCQs (in local language)	Learner assessment in local language Practice with bag and mask performance checklist Use of OSCEs as formative learner assessment (unfamiliar format)

on items suggesting they were well trained to teach the course, the materials were useful, and they did not have difficulty with the assessment processes (Table 3). Learners in both sites rated most items ≥4. Learners in Kenya provided ratings of ≤4 on two items related to the helpfulness of the flip chart (focus group suggested these were due to small graphics) and the utility of the check yourself questions (Table 4), not a typical learning format.

An analysis of comments from course evaluations and focus group discussions provided interpretive detail on user perceptions of the course. Facilitators and learners at both sites voiced a number of common points. They suggested changes to the course structure including more time for teaching/learning, particularly for practice, and modifications to enhance the teaching aids, such as translating material into local languages and enlarging the flip chart and action plan images. The importance of the Golden Minute was understood. The simulator was reported to be better than ones previously available. Participants suggested that seeing a video or live birth would be helpful. They also mentioned the need to increase capacity by offering more training courses, obtaining more equipment and supplies for practice sessions, and opportunities for practice post-course. Learners provided variable feedback about the assessment processes; some found it acceptable while others found the testing challenging. OSCE assessment was a new experience. Table 5 summarizes the key information from these data.

3.2. Learner assessment data

The assessment of learners measured what the learners knew (multiple choice questions), as well as their performance of skills and integration of skills with decision-making (bag and mask and OSCE).

In Kenya, data for the MCQ and bag and mask skill checklist demonstrated a discrepancy between cognitive knowledge and skills among facilitators before the program.[16] After HBB, there were significant gains in knowledge and skills among facilitators and learners. Post-course scores on the MCQ and bag and mask skills were similar between Kenya and Pakistan. However, mastery of bag and mask ventilation, by the criterion of 12/12 steps performed correctly, was not achieved by facilitators or learners on a single attempt. OSCE scores were similar between the 2 sites and similar for facilitators and learners. However, facilitators as compared to learners more consistently performed all the key assessments and interventions required for successful completion of the OSCEs (Table 6).

An analysis of rates of successful completion for the 4 learner assessment instruments and individual item analysis revealed potential shortcomings in the quality of the instruments. A mixture of multiple-choice questions with one or two correct answers resulted in skipped second responses. All participants expressed difficulty in remembering long series of steps in the bag and mask skill checklist (e.g., the 5 interventions to improve ventilation as part of the 12 steps to prepare for and carry out ventilation). Item analysis indicated difficulty in maintaining mask seal, ventilating at the correct rate, and assessing chest rise. The profile of items omitted or done incorrectly in OSCE B mirrored that of the bag and mask skill checklist.

4. Discussion

Two sites in Kenya and Pakistan undertook a formative evaluation of the HBB program. Facilitators and learners at both sites expressed high levels of satisfaction with the program and high self-efficacy with regard to resuscitation after participating in HBB. Both quantitative ratings on course evaluations and qualitative feedback through evaluation comments and focus groups indicated the program was structured well and course content and materials were appropriate. The facilitators in Kenya felt they had somewhat limited time for discussions and hands-on practice while in Pakistan they reported having enough time. This finding could be partially explained by differences in on-site implementation, levels of training/expertise and assessment as well as workplace differences.

The assessment of participant knowledge, skills, and performance demonstrated discrepancies among three domains and between facilitators and learners. The percentage of facilitators who passed the MCQ was high pre-course (75% in Kenya) and post-course (95% in Kenya and 82% in Pakistan); however, successful completion of a bag and mask skills checklist was low. Previous follow-up studies of resuscitation training have identified low concordance between knowledge and skills and self-efficacy and skills,[17,18] a finding similar to studies of self-assessment ability which show variability in physician self-rated assessments and external observations.[19] Although learners in Kenya showed a significant increase in knowledge after the course, the percentages of learners at both sites who successfully passed the MCQ was low (<55% with a total score >80%). Barriers identified included lack of availability of the learner workbook for study before the course, limited literacy in English and conflicts with previous training or practice patterns. Problems identified with the assessment itself included unfamiliarity with the testing format and confusion over questions with 2 correct answers.

The overall performance on the bag and mask skill checklist was unexpectedly low. Post-HBB training, few facilitators demonstrated mastery of all 12 skills (31% Kenya and 46% Pakistan), and even fewer learners (15% Kenya, 17% Pakistan) successfully completed the checklist on their first attempt after HBB. Complete mastery of the skill of bag and mask ventilation (100% correct performance) has not previously been the standard for life support courses; it is a complicated skill and may require more time for mastery. Participants were provided neither the checklist nor the resuscitation equipment prior to their assessment, and the scores likely reflect insufficient time to practice newly acquired skills. Participants also cited difficulty remembering the large numbers of steps in the checklist.

Successful completion of the OSCEs varied widely among facilitators and learners and between the scenarios. Few facilitators

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Table 6
Knowledge, skills, and performance assessments: scores and successful pass rates.

Instrument group	Pre mean (SD[a])	Pre passes	Post mean (SD)	Post passes	*t*-Test	*p*	Effect size
MCQ							
Kenya facilitator	20.6 (1.9)	15 (75%)	22.3 (3.0)	19 (95%)	-2.89	.05	0.7
Kenya learners	14.1 (2.7)	1 (2%)	19.6 (2.5)	26 (54%)	15.29	.001	2.12
Pakistan facilitator teachers			20.2 (3.1)	9 (82%)			
Pakistan learners		19.5 (2.8)	34 (52%)				
Bag and mask							
Kenya facilitator	2.42 (2.6)	0	10.50 (1.62)	5 (31%)	13.7	.000	4.21
Kenya learners	0.17 (.63)	0	9.44 (1.9)	7 (15%)	34.44	.000	6.55
Pakistan facilitator		11.8 (.87)		5 (46%)			
Pakistan learners		9.21 (2.46)		9 (17%)			
OSCE A							
Kenya facilitator			8.9 (1.7)	10 (50%)			
Kenya learners			9.13 (1.8)	29 (60%)			
Pakistan facilitator			8.36 (.92)	11 (100%)			
Pakistan learners			8.32 (1.6)	40 (83%)			
OSCE B							
Kenya facilitator			19.35 (1.8)	14 (70%)			
Kenya learners			15.81 (3.98)	10 (20.8%)			
Pakistan facilitator			17.64 (1.7)	5 (45.5%)			
Pakistan learners			15.58 (3.9)	12 (22.6%)			

[a] Standard deviation.

or learners were familiar with the OSCE format. As many did not master the skill of bag and mask, it is not surprising that they did not succeed at the OSCE. Participants cited limited time to practice the integration of separate skills into a continuous series of actions. Facilitators had difficulty with OSCEs and even those with the skill to perform integrated resuscitation may have lacked the ability to teach it effectively. The lack of success with bag and mask ventilation and OSCEs may be attributed to inexperience and unfamiliarity with bag and mask ventilation, insufficient practice time a lack of prior exposure to OSCE format and high standard of performance.

The formative evaluation of HBB resulted in further development of the educational program and modification of assessment tools. Revision of course materials included larger illustrations, recasting of abstract concepts with more concrete steps, standardization of language to facilitate translation, and the incorporation of the bag and mask checklist into the learner workbook. Skills practice has been fully integrated into the presentation of knowledge content, and additional exercises with guided instruction have been added to further reinforce the steps in preparation for birth and The Golden Minute®. The assessment tools were modified to have a single correct response to all MCQs and re-written to facilitate understanding and translation. The bag and mask skill checklist was restructured to reduce the number of steps. The corrections for inadequate response to bag and mask ventilation were grouped into 3 adjustments. The criterion for ventilation at 40 breaths/min was changed to a range of breaths/min. The instructions to facilitators were enhanced for OSCEs. Additional changes to the course agenda included increased time for practice and consolidation of skills prior to learner assessment as well as encouragement of ongoing self-reflection and deliberate practice in the workplace. As both adequate neonatal resuscitation and teaching ability are critical for effective facilitation, increased attention is being paid to careful selection and training of facilitators to ensure that those selected are able to demonstrate adequate neonatal resuscitation skills and teaching ability before they become facilitators.

Further evaluation and learner/facilitator assessment data will be required to inform subsequent refinements to the educational program. The current study was limited to the training of 1-2 generations of trainers/facilitators and an initial focus on the first four levels of outcome. Later evaluations will focus on actual performance in the workplace, patient and community health.[10] A Web-based implementation guide under development incorporates the study findings into additional advice on structure of the training cascade, selection of facilitators, sample workshop agendas, conduct of assessments, and continued practice in the workplace.

The results of the program evaluation raise questions about appropriate outcomes for resuscitation training courses. The observed discordance among self-efficacy, knowledge, and skills has been noted in follow-up of many life-support training initiatives.[17,18] Educational theory supports the concept that mastery of a skill may be more readily maintained within the workplace. The dual objectives of efficiency and effectiveness of training may be in competition when determining the length of resuscitation training courses. Single-day courses, while cost-effective, may lack the necessary time for consolidation of new knowledge and skills. Flexible course designs, which permit acquisition of skills, consolidation of new learning, and subsequent assessment, may help achieve mastery.[20,21] Facilitators need to be better equipped to instruct learners. When learners continue to practice after the course, the deterioration in knowledge and skills may be minimized.

Field testing and modification of resuscitation programs are essential steps before implementation with new groups of learners. Future investigations must focus on workplace performance and patient outcomes.

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Contributors

All of the authors provided substantial contributions to conception and design, acquisition of data or analysis and interpretation of data; involved in drafting or critical review of the manuscript for important intellectual content; and approved the final version of the manuscript.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.resuscitation.2011.07.010.

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