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ORIGINAL ARTICLE

Resuscitation skills after Helping Babies Breathe training: a comparison of varying practice frequency and impact on retention of skills in different types of providers

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Background: Helping Babies Breathe (HBB), a basic neonatal resuscitation curriculum, improves early neonatal mortality in low-resource settings. Our goal was to determine retention of resuscitation skills by different cadres of providers using the approved HBB Spanish translation in a rural clinic and community hospital in Honduras.

Methods: Twelve clinic and 37 hospital providers were trained in 1 d HBB workshops and followed from July 2012 to February 2014. Resuscitation skills were evaluated by objective structured clinical evaluations (OSCEs) at regular intervals. Clinic providers practiced monthly, whereas hospital providers were randomized to monthly practice for 6 months vs three consecutive practices at 3, 5 and 6 months.

Results: In the rural clinic, follow-up OSCE assessment showed rapid loss of skills by 1 month after HBB training. For all providers, repeated monthly testing resulted in improvements and maintenance of OSCE performance. In the community hospital, over all time points, the group with monthly OSCEs had 2.9 greater odds of passing compared with the group who practiced less frequently. Physicians were found to have 4.3 times greater odds of passing compared with nurses.

Conclusions: Rapid loss of resuscitation skills occurs after an initial training. Repeated practice leads to retention of skills in all types of providers. Further investigation is warranted to determine the clinical correlation of neonatal outcomes after HBB training.

Keywords: Birth asphyxia, Helping Babies Breathe, Neonatal mortality, Neonatal resuscitation, Objective structured clinical evaluation, Retention of skills

Introduction

On a global health scale, neonatal resuscitation has been shown to decrease rates of neonatal mortality due to one of the major causes of death: birth asphyxia (or intrapartum-related events).[1] Thus proper implementation of neonatal resuscitation programs provides an opportunity to save hundreds of thousands of newborn lives.[2,3] Helping Babies Breathe (HBB) is a global curriculum of neonatal resuscitation that focuses on the most essential steps of basic resuscitation, including drying, warmth, stimulation, suction and bag-mask ventilation (BMV), to which >95% of babies will respond.[2,4–8] The program has been successfully taught via a train-the-trainer cascade that has reached >400 000 providers in at least 77 countries,[6,9] and studies in both Africa and Asia have shown reductions in early neonatal mortality, asphyxia-related mortality and stillbirth rates as a result of HBB training to providers in hospital and clinic sites.[10–14]

Despite these clinical successes, the educational outcomes after HBB training mirror what has been noted in US pediatric resident populations after neonatal resuscitation training: without further practice or refresher training, skills are not maintained when reassessed weeks to months later.[15–20] For example, after

HBB training, few providers had mastered the skill of BMV, and despite adequate performance in simulations with a low-fidelity mannequin after HBB training, the performance of clinical skills in real-life delivery situations was not always present.[16,21,22] In Tanzania, passing of an objective structured clinical evaluation (OSCE) decreased from 87.1% in the immediate post-workshop period to 79.4% at 4–6 weeks and 55.8% at 4–6 months.[17] In Ghanaian midwives, OSCE performance decreased from 94.9% immediately after a workshop to 81.2% 4 months later.[23] While it is recognized that more frequent practice of these essential life-saving skills is needed after initial training, the frequency at which different providers need to perform this practice is unknown.[24,25]

In late 2015, the International Liaison Committee on Resuscitation (ILCOR) Neonatal Task Force released the most recent treatment recommendations incorporated into the seventh edition of the Neonatal Resuscitation Program (NRP) and the second edition of Helping Babies Breathe.[7,26] The studies exploring this theme exhibited a low quality of evidence and showed no difference in patient outcomes, but did show some advantages in psychomotor performance, knowledge and confidence when training occurred every 6 months or more frequently.[26] Therefore, both the seventh edition of the NRP and the second edition of Helping Babies Breathe suggest that a system of ongoing practice is necessary for skill retention but otherwise make no specific recommendations. While it was acknowledged that a higher quality of evidence is needed to formulate stronger recommendations, a weak recommendation can be made that recurrent training should occur more frequently than once per year, although the exact frequency is unknown.[27]

As such, the objective of our study was to evaluate HBB providers after an initial training by administering the standard OSCE at varying intervals to determine retention of basic skills and, in particular, the use of effective BMV in a simulated scenario. Our goal was to determine how different providers would retain skills and perform on the OSCE over time when practicing at a certain frequency. Our hypothesis was that an increased frequency of practice would maintain skills over time for all providers and that improvement would be seen over time with a cumulative number of practice sessions even in those that did not practice as frequently.

Materials and methods

Study design and interventions

The study was exempted by the Cincinnati Children's Hospital Medical Center Institutional Review Board and approved by the Shoulder to Shoulder Medical Advisory Board and the Secretary of Health, Intibucá, Honduras. The study took place over the time period July 2012 to February 2014 at two study sites: a rural clinic, Hombro a Hombro, in Santa Lucía, Honduras and a rural community hospital, Hospital Enrique Aguilar Cerrato, in La Esperanza, Honduras. During the study period the clinic served a catchment area of approximately 36 000 and had approximately 10–15 deliveries per month. The hospital is among 14 community hospitals in Honduras and had approximately 300 deliveries per month. The two sites were separated by 80 km and 3500 m of elevation gain.

At both sites, the HBB provider course (first edition) was offered as a 1 d, 8 h workshop.[28] The course was facilitated by HBB Master Trainers from the USA who were capable of speaking and teaching in Spanish. The course was taught entirely in Spanish and used the approved Spanish HBB translation (Ayudando a Los Bebés a Respirar). Participants completed the HBB course using the HBB Action Plan, learner workbooks, low-fidelity newborn simulators and BMV equipment. From July 2012 to May 2013 the study was piloted in the rural clinic to practice with the approved Spanish translation and to determine the feasibility of frequent subsequent simulations in a busy health care setting with a rotating group of providers. In the rural clinic, all available providers (n=12) were trained in August 2012 after 6 weeks of baseline data collection and delivery room observation. In the community hospital, initial HBB training was held in August 2013 and a total of 70 health care personnel participated. Three workshops were conducted to accommodate all the pertinent staff at the hospital, with 20–25 participants per day and a trainer:provider ratio of 1:6.

Immediately following the HBB workshop, participants were assessed in the rural clinic with the four HBB learner assessments, including a multiple-choice questionnaire (MCQ), BMV skills checklist and two objective structured clinical evaluations (OSCEs A and B), all available online.[28] These assessments were validated in Asian and African populations prior to the release of HBB and in this Latino population with the initial HBB workshop.[21,29] Importantly, OSCE B mirrors the entire Action Plan, or algorithm, of the HBB curriculum and the exact life-saving steps that need to be performed in basic neonatal resuscitation. Participants continued to perform OSCE B with an HBB Master Trainer at approximately monthly intervals; the dates and times of these OSCEs occurred when the participant was available on site at the clinic, at their convenience. Despite previous evidence demonstrating that doctors and nurses perform at a similar level on the OSCEs immediately after HBB training,[22] we noted marked differences over time that determined the need to stratify the cohort for the subsequent study in the community hospital.

In the community hospital, participants were assessed before the start of the workshop with three of the four HBB learner assessments: the MCQ, BMV skills checklist and OSCE B. On the same day, immediately following HBB training, participants completed all four learner assessments. We previously reported on the results of these immediate post-HBB scores in this hospital setting.[22] Participants were scored on their first attempts for each assessment but were also given the opportunity to practice with the simulator afterwards until they felt comfortable with their skills and were able to pass the assessments.

To test what was needed for retention of skills, learners were followed for 6 months, after being stratified by their profession and randomly divided into two groups for follow-up testing. Group 1 received follow-up testing at approximately 1 month intervals (six follow-ups), whereas group 2 received subsequent follow-up testing at 3 months, then 2 months and then 1 month (three follow-ups). The initial refresher for group 2 was at 3 months, as this has been a common refresher point in the published literature where learners demonstrate a degradation of skills, followed by more frequent follow-up to determine if an increase in retention would occur. The dates and times of these OSCEs occurred when the participant was available on site at the hospital, at their convenience. At each testing interval the learners repeated the MCQ and OSCE B performed with the low-fidelity simulator. OSCE B was administered in Spanish by the same Master Trainer to all individuals, who debriefed the individual learners after each practice session by eliciting self-reflection and giving feedback. The Master

Trainer scored each individual on their first attempt at the OSCE B, although if the learner failed the first attempt he/she repeated the OSCE until a pass score was obtained. These OSCE sessions lasted approximately 5–15 min, depending on the number of mistakes made, which would require a longer debriefing.

The primary outcome measure was the OSCE B score. Secondary outcomes included passing on the first attempt (performing 14 of 18 steps, including the required 4 essential steps) and the number of attempts until passing.

Delivery room observations were performed before and after HBB training in the community hospital as part of a quality improvement study; the changes in neonatal practice observed in the delivery room are reported in a separate publication.[30]

Statistical analyses

Descriptive statistics were calculated for all variables, including means with associated standard deviations or medians with interquartile ranges (IQRs) for continuous variables, and frequencies with percentages for categorical variables. Histograms and box plots were used to evaluate distributions for normality. The χ^2 or Fisher's exact test was used to compare demographic characteristics between groups. The Wilcoxon rank sum test was used to test differences in years of medical training and practice between groups. Generalized estimating equations (GEEs) with an exchangeable correlation structure were used to examine changes in OSCE B score over time from the immediate post-workshop test to 6 months. Appropriate link functions were used based on the dependent variable of interest. GEE models were used in order to include all available OSCE B scores and account for correlation among repeated tests on the same individual. Covariates in the models included group (practice frequency) and role (physician or nurse). The 3 and 6 month time points were compared with the immediate post-test. Odds ratios with 95% confidence intervals and p-values for the differences in least squares means were adjusted for multiple comparisons using the Bonferroni–Holm method. Statistical significance was determined at $\alpha<0.05$. SAS (version 9.4; SAS Institute, Cary, NC, USA) was used to conduct all analyses.

Results

Rural clinic pilot study, Santa Lucía

Of the 12 providers trained, 6 physicians and 5 nurses completed the initial post-HBB assessments in August 2012 and then had up to five follow-up OSCEs (one physician did not do the initial post-HBB assessments but was included for follow-up). Physicians scored 3.0 points (standard error [SE]=0.78) higher than nurses (p=0.02). However, follow-up testing showed rapid loss of skills by the second OSCE among nurses (15.7 [SE 0.6] to 11.0 [SE 1.4]). Nurses had more variation in repeated OSCE evaluation scores, although for both nurses and physicians, repeated testing resulted in improvement in OSCE performance (Figure 1).

Community hospital study, La Esperanza

Seventy providers completed the workshop and were described in another study that indicated that even though doctors had higher pretest scores than nurses, doctors and nurses were able to perform at a similar level after training.[22] While all 70 participants were randomized to either group 1 or group 2, only 37 individuals, including 19 physicians (51.4%) and 18 nurses (48.6%), were able to be followed due to multiple providers being sent to other hospitals, rural rotations or leaving for other jobs, a challenge with simulation research in low-resource settings.[31] Of these 37 providers, 20 were randomized to group 1 (monthly OSCE practice) and 17 were randomized to group 2 (OSCE practice at months 3, 5 and 6). The demographics of the participants are shown in Table 1. The two groups were similar with regard to sex, role, years of medical training, resuscitation workshop experience and simulation experience, although participants in group 1 had a higher median number of years of medical practice.

Participants in both practice frequency groups and different roles scored well on the MCQ knowledge assessment. The lowest group mean correct responses was 92% at the initial post-test and remained high, reaching 100% in all groups at later time points. Both physicians and nurses who performed monthly OSCE practice scored 1.3 points (SE 0.42) higher on the OSCE than those who practiced less frequently. At 3 months, scores in both groups decreased on average 1.3 points (SE 0.50), but after 6 months scores were 1 point higher than the initial post-training test scores. Physicians scored 1.6 points (SE 0.4) higher than nurses (Table 2). After the immediate post-test, the probability of passing on the first attempt decreased for physicians and nurses in both groups. Over all time points, the group with monthly OSCEs had 2.9 times greater odds of passing on the first attempt compared with the group that practiced less frequently. In addition, physicians had 4.3 times greater odds of passing on the first attempt compared with nurses. Three months post-training, the probability of passing on the first attempt ranged from 4% among nurses who practiced less than monthly to 36% among physicians who had monthly OSCEs (Table 3). From 3 to 6 months, participants' probability of passing on the first attempt improved, although this was still lower than the immediate post-training test (Figure 2). Compared with the immediate post-training test, the probability of passing on the first attempt after 6 months significantly differed only for physicians who had OSCEs monthly (94% to 80%, Bonferroni–Holm adjusted p=0.05). The pass rates among nurses in both groups and physicians who practiced less than monthly were lower than for the initial post-test, but rates did not significantly differ after adjustment for multiple comparisons (Table 3).

Discussion

Training birth attendants in low- and middle-income countries basic neonatal resuscitation is an important intervention to improve the rates of neonatal mortality and stillbirths.[1–3,14,32,33] While it is well known that skills drop off after an initial training, understanding the amount of practice required to retain basic resuscitation skills is a significant gap in medical education knowledge.[17,24,34] While the 2015 International Liaison Committee on Resuscitation (ILCOR) Consensus on Science and Treatment Recommendations (CoSTR) acknowledges that more frequent practice is needed after initial training in neonatal resuscitation, there is very little evidence upon which to base further recommendations for how frequently or intensely this should occur.[26] Therefore questions such as 'How often should refreshers or practices be held to maintain skills?' and

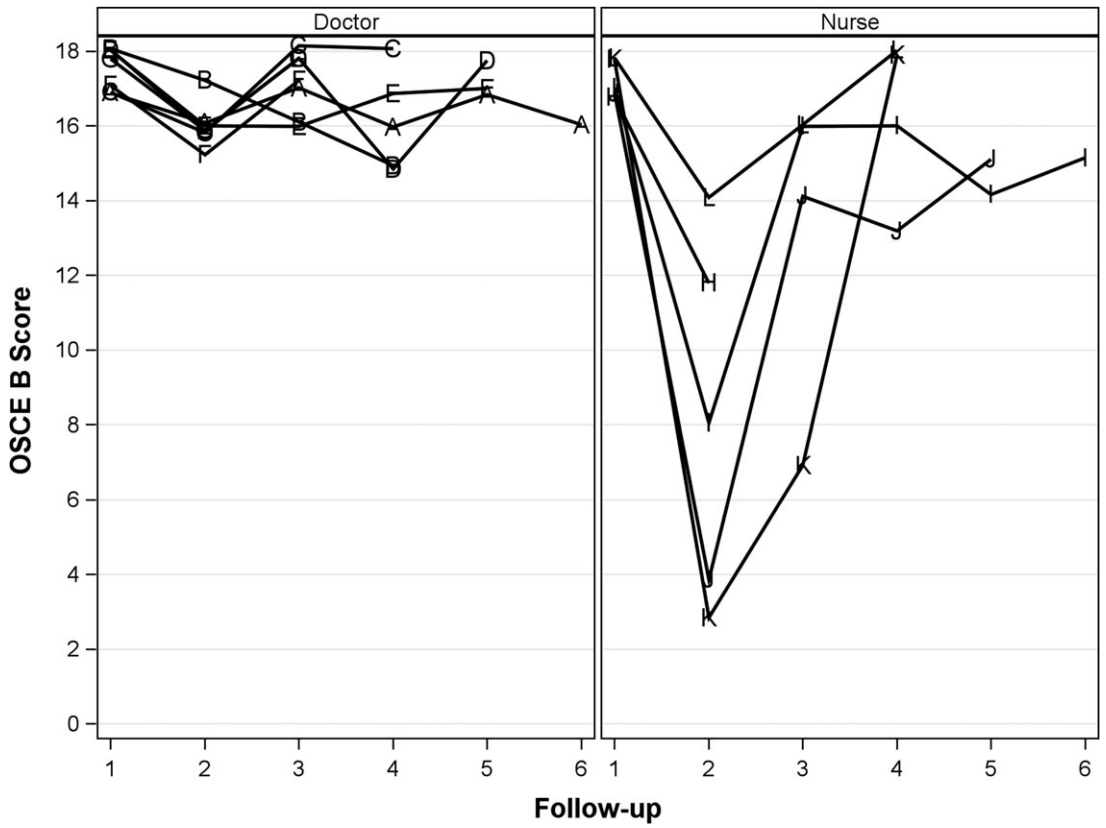

Figure 1. OSCE B scores among six physicians and five nurses in a rural clinic (Santa Lucía) pilot study over time after initial Helping Babies Breathe training.

Table 1. Demographics of community hospital participants

	Group 1 (monthly practice for 6 months; n=20)	Group 2 (practice at months 3, 5 and 6; n=17)	p-Value
Female, n (%)	20 (95.0)	12 (70.6)	0.08[a]
Physician, n (%)	9 (45.0)	10 (58.8)	0.40
Nurse, n (%)	11 (55.0)	7 (41.2)	
Years of medical training, median (IQR)	5.5 (2.0–7.5)	6 (4–7.5)	0.92
Years of medical practice, median (IQR)	4 (1.5–11.5)	2 (0.8–9.0)	0.04
Previous resuscitation workshop experience, n (%)	11 (55.0)	12 (70.6)	0.33
Previous simulation experience, n (%)	15 (75.0)	10 (62.5)[b]	0.48[a]

[a]Fisher's exact test.
[b]Missing previous simulation experience: group 2 (n=1).

'Does this differ by the type of provider and how often they use the skills in real life?' remain unanswered. The answers to these questions may also differ in low-resource settings, where the majority of the deliveries around the world occur in the home, far from medical treatment, and a single care provider may be the only individual present to care for both the mother and the newborn infant.[24] This makes it even more essential that such providers, with no immediate backup available, are able to perform these lifesaving skills 100% of the time when they are needed in a clinical emergency.

Yet, research on simulation-based training in low-resource settings is difficult to conduct, but much needed.[31] We have previously shown that immediately after HBB training in a rural hospital in Honduras, assessments of cognition (MCQs) and psychomotor performance of resuscitation (OSCEs) improved, and indeed nurses were able to perform at a similar level to

Table 2. Least squares mean estimate (95% CI) of OSCE B scores

	Least squares mean estimate (95% CI) OSCE B scores			p-Values		
	Immediate post-training (0 months)	3 months	6 months	0 vs 3 months	3 vs 6 months	0 vs 6 months
Group 1						
Physician	n=9; 16.7 (15.7–17.6)	n=8; 15.3 (14.6–16.1)	n=5; 17.7 (17.1–18.2)	0.01*	<0.0001*	0.002*
Nurse	n=9; 15.1 (14.4–15.8)	n=10; 13.8 (12.9–14.6)	n=10; 16.1 (15.6–16.6)	0.01*	<0.0001*	0.01*
Group 2						
Physician	n=10; 15.4 (14.0–16.7)	n=10; 14.1 (13.2–14.9)	n=5; 16.4 (15.5–17.3)	0.06	<0.0001*	0.01*
Nurse	n=7; 13.8 (12.7–14.9)	n=7; 12.5 (11.7–13.3)	n=7; 14.8 (14.1–15.5)	0.0007*	<0.0001*	0.0004*

*Significant after Bonferroni–Holm adjustment for multiple comparisons.
Group 1 practiced monthly for 6 months.
Group 2 practiced at 3-, 2- and 1-month intervals (months 3, 5 and 6).

Table 3. Estimated probability (95% CI) of passing the OSCE B on the first attempt

	Estimated probability (95% CI) of passing on first attempt			p-Values		
	Immediate post-training (month 0)	3 months	6 months	0 vs 3 months	3 vs 6 months	0 vs 6 months
Group 1, Physician	n=9; 0.94 (0.75–0.99)	n=8; 0.36 (0.16–0.62)	n=5; 0.80 (0.55–0.92)	<0.0001*	0.01	0.02
Group 1, Nurse	n=9; 0.79 (0.53–0.93)	n=10; 0.12 (0.04–0.29)	n=10; 0.48 (0.28–0.69)	<0.0001*	0.006*	0.07
Group 2, Physician	n=10; 0.85 (0.63–0.95)	n=10; 0.17 (0.07–0.35)	n=5; 0.58 (0.33–0.80)	<0.0001*	0.004*	0.02
Group 2, Nurse	n=7; 0.57 (0.35–0.77)	n=7; 0.04 (0.01–0.15)	n=7; 0.25 (0.10–0.49)	<0.0001*	0.001*	0.10

*Significant after Bonferroni–Holm adjustment for multiple comparisons.
Group 1 practiced monthly OSCEs for 6 months.
Group 2 practiced OSCEs at 3-, 2- and 1-month intervals (months 3, 5 and 6).

physicians in these post-HBB skills assessments.[22] This finding was consistent with what has been seen in other studies demonstrating that HBB increased acquisition rates of skills and knowledge after training.[15,21,35–37] However, it has been unclear what frequency of practice is needed to maintain skills after initial acquisition. Of great concern, a Global Network study from Kenya and Tanzania assessed basic resuscitation skills approximately 6 months after initial HBB training and found that while knowledge was retained, scores on skills evaluations dropped significantly.[34] In fact, the number of individuals passing the OSCE was significantly different even 4–6 weeks after a course compared with just after the training.[17] Similarly, our study showed that providers declined in psychomotor skills after HBB training, although scores on cognitive knowledge assessments remained high.

A systematic review by Reisman et al.[35] demonstrated that refresher training in neonatal resuscitation can mitigate the declines in knowledge and skills over time. In Ghana, midwives whose OSCE scores fell 4 months after a training participated in a refresher course and were evaluated 4 months after that, and scores were found to be statistically similar to their initial scores.[23] Importantly, in both our pilot intervention in the rural clinic and a randomized intervention in a rural hospital, ongoing practice resulted in improved performance in a simulated assessment of resuscitation. However, skills may decline at different rates depending on various provider characteristics, such as the type of facility where the provider works, prior resuscitation training and the type of training (initial vs refresher).[34] Our previous study of this same cohort that examined the pre-HBB and immediate post-HBB assessments indicated that doctors had higher scores on the OSCE B and BMV skills checklist before the HBB course compared with nurses.[22] Furthermore, a mixed effects model indicated that those with previous simulation experience were also able to perform better on the OSCE B.[22] This current study indicated that both doctors and nurses had some decline in skills after initial HBB training, but doctors were also able to rebound with higher scores after retesting, potentially because of additional background resuscitation training, simulation experience and opportunities for performance in clinical situations that provided them with more 'muscle memory' of practical skills.

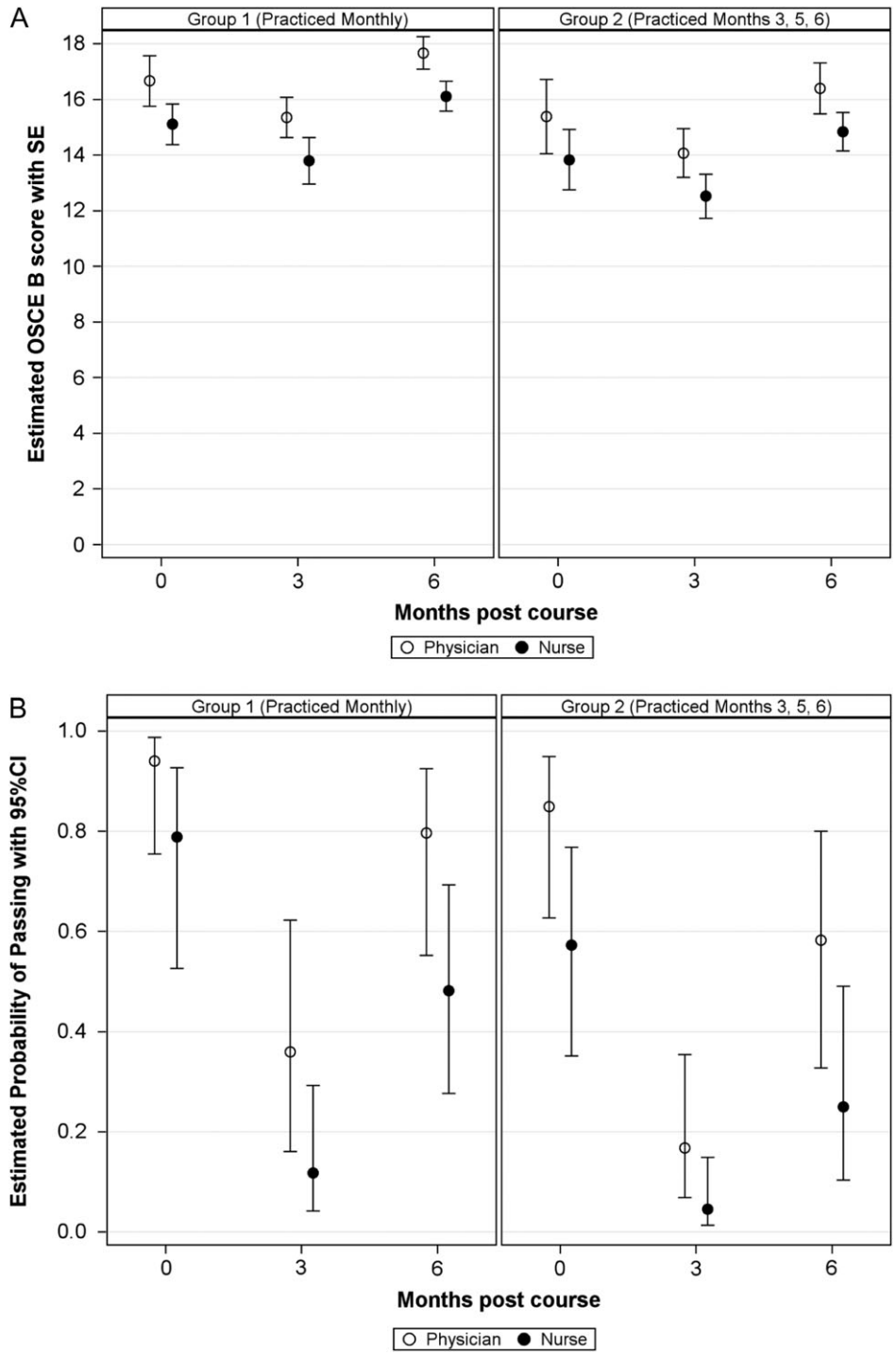

Figure 2. (A) Least squares mean estimates with SE of OSCE B scores in the hospital (La Esperanza) study. (B) Estimated probability (95% CI) of passing OSCE B on the first attempt in the hospital (La Esperanza) study among those who practiced monthly (group 1; left panel) and those who practiced at 3-, 2- and 1-month intervals (months 3, 5 and 6; group 2; right panel).

This study speaks to the importance of testing during training as a way to further improve skills. Kromann et al.[38] evaluated medical students who participated in a 4 h resuscitation course. The intervention group had 3.5 h of instruction and 30 min of testing, while the control group had 4 h of instruction only. The authors found that the students in the intervention group had higher learning outcomes and assessment scores, making them conclude that testing had an intrinsic effect on memory of the tested material. This effect of testing may also play a role in how often different types of providers need practice to maintain

skills. To this point, in the Global Network study of HBB in India and Kenya, those with no prior resuscitation training had increased deterioration of resuscitation skills after 6 months than those who had prior resuscitation training.[34] In this particular hospital in Honduras, doctors were called to deliveries requiring more complex resuscitations and performed more advanced skills such as BMV and endotracheal intubation than nurses. Undoubtedly nurses benefited from ongoing practice of basic resuscitation skills assessed by the OSCE (including BMV), as demonstrated by continued improvement and maintenance in their OSCE scores, just not to the same degree.

The most commonly missed items on the OSCE could be targeted in ongoing practice. The three most commonly missed steps were 'starts ventilation within the Golden Minute', 'calls for help' and 'improves ventilation'; these steps were also commonly missed in the immediate post-course period.[22,29] From the initial validation of HBB, it was concluded that the skill of BMV is so complex that a 1 d workshop is insufficient to master the skill and further practice is required to ensure that the provider is initiating BMV within the Golden Minute.[21,22] 'Improves ventilation' is considered an essential step, i.e. it must be performed in order to pass. To complicate matters further, it is composed of five separate actions that the provider can perform to improve ventilation (reposition the head, reapply the mask, clear secretions, open the mouth and squeeze the bag harder). In order to perform this step correctly, the provider must perform all five actions. As the OSCE can be used as both a summative and formative assessment, revision of the OSCE for the second edition of HBB (released in fall 2016) included simplification of the multistep items in order to better promote learners' abilities to assimilate, practice and retain lifesaving resuscitation skills.[29] Furthermore, the second edition of HBB now prompts debriefing and feedback with questions that promote self-reflection and assessment of how to improve performance for future simulation and real-life delivery room situations.[7] These are interventions that have also been shown to help in retention of skills.

Our study adds to the evidence that some system for ongoing practice is essential for maintenance of resuscitation skills, as has been seen in US settings.[39,40] However, in low- and middle-income settings, such ongoing practice is essential for resuscitation skills maintenance and educational outcomes that are crucial to improved neonatal survival.[41] Ersdal et al.[16] showed that 7 months after a 1 d HBB training, providers were able to maintain their performance in simulation; however, without ongoing practice, local ownership of newly acquired resuscitation skills, quality improvement and supportive supervision skills were not translated into clinical practice. Our study showed that the group with monthly OSCEs had 2.9 times greater odds of passing on the first attempt compared with the group who practiced less frequently; it is unclear whether the retention of skills in our cohort could have been better maintained with shorter intervals between the initial training and ongoing practice. Indeed, a study in Tanzania showed that low-dose, high-frequency training performed weekly (at the beginning of each shift), coupled with monthly refresher training, improved 24 h neonatal mortality.[42] Another study in Nepal demonstrated that daily BMV skill checks, integrated with other quality improvement measures, such as weekly review meetings, case reviews and self-evaluation checklists, improved retention of skills and halved the odds of intrapartum stillbirth and 24 h neonatal mortality.[12,43] A study in Kenya evaluated a system of ongoing practice with just-in-time training with a peer compared with an OSCE administered by a Master Trainer. While there was too much crossover in the study to determine whether just-in-time training in this setting was a superior method of practice to supervised OSCEs, all study participants had improved skills retention with some form of ongoing practice.[31] Similarly, in the USA, pediatric residents subjected to a Rapid Cycle Deliberate Practice, an approach that emphasized rapid acquisition of procedural and teamwork skills, had a shorter interval between the onset of pulseless ventricular tachycardia to initiation of compression and defibrillation in simulated cardiopulmonary resuscitation.[44] This collective evidence resulted in the recommendations found in the second edition of HBB, further emphasizing the need for a plan for refresher courses and ongoing practice after initial training.[7] However, initial training and subsequent refreshers may need to be tailored to the past experience, knowledge and skill set of different types of learners to best optimize retention of skills.

Our study did have several limitations. In both settings we did not have a control group that received no ongoing practice, as this was not deemed acceptable by the clinic and hospital directors. We did have separate evaluators at the clinic and hospital site, so inter-rater variability was a concern. Both raters were oriented by the same Master Trainer and given a list of criteria for grading the OSCE. Furthermore, they co-graded with the Master Trainer to ensure that their grading was similar. While we did use the standard OSCE designed for HBB for our assessments, it could be argued that the providers became accustomed to mastering that specific evaluation and thus those that practiced more frequently would logically perform better on the evaluation. Nevertheless, the OSCE is reflective of the HBB Action Plan, or algorithm, and covered the basic, most essential skills in neonatal resuscitation, and the OSCE was the skills-based test for that algorithm. Furthermore, we did not have sufficient power to correlate our outcomes with overall neonatal outcome indicators such as asphyxia-related or neonatal mortality, which is what we ultimately hope to improve by ensuring providers can perform these skills in simulated practice. A separate analysis indicated that more providers effectively stimulated babies after HBB training, thereby resulting in more babies breathing spontaneously within the first minute after birth, decreasing the number of babies who required BMV.[30] Future simulation-based research should evaluate in greater depth how the performance in simulation correlates with the clinical outcomes, including neonatal mortality and morbidity.

Conclusions

Ongoing practice after an initial HBB course helped to improve and maintain skills in basic neonatal resuscitation. As such, some system of ongoing practice is crucial to maximize the ability to perform these essential lifesaving skills during real-life situations when they are urgently needed. Paying attention to the individual characteristics of the learners, such as prior experience with neonatal resuscitation or simulation, may influence recommendations on how much practice is needed to maintain skills.

Authors' contributions: MET performed the data analysis, revised and approved the final manuscript. SJ performed data collection, revised and approved the final manuscript. KKT performed data collection, revised and approved the final manuscript. JCV performed data collection, revised and approved the final manuscript. BDK-R designed the study, performed data collection, wrote the initial manuscript and revised and approved the final manuscript.

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Ethical approval: Not required.

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