Development and Impact of Helping Babies Breathe Educational Methodology

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abstract

The educational pedagogy surrounding Helping Babies Breathe (HBB) has been transformative in going beyond a curriculum focused only on basic neonatal resuscitation; indeed, it created the framework for an educational program that has served as a model for replication for other impactful programs, such as the Helping Mothers Survive and other Helping Babies Survive curricula. The tenets of HBB include incorporation of innovative learning strategies such as small group discussion, skills-based learning, simulation and debriefing, and peer-to-peer learning, all of which begin the hard work of changing behaviors that may eventually affect health care systems. Allowing for adaptation for local resources and culture, HBB has catalyzed innovation in the development of simplified, pictorial educational materials, in addition to low-tech yet realistic simulators and adjunct devices that have played an important role in empowering health care professionals in their care of newborns, thereby improving outcomes. In this review, we describe the development of HBB as an educational program, the importance of field testing and input from multiple stakeholders including frontline workers, the strategies behind the components of educational materials, and the impact of its pedagogy on learning.

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BACKGROUND

Helping Babies Breathe (HBB) is a simple, pictorial, portable, skill-based resuscitation program that emphasizes the most essential basic skills of neonatal resuscitation.[1,2] It was specifically designed for resource-limited areas wherever infants may be born. The goal was to equip birth attendants with the necessary skills to rapidly assess a newborn, provide warmth, help the newborn to breathe, and give other newborn care in the critical moments after birth. Given the large number of global deliveries that occur in homes or community-based settings, the challenges were to create a curriculum that could effectively transfer knowledge and skills to birth attendants[3] while staying grounded in the scientific evidence of the International Liaison Committee on Resuscitation and educational model of American Academy of Pediatrics Neonatal Resuscitation Program (NRP). The educational design of HBB had to account for infrastructural challenges of health systems, resource limitations, variable knowledge base of learners, and differences in cultural practices and beliefs.[4]

Since its inception, >850 000 birth attendants in 80 countries have been trained and the curriculum has been translated into >27 languages.[5] With its broad reach worldwide, HBB incorporates innovative learning methods into its educational design geared toward improving educational efficiency in both the acquisition and retention of skills, simulation, skills-based hands-on learning, peer-to-peer practice, and training-of-trainers (TOT) cascades. These strategies make the educational experience learner, rather than facilitator, centered.

EDUCATION PROGRAM AND MATERIAL DEVELOPMENT

The educational materials and simulation tools were developed simultaneously to incorporate active learning and hands-on skills practice throughout the program and with the thinking that birth attendants worldwide have differing levels of education and literacy. The thoughtful design used principles of adult learning theory and included the following components.

Action Plan

The HBB action plan was the central educational device for the program and provides a pictorial representation of the essential basic steps of neonatal resuscitation and the order in which they are to be performed (Fig 1). Deliberately designed for simplicity, with minimal, carefully chosen words, the action plan was designed so that it would be imprinted in the memory of health care providers. They could easily remember the infrequently required but life-saving action of bag-mask ventilation to help a newborn breathe within the critical Golden Minute after birth. The action plan was easy to display prominently as a job aid in delivery rooms or for the midwife to use while doing home deliveries.

The format of the action plan followed the principles of evaluation, decision, and action. Three different colors (green, yellow, and red) indicated the level of intervention a newborn may need. Green guided the provider to a well infant, yellow guided them to an infant who needed closer attention, and red implied the infant needed advanced care that could be in the same or different facility.

Facilitator Flipchart

The facilitator flipchart was designed as a portable teaching tool that replaced slides and did not require electricity or projectors for use. The front page, which faced the provider, had a picture illustrating the main message. The page facing the facilitator had guidance for "explain and demonstrate," which summarized key messages (Fig 2). The facilitator was directed to demonstrate the activities using the simulation tools developed for HBB. "Facilitate practice" was for the facilitator to have the learners practice the activity in groups of 2 or 3. "Check yourself" questions were multiple-choice questions that reviewed the main messages on the page. These questions often served as the basis for group discussion. The participants recognized differences in current practices and what they were being taught. This provided the seed for thinking through possible behavior changes they could make to improve care. The "background" section had additional information describing reasons for certain activities and educational advice. The "educational advice" helped facilitators learn how to present the information on the page in an engaging format. In the second edition, the action plan was added to every page, with an indicator of where the learners were in the algorithm, to connect each page's content to the overall schematic.

After the above content, cognitive assessment included a multiple-choice questionnaire, skill assessments included a bag-mask checklist and 2 objective structured clinical evaluations (OSCEs), short simulation scenarios designed to assess how the learners performed in the evaluation, decision, action cycle. The flipchart also contained guidance for learners on formulating their own scenarios. There was information related to what the facilitator should do to prepare for the workshop, skills needed for facilitating a workshop, and what should be done after the workshop to improve outcomes.

Learner Workbook and Provider Guide

The learner workbook was laid out in sections corresponding to the colors of the action plan and flipchart. With the first edition of HBB, the goal was to have learners review the materials

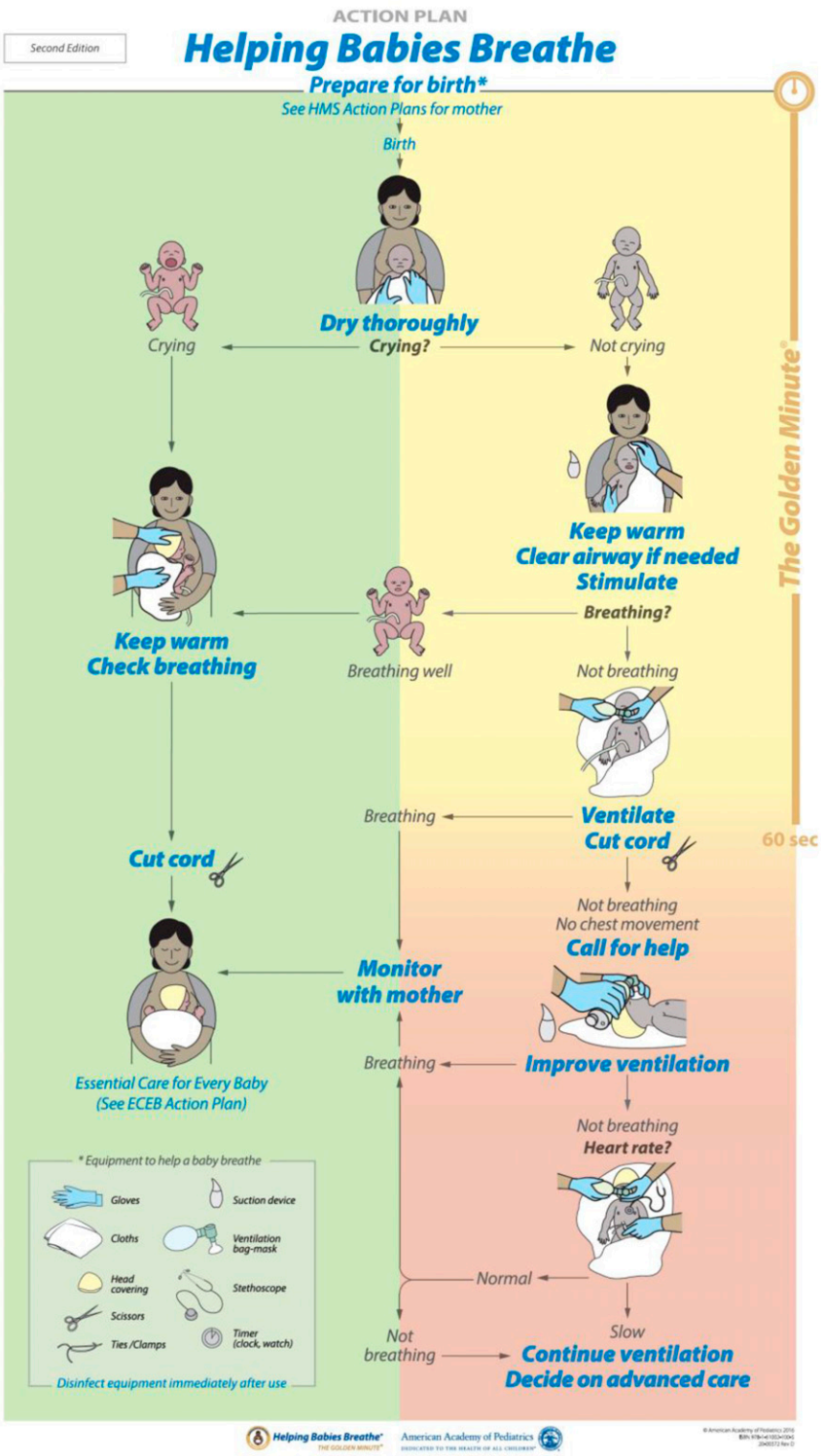

FIGURE 1
Action plan, HBB second edition. Reproduced with the permission of the American Academy of Pediatrics.

before coming to the face-to-face workshop. However, this often did not occur for a variety of reasons, including not receiving the workbook, not having time to review it, or not understanding the instructions. For the second edition, the learner workbook transitioned into a provider guide, the goal of which was to be a resource for activities before, during and after the workshop. It provided activities such as self-check questions and guidance for simple quality improvement indicators.

Simulation Tools

Simulation-based resuscitation training had been shown to improve knowledge and skills.[6] Simulation-based workshops provided an opportunity for learners to advance through the clinical scenarios, practice skills, engage in peer-to-peer practice, develop teamwork, and provide feedback. Simulation tools had traditionally been sophisticated and often not used at scale in resource-limited environments. For HBB, NeoNatalie (Laerdal Global Health), a lower-cost, easily transportable mannequin, was designed that could be filled with water to weigh the same as a newborn and could be "operated" by a facilitator to mimic crying, breathing with chest wall excursion, and an umbilical pulse (Fig 3).

INFLUENCE OF HBB

HBB proved to be successful, with learning and skills transfer resulting in improvements that saved newborn lives.[7,8] The format was replicated for other programs that formed the Helping Babies Survive suite of programs, including Essential Care of Every Baby and Essential Care for Small Babies.[9] The success of HBB also made the educational format attractive for teaching concepts related to the care of the mother, as seen in the Helping Mothers Survive suite of programs including Bleeding after Birth, Preeclampsia and Eclampsia, Essential Care for Labor and Birth, and Threatened Preterm Birth.[10] All the programs follow a similar pictorial color-coded design for the action plan and follow

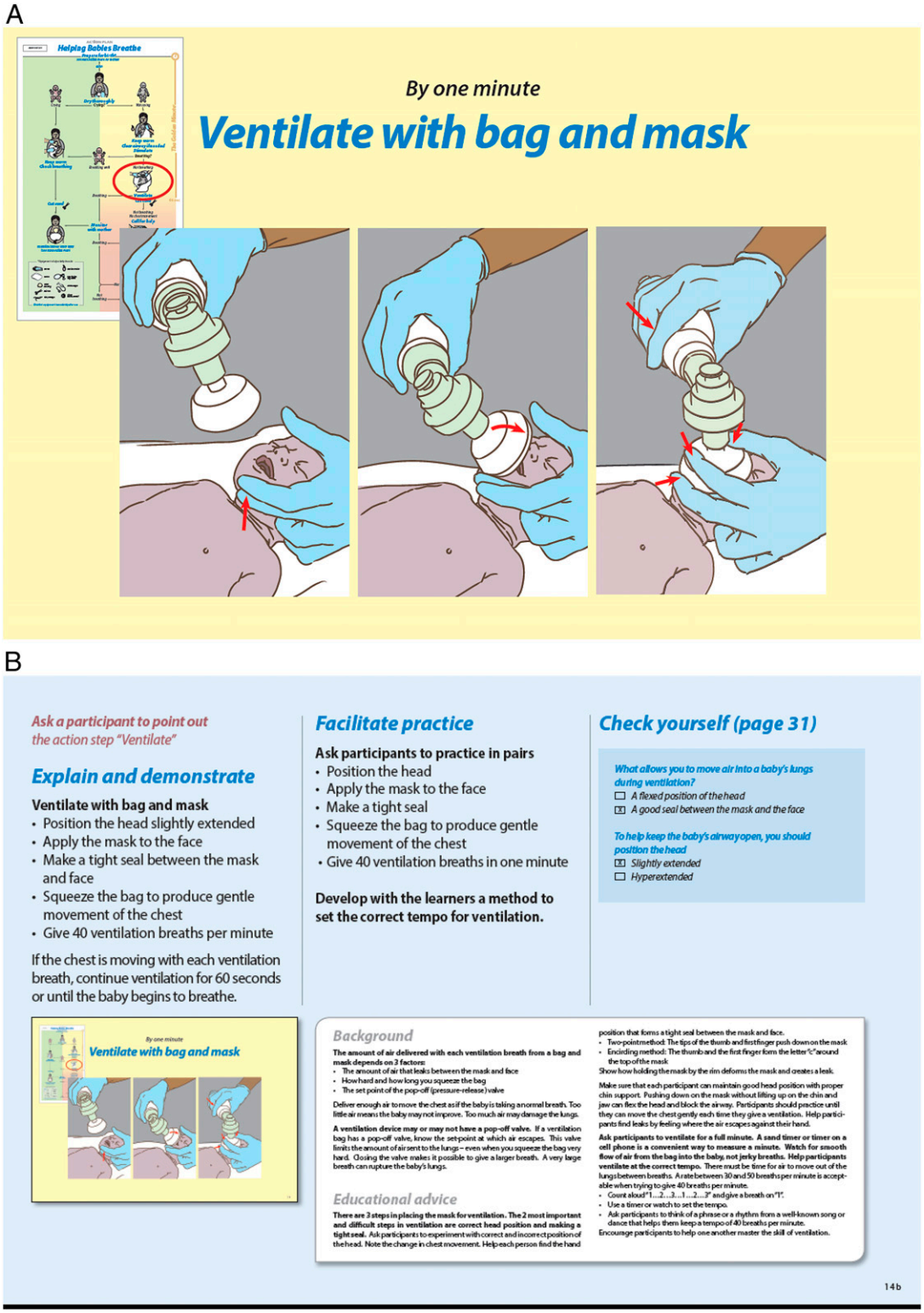

FIGURE 2
Flip chart from HBB second edition. A, Learner view. B, Facilitator view. Reproduced with permission of the American Academy of Pediatrics.

FIGURE 3
Educational materials for workshop: simulator, bag and mask, Action plan, facilitator flipchart. Reproduced with permission of the American Academy of Pediatrics.

a similar format for the facilitator flipchart and provider guide. Thus, a midwife could use a similar format to learn care of the infant and mother together.

With the development of Essential Care for Every Baby and Essential Care for Small Babies, the focus was on the care that all infants needed after the initial birth stabilization process. The programs included not only important skills such as recognition of danger signs and administration of antibiotics but also empowerment of parents to take care of their infants when they went home. The parent guides were designed to provide reminders about infection prevention, feeding the infant breast milk only, proper cord care, and recognition of danger signs, which would prompt treatment of possible sepsis and referral for ongoing care, if required. Local adaptation of the guide was encouraged; for example, in Tanzania, obstetricians who liked the pictorial design added dangers signs for the mother. This parent guide was also translated into Swahili, Bengali, and Hindi for use where English was not often a language of communication. The new parent guides can be adapted and the language can be locally modified.

PROGRAM EVALUATION

Feedback from the field was incorporated into HBB's educational design to produce a comprehensive, scientifically sound, and efficient education program. The HBB Global Implementation Task Force planned and implemented a structured development and evaluation of the program to obtain input from frontline health care providers and experts around the world.[11] Multiple stakeholders and a Delphi panel contributed to the iterative process. Training of facilitators and learners was done with both quantitative and qualitative components in field test sites in Kenya and Pakistan. Course evaluations and focus groups provided data on facilitator and learner perceptions. Knowledge and skill assessments included before and after scores from multiple-choice questions and post-training assessment of bag-mask skills, as well as 2 OSCEs. Facilitators and learners expressed high satisfaction with the program and high self-efficacy with respect to neonatal resuscitation. Assessment of participant knowledge and skills pre- and post-program demonstrated significant gains. However, the majority of participants could not demonstrate mastery of bag-mask ventilation on the post-training assessment without additional practice.[11] Mastery of ventilation skills and integration of skills into case management were thought to be unachievable in classroom settings without additional practice, continued learning, and active mentoring in the workplace. These findings were used to modify the program structure, materials, and assessment tools. This included further simplification, clarification of concepts, quality improvement tools, and identification of skills for good facilitation.

This rigorous process of program development for HBB set an example for other educational programs that input from frontline workers was an integral part of curriculum development. All of the subsequent suite of programs for the infant (Helping Babies Survive) and mother (Helping Mothers Survive) have been similarly evaluated and modified after testing in the field.[12,13]

INNOVATION IN LEARNING

HBB followed the principles of adult learning and took the lessons from adult learning theory and translated them into practice.[14] Innovative learning strategies such as small group learning, peer-to-peer facilitation, hands-on practice, and simulation and debriefing were incorporated. Rather than large classroom settings, a single facilitator would demonstrate essential skills laid out in the "action plan" to groups of 6 health care providers, a ratio

chosen after trials of learning sessions during program development. The small group format allowed learners to ask questions and discuss issues that were important to them, including how to best implement learning. Furthermore, facilitators could easily adapt to the learning styles and needs of the learners and could observe all 6 participants practicing the skills. These actions were then repeated with ongoing peer-to-peer interaction by using a low-tech mannequin while working in pairs. The peer-to-peer practice sessions let participants serve in both the provider/learner and facilitator roles. This allowed them to function as the team leader and empowered them to conduct the resuscitation when the need arose. A midwife in Tanzania recounted her experience following HBB training:

> "What I have personally learned is helping a child to breathe after birth. I noticed that before I got simulation trainings, we left many children to die while there was a way to help them survive but I did not know how. But after I learned from HBB simulation workshops, I came to practice it and it worked well even when I thought to give up, I continued to resuscitate them."

Historically, neonatal resuscitation programs have taken the lead on incorporating simulation into their educational frameworks.[15] Similar to the NRP, HBB relied heavily on the use of simulation for knowledge transfer and skills acquisition. Although the simulation aspect of HBB workshops allowed providers to practice skills, they were also able to self-reflect on their own performance, in addition to debriefing and receiving feedback from facilitators and their peers. Such feedback was elicited through the short OSCEs, scenarios that required participants to perform certain interventions in response to a delivery according to the action plan. The OSCEs allowed for learners to practice the essential life-saving skills in a formal assessment that could be quantified.[16,17] Compared with pre-workshop assessments, it was not surprising that performance on OSCEs and a bag-mask skills checklist improved at the end of an HBB workshop.[18–20] Performance on OSCEs immediately post-workshop also showed that different cadres of workers performed similarly on the OSCEs, despite doctors having had more training and clinical experience in neonatal resuscitation than nurses and midwives.[18,19]

Beyond the initial training, some system of ongoing low-dose, high-frequency practice was essential to retain and improve resuscitation skills. It was well known that the critical life-saving skills of bag-mask ventilation were not easily learned in a one-day workshop,[11] and they rapidly dropped off after a workshop, particularly in busy facilities when the staff did not have time to practice.[21] HBB training and subsequent practice were often bundled with other interventions to create quality improvement initiatives geared toward improving neonatal outcomes.[22,23] These short practices could take only a few minutes at the beginning of a shift.[23,24] The NeoNatalie mannequin was left in a prominent location in the work areas of those who attended deliveries, and practices occurred regularly. In Tanzania, HBB facilitators conducted frequent OSCEs of learners over the course of a year. The study results revealed a significant decrease in 24-hour neonatal mortality, from 11 to 7 per 1000 live births.[25] Secondary analysis of a study in Kenya where practices were assessed by OSCE and facilitated by an HBB facilitator or a peer revealed that students and other novice learners performed better when their practices were overseen by an HBB facilitator, whereas nursery nurses with more experience and protected time for practice were able to retain skills through peer-to-peer practice and feedback.[23]

The OSCEs in HBB could be used as both summative and formative tools to support low-dose, high-frequency practice. Researchers comparing monthly HBB practice with less-frequent practice of resuscitation skills demonstrated that the groups who practiced monthly had 2.9 greater odds of passing these OSCEs compared with groups who practiced less frequently.[26] Although doctors and nurses had similar OSCE scores immediately after the initial HBB workshop, doctors (who entered the study with higher levels of previous neonatal resuscitation training and experience) had 4.3 times greater odds of passing subsequent OSCEs compared with nurses.

The concepts of simulation and debriefing in settings where HBB is implemented may be new concepts to the learners. At one site in Kenya, a survey revealed that for 55% of learners trained in HBB, simulation was a new concept for them.[27] Furthermore, giving feedback and debriefing were also new. Debriefing, completion of clinical care audits and case reviews, could be misinterpreted as assigning blame in groups less experienced with providing feedback.[28] Introducing concepts of simulation and debriefing early in training is key to lessening stigma associated with the needed process of feedback and will ultimately allow for improvement in both individual and team performance.

When HBB was first released in 2010, it was disseminated through a TOT cascade, a model that had been used in the NRP experience in China.[29] TOT cascades have been used to scale up programs across a spectrum of topics, including neonatal resuscitation, laboratory management, evidence-based practices on autism, and mental health curricula, among others.[29–32] Advantages with TOT include cost effectiveness, the

potential for rapid expansion, development of local capacity, and cultural relevance. Authors of a study in Ethiopia showed that an HBB TOT of >1100 midwives in 132 hospitals cost ~$2105 per facility or $197 per trainee. Barriers to implementation of TOT model included lack of preparation of hospital-based educators and limited logistic support for facilitators.[33]

There are concerns about fidelity of implementation, defined as accurate delivery of core messages according to the curriculum, and low propagation rates of TOT graduates, with some studies reporting that 30% to 50% of TOT graduates did not provide any training for others. Furthermore, monitoring systems to determine what happened downstream in the training cascade were not initially established to track this information beyond the initial graduates (for example, number of further trainees, their knowledge retention, and their clinical outcomes).[34,35]

HBB SECOND EDITION

Given HBB's linkage to the scientific evidence on neonatal resuscitation, HBB was revised on a 5-year cycle corresponding with International Liaison Committee on Resuscitation review of literature. Taking stock after implementation of HBB first edition led to concrete examples of lessons learned that led to improvements incorporated into HBB second edition (Table 1).

The second edition of HBB was released in 2016 and was developed by many of the same people who developed the original HBB as a planned process for renewal and with an additional review of current knowledge and recommendations. HBB second edition was field tested in India and Sierra Leone to improve confidence in the modifications and improvements.[37] The field trials continued to push for further simplification of the HBB program. The second edition also emphasized that an initial workshop was only the beginning of the work needed to decrease asphyxia-related neonatal mortality. The hard work, which really began after the workshop, included guidance for facilitators to provide supportive supervision for two key follow-on activities after the initial training; first, a system for ongoing practice of these essential life-saving skills to facilitate retention, and second, local implementation via stronger connections to local health care systems and quality improvement methodologies. The second edition of HBB also contained more content to support facilitators in their newly expanded role of long-term mentor and quality improvement coach. Although quality improvement was a separate entity, attempts were made to introduce the concept of quality improvement, and providers were encouraged to think about what they would change to improve in their day-to-day care of mothers and infants. This allowed providers to feel empowered and to think about how they could improve as a team.

TABLE 1 Lessons Learned From Implementation of HBB

Facilitators have benefitted by deliberate practice of facilitation that included debriefing skills.
Self-directed learning before the workshop did not always occur; thus, the development of a provider guide to allow for post-workshop practice, self-check questions, and guidance for simple quality improvement processes would be beneficial for learners in the form of a provider guide.
Facilitators supported facilitator-to-learner ratio of 1:6. They indicated they were able to observe all the learners.
Identification of outcome and process quality indicators linked to the action plan will help identify how to improve outcomes.
Peer-to-peer learning may help retain skills and empower providers.
Providers need simulation and practice areas.
A comprehensive approach with implementation in the field[25,36] is necessary to effect change.

OUTCOMES

The Kirkpatrick Model[38] is probably the best-known model for analyzing and evaluating the results of educational programs. Its 4 levels include (1) reaction, participants' reaction or satisfaction to the training; (2) learning, participants' understanding of the training as measured by knowledge, skills or experience; (3) behavior, participants' use of new skills or behaviors at work; and finally (4) results, the impact on desired clinical outcomes. Over the course of its 10-year history, HBB has demonstrated impact at all 4 levels. For the first level, field trials for both first and second editions demonstrated high levels of satisfaction from learners, particularly with hands-on skills practice and small group instruction, giving them more contact with a knowledgeable facilitator than previously.[11,37] Focus groups conducted in Tanzania after HBB training revealed that participants thought HBB helped increase knowledge, skills, and confidence but that ongoing supportive supervision and follow-up visits were critical to continue to maintain skills. For the second level, researchers of multiple studies have also demonstrated effective knowledge transfer immediately post-workshop,[39] as noted by both cognitive and skills-based assessments.[18–20] For the third level, direct observation of essential newborn care practices and resuscitation in Honduras showed improvements in care after HBB training. Those trained in HBB dried and stimulated nonbreathing infants performed delayed cord clamping, skin-to-skin care, and initiation of early breastfeeding more often than those not trained in HBB.[40] It was noted in this study that only 1 of the 94 deliveries attended by HBB-trained personnel required bag-mask ventilation, likely because the initial steps were performed effectively. In a study in Sudan of 71 village midwives, 61% of whom were functionally illiterate, researchers demonstrated that improperly performed resuscitation

practices were much less–frequently seen after HBB training.[36]

Regarding outcomes (level 4), researchers in clinical studies and 2 recent meta-analyses of 7 studies in multiple countries demonstrated that HBB training decreased rates of stillbirth, perinatal mortality, and early neonatal mortality.[7,8,25,41,42] The studies were heterogeneous in nature and considered of moderate quality, indicating a need for alignment of indicators to study neonatal resuscitation.

FUTURE EDUCATIONAL INNOVATIONS

Although HBB has illustrated the power of simplicity to demystify neonatal resuscitation and make it accessible to different cadres and levels of learners, future innovation is needed to address ongoing gaps in the following areas.

HBB as a Learning Model

HBB focuses on learning rather than teaching. Health care providers often see this as a different (and more effective) method of learning as illustrated in the following quote from a frontline health care worker in Tanzania: "I see this (training) makes it different from others. For this hands-on skill orientation is different; the lessons are in good arrangement and it is practical. So, it is easy to remember. This makes it unique and creates perfectness of us. I have loved this so much." HBB has been a model for other educational programs to move toward a more hands-on interactive approach. For the future, and particularly in this coronavirus disease era, face-to-face training is challenging, and other learning mechanisms such as electronic learning or other digital tools may need to be incorporated.

Integrated Learning Empowers the Team

The HBB model of learning improves confidence of health care providers and facilitates teamwork as illustrated in this quote from a midwife in Tanzania: "After this training, everyone has confidence… For example, if you have a case and you call for help, it is not like previous days before training whereby my fellow providers were reluctant to support. My teammates and me are working close to each other." Even if team members for the mother and the infant are separate, integrated learning opportunities may facilitate teamwork and improve care and outcome for mothers and infants. Teaching these at a similar time might promote better future team interactions and confidence, leading to better performance. A team approach may also lead to better quality improvement implementation.

Consolidation of Knowledge and Skills

The need for consolidation and retention of knowledge and skills has been recognized with NRP.[15] One-time educational or training courses are not enough to maintain knowledge and skills. HBB exercises and OSCE tools have been used to develop ongoing peer training tools (Fig 4) to facilitate low-dose, high-frequency simulation while health care personnel are "on the job." Further innovation is required to determine the content and frequency of practice with peer-to-peer learning needed to maintain skills. Furthermore, research is needed to understand the best way to train providers in performing interventions that are infrequently required but urgently needed as life-saving care, such as bag-mask ventilation.

Using Learned Abilities and Future Quality Improvement

Participants of HBB workshops may not always be able to effectively use their knowledge and skills after training. Although HBB may help providers to be better equipped to facilitate use of their abilities, more quality improvement skills may be needed with a team approach to address barriers and change clinical outcomes. In Canada, it was demonstrated that multidisciplinary team members being trained in quality improvement together (Evidence-based Practice for Improving Quality)[43] led to a reduction in newborn mortality and morbidity across the country.[44] In addition, HBB has focused primarily on health service providers, with limited preservice training. If HBB (including concepts of simulation, debriefing, and quality improvement) were introduced in preservice settings (such as schools of midwifery, nursing, and medicine), health providers would likely become accustomed to more active forms of lifelong learning, with all care providers continually striving to improve the quality of care for mothers and infants.

Real-Time Objective Feedback on Skills Performance

Similar to other clinical skills taught to learners, decay has commonly characterized HBB learning, especially the technique of effective bag-mask ventilation. When skills decline, reacquisition can be facilitated through retraining and enhanced mentorship. The role of electronic devices that objectively measure and provide feedback on quality of HBB skills requires further elucidation. Whether electronic performance measurement and real-time feedback may empower HBB providers to effectively retrain themselves toward improvement is an important area in need of further study. Devices like the Augmented Infant Resuscitator could provide effective real-time feedback related to the volumes of gas delivered with bag and mask ventilation of newborns to learning (and relearning) these skills.[44,45] In the spirit of HBB, ease of implementation and deployment in low-resource settings for such electronic feedback devices will require this to be cost-effective, use limited resources (eg, taught without the necessity for electricity), and be able to be demonstrated as robust

FIGURE 4
Peer-to-peer learning.

enough to "compete" with other educational needs.

National, Regional and Global Skills Monitoring for Program Improvement

The effectiveness and challenges related to HBB implementation have been documented from systematic surveys and research projects. These surveys and research projects are time consuming and often costly. As advances in digital technologies, data science, and analytics grow, integration of devices that objectively measure care provided (such as assisted ventilation with a bag and mask) with measurement of demographics and outcome may provide information about use of learning and guide practices such as low-dose high-frequency simulation. This may also detect changes in skills performance, facilitate quality improvement planning, and inform health systems about program implementation at scale. Comprehensive newborn programs that are implemented with local partners[46] will pave the future to meet the goals of decreasing neonatal mortality.

CONCLUSIONS

In the last 10 years, HBB has had considerable impact on saving newborn lives. Its effective educational pedagogy continues to serve as a model for other training programs to promote knowledge transfer of life-saving interventions to learners with a variety of backgrounds and capabilities. This pedagogy has catalyzed the development of innovative learning strategies, educational materials, and devices that are customizable and adaptable for resource-limited settings, thereby increasing coverage of essential skills like neonatal resuscitation and essential newborn care. There is a bright future to fulfill the global dream that every newborn, no matter where in the world he or she is born, will be attended to by a person who will carry out effective resuscitation should the need arise. As newborns are seeds of the future for all nations, so also may HBB be a seed for the future for many aspects of learning throughout the world.

ABBREVIATIONS

HBB: Helping Babies Breathe
NRP: Neonatal Resuscitation Program
TOT: training-of-trainer
OSCE: objective structured clinical evaluation

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