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Helping mothers survive bleeding after birth: an evaluation of simulation-based training in a low-resource setting

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Key words
Maternal mortality, education, patient simulation, Tanzania, knowledge, clinical skills, obstetrics, postpartum hemorrhage

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Conflict of interest
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Abstract

Objective. To evaluate "Helping Mothers Survive Bleeding After Birth" (HMS BAB) simulation-based training in a low-resource setting. *Design.* Educational intervention study. *Setting.* Rural referral hospital in Northern Tanzania. *Population.* Clinicians, nurse-midwives, medical attendants, and ambulance drivers involved in maternity care. *Methods.* In March 2012, health care workers were trained in HMS BAB, a half-day simulation-based training, using a train-the-trainer model. The training focused on basic delivery care, active management of third stage of labor, and treatment of postpartum hemorrhage, including bimanual uterine compression. *Main outcome measures.* Evaluation questionnaires provided information on course perception. Knowledge, skills, and confidence of facilitators and learners were tested before and after training. *Results.* Four master trainers trained eight local facilitators, who subsequently trained 89 learners. After training, all facilitators passed the knowledge test, but pass rates for the skills test were low (29% pass rate for basic delivery and 0% pass rate for management of postpartum hemorrhage). Evaluation revealed that HMS BAB training was considered acceptable and feasible, although more time should be allocated for training, and teaching materials should be translated into the local language. Knowledge, skills, and confidence of learners increased significantly immediately after training. However, overall pass rates for skills tests of learners after training were low (3% pass rate for basic delivery and management of postpartum hemorrhage). *Conclusions.* The HMS BAB simulation-based training has potential to contribute to education of health care providers. We recommend a full day of training and validation of the facilitators to improve the training.

Abbreviations: AMTSL, active management of third stage of labor; BAB, Bleeding After Birth; HBB, Helping Babies Breathe; HMS, Helping Mothers Survive; PPH, postpartum hemorrhage.

Introduction

Hemorrhage is the leading cause of maternal mortality in Africa (33.9%, 95% confidence interval (CI) 13.3–43.6%) and Asia (30.8%, 95% CI 5.9–48.5%) and should be targeted to reduce the number of maternal deaths (1). Audit suggests that better management of postpartum hemorrhage (PPH) through training can improve care and reduce maternal mortality (2–5). Simulation-based education is increasingly used to train health care providers in obstetrical emergencies (6–11). It is suitable for both pre- and in-service settings, thereby providing a continuum of training throughout a professional career.

To improve quality of care during the day of birth, Jhpiego and Laerdal Global Health developed the simulation-based training "Helping Mothers Survive" (HMS) (12). The training materials were reviewed by external stakeholders from different international organizations. HMS targets health care providers in countries with a high burden of maternal mortality. The first module, "Bleeding After Birth" (BAB), focuses on basic delivery care, active management of third stage of labor (AMTSL), and treatment of PPH (12). The training is designed for all levels of health care providers. It is compatible with Helping Babies Breathe (HBB), a simulation-based training that teaches routine newborn care and resuscitation (13).

The aim of this study was to evaluate HMS BAB training by addressing the following research questions: (i) To what extent is HMS BAB training acceptable and feasible in a low-resource setting? (ii) To what extent do knowledge, skills, and confidence of health care providers change after HMS BAB training?

Material and methods

An educational intervention study was carried out in March 2012 at Haydom Lutheran Hospital, a rural referral hospital in Northern Tanzania. Annually, approximately 5000 women give birth in the hospital. Ethical approval was obtained from the Tanzanian National Institute for Medical Research (reference NIMR/HQ/R.8a/Vol.IX/1247), the Tanzania Commission for Science and Technology (reference 2012-56-NA-2011-201), and the VU University Medical Center, the Netherlands (reference 2011/389). Permission to conduct the study was obtained from the hospital management. Written informed consent was obtained from each participant before entering the study.

HMS makes use of a train-the-trainer model in which training is cascaded down from master trainers to local facilitators to learners (14). In this study, master trainers were certified trainers and health care professionals (three nurse midwives and one medical doctor) from the USA, Norway, the Netherlands, and Tanzania. They trained local facilitators in a one-to-one ratio. The hospital management selected local facilitators based on clinical and teaching experience. Training started with an introduction regarding the development and aim of the HMS BAB training (1 h). This was followed by 3 h of theory regarding basic delivery care, active management of third stage of labor, and treatment of PPH, using training materials such as the "Action Plan" (wall poster to aid decision making), a "Training Flip Book" (graphic display used during training), and a "Facilitation Guide" (in English) (15). In the second half of the day, MamaNatalie (Laerdal Global Health, Stavanger, Norway), a low-cost, low-tech birthing simulator was introduced. The different components of AMTSL and treatment of PPH were addressed by using the mannequin. Each facilitator took part in scenario training and received feedback from the master trainer.

Subsequently, local facilitators trained local learners in a half-day session under supervision of master trainers. In total there were six training sessions, divided over three days. Clinicians, nurse-midwives, medical attendants (nurse aids without formal medical education), and ambulance drivers (without formal medical education) involved in maternity care (including nurse-midwives from the intensive care unit and operating theatre) were selected by the hospital management to attend training. Training took place in a communal room in the hospital and started with a simulated scenario of a birth complicated by PPH and maternal death with a facilitator taking on the role of a patient actor. An introduction of the course by one of the master trainers followed and subsequently the learners were allocated to the four available facilitators. Training was conducted in small groups and the groups contained health care providers of different cadres (maximum six learners per facilitator). It started with 1.5 h of theory using the HMS BAB training materials, and was followed by 1.5 h of skills and scenario training with the birthing simulator. Each learner took part in one scenario and received feedback from the facilitator.

Key Message

Helping Mothers Survive Bleeding After Birth simulation-based training has the potential to contribute to the education of health care providers of different cadres regarding basic delivery and treatment of postpartum hemorrhage. We recommend a full day of training and validation of facilitators.

Evaluation and assessment

The intervention was assessed according to level 1 and 2 of the Kirkpatrick model, a method commonly used for evaluation of training programs (Figure 1) (16). To assess course perception (level 1), both facilitators and learners were requested to fill out an evaluation questionnaire immediately after training to record their opinion about the feasibility and acceptability of HMS BAB training. A 5-point Likert scale was used (ranging from 1 = strongly disagree to 5 = strongly agree). In addition, suggestions to improve training could be made in an open remark. A draft evaluation questionnaire had previously been reviewed and approved by maternal health experts in a group meeting.

Level 2 of the Kirkpatrick model relates to knowledge, skills, and attitudes acquired due to training. Knowledge was assessed by means of a written 26-item knowledge test that was administered immediately before and after training. It consisted of 14 multiple-choice questions and 12 yes/no questions. The criterion-referenced pass score was ≥70% correct answers. The knowledge test was developed and validated by Jhpiego. First, competences required for PPH prevention and management were selected and linked to a measurable item. Subsequently, 34 maternal health experts validated the content of the knowledge test by (i) setting a criterion-referenced pass score using the Angoff procedure, (ii) providing suggestions for improving the wording of the questions, and (iii) answering each question to the best of their ability. One hundred percent of all experts who were asked to complete the test passed the test, thereby ensuring construct validity. Differential item function was addressed after finishing this study. The results from the validation of the HMS BAB training in three countries were similar, showing no evidence of bias.

Due to logistic reasons, only health care providers working in labor ward, ambulance drivers, and facilitators were enrolled for skills assessment (Figure 2). They were tested in the week before training, and again in the week after training. Performance was assessed in two simulated scenarios using the birthing simulator: "basic delivery" and "management of PPH due to uterine atony". The

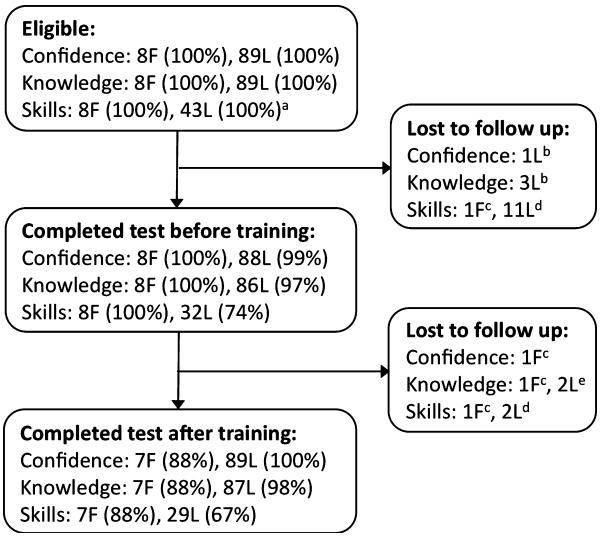

Figure 2. Flow chart of facilitators (F) and learners (L). [a]Due to logistic reasons, only health care providers working in labor ward, ambulance drivers, and facilitators were enrolled for skills assessment. [b]Three learners arrived too late at the training venue and therefore missed test before training, but completed test after training. [c]One facilitator was not available for follow up due to clinical duty. [d]Eleven learners were not available for follow up due to leave, illness, and clinical duty. [e]One learner refused to complete the knowledge test because the allowance was too low, one learner forgot to complete the knowledge test.

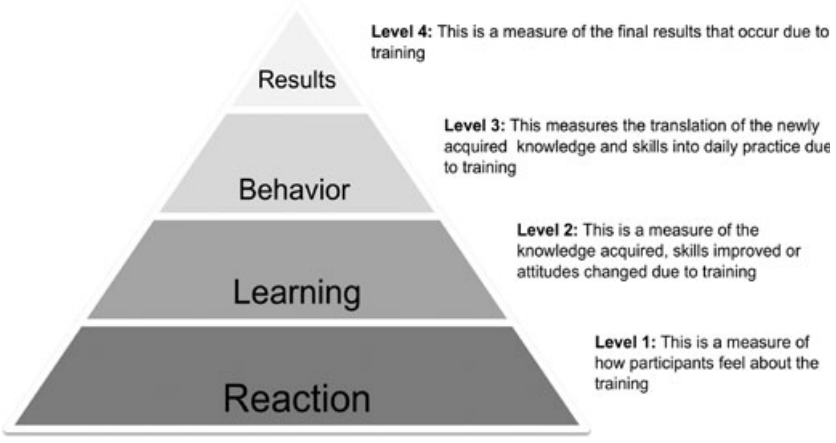

Figure 1. Kirkpatrick model for evaluation of training programs.

second scenario was further divided into "management of PPH" and "performance of bimanual uterine compression".

A draft checklist based on literature and clinical experience was created, and six maternal health experts reviewed the draft checklist (17,18). The checklist was pilot-tested on dummy videos of simulated scenarios of basic delivery and management of PPH and few adjustments were made. Two scoring categories were created: done and not done. Eventually, 16 items for uncomplicated delivery and 18 items for management of PPH were selected for the checklist. Finally, essential items were identified that needed to be done in order to pass the test (five items for basic delivery, and eight items for management of PPH). The six maternal health experts reviewed and approved the final version of the checklist.

Before starting the skills test, MamaNatalie was introduced to the facilitators and learners to familiarize them with the mannequin. Furthermore, the concept of simulation was explained, along with a description of what was to be expected from the health care worker. A scenario description was given prior to the start of each scenario.

The skills test was videotaped and subsequently assessed by two independent assessors (both residents in obstetrics and gynecology in the Netherlands). The assessors were blinded for the time of testing (pre- or post-intervention). Both assessors individually evaluated five dummy videos of basic delivery and management of PPH. The inter-rater agreement of dummy testing was greater than 80%. Subsequently, the first assessment of the videos of the skills test followed. Overall inter-rater agreement was 90%, and the inter-rater agreement per item on the checklist ranged from 61.1% to 100%. The Kappa (K) measure of agreement ranged between $K = 0.37$ and $K = 1.00$ for the pre-test and $K = 0.14$ and $K = 1.00$ for the post-test assessment. During a second assessment the two assessors assembled, watched the videos together, and discussed items that were scored differently. Final scores were unanimously agreed upon.

Attitude was addressed by assessing confidence of facilitators and learners in their ability to perform AMTSL, manage PPH, determine completeness of the placenta, perform bimanual uterine compression, and access advanced care. Confidence was appraised using a questionnaire, which was filled in by all facilitators and learners immediately before and after training. Five answers were possible ranging from 1 = I cannot perform this skill to 5 = extremely confident. This questionnaire also contained questions about their characteristics.

Prior to the study, all evaluation and assessment tools were tested locally and adjusted accordingly as needed. All assessment materials were available in two languages: English and Kiswahili.

Statistical analysis

We performed a power calculation based on consensus of the authors, as there was no pilot data or literature on the effect of simulation-based training on knowledge and skills of health care workers in low-resource settings. To show an improvement of knowledge of health care providers from 50% sufficient knowledge before training to 80% after training with 80% power and a confidence interval of 95%, a sample of 40 health care providers was needed before intervention and the same number after intervention. Data were double-entered and checked in EpiData (The EpiData Association, Odense, Denmark), and analyzed using IBM SPSS Statistics, version 20 (IBM, Armonk, NY, USA). Descriptive statistics were calculated for participant characteristics, training evaluation, confidence, knowledge, and skills. Results are reported as number (n), percentage, mean, and standard deviation. Results before and after training results were compared using matched cohorts only. Paired-samples t-tests (two-tailed) were conducted to evaluate the impact of the intervention on the mean score of knowledge and skills. To assess the inter-rater reliability we calculated the percentage of agreement between the two assessors and Kappa measure of agreement for each item on the checklists. Wilcoxon signed rank test was used to compare the level of confidence before and after training.

Results

Four master trainers trained eight local facilitators. The group of facilitators consisted of one medical attendant, four nurse-midwives (two of whom were tutors in the midwifery school), and three clinicians. The majority of facilitators (63%) were active birth attendants at the time of training. Seven of eight (88%) facilitators received pre-service training in AMTSL, and 75% received training in management of PPH. Only three of eight (38%) facilitators had received in-service training in AMTSL and management of PPH throughout their professional career (Table 1). Eight facilitators completed the knowledge and skills test and confidence questionnaire before training and seven facilitators completed the knowledge and skills test and confidence questionnaire after training. Mean scores of the knowledge test improved, and after training, 100% of the facilitators passed the knowledge test (Table 2). Although mean scores of the scenarios "basic delivery" and "bimanual uterine compression" improved, only two of seven (28.6%) passed the skills test for basic delivery and none passed the skills test for management of PPH (Table 3). Confidence of facilitators improved significantly after training (data not shown).

Table 1. Participant characteristics.

	Facilitators (n = 8) %	Learners (n = 89) %
Qualification		
Ambulance driver	0	7
Medical attendant	13	15
Nurse-Midwife	50	67
Clinician	38	11
Active birth attendant	63	46
Pre-service training AMSTL	88	69
Missing	13	6
Pre-service training management of PPH	75	73
Missing	25	5
In-service training AMTSL	38	30
Missing	25	8
In-service training management of PPH	38	18
Missing	25	10
Attended HBB training	38	48
Missing	25	6

AMTSL, Active Management of Third Stage of Labor; PPH, Postpartum Hemorrhage; HBB, Helping Babies Breathe.

Local facilitators trained 89 learners according to the train-the-trainer model (Figure 2). The number of learners per facilitator ranged from three to six. The group of learners included six ambulance drivers, 13 medical attendants, 60 nurse-midwives, and 10 clinicians. Half of the learners (46%) were active birth attendants at the time of training. Thirty percent of all learners had received in-service training of AMTSL, and 18% had received training on management of PPH during their career to date (Table 1).

Table 4 shows the results of the written evaluation of the HMS BAB training. Eighty-one learners and seven facilitators filled in the evaluation questionnaire. There was no difference between the two groups; therefore the results are shown together. Both facilitators and learners indicated that there was too little time allocated for theory and practice during training. Instead of a half-day course, a full day of training was suggested. Although teaching materials were well accepted, facilitators stated in an open remark that they should be translated into the local language. Furthermore, both facilitators and learners indicated that training could be done with different cadres training together.

In total, 84 learners completed the 26-item knowledge test before and after training (Table 2). Mean scores increased significantly from 74% to 80%, and pass rates increased accordingly from 63% to 75%. Clinicians and nurses had higher mean scores and pass rates compared with medical attendants and ambulance drivers.

Twenty-nine learners completed the skills test before and after training (Table 3). Learners significantly improved their skills in all three scenarios, as is shown by the increase in mean score. However, pass rates were very low. Pass rates for basic delivery increased from 0% to 3.4% and pass rates for management of PPH decreased from 6.9% to 3.4%.

Confidence of learners regarding AMTSL, management of PPH, determination of completeness of the placenta, performance of bimanual uterine compression, and ability to access advanced care increased significantly after training (Figure 3).

Discussion

HMS BAB simulation-based training was considered acceptable and feasible in this low-resource setting. There is a clear need for in-service training as shown by the low coverage of in-service training received by the facilitators and learners. Knowledge, skills, and confidence of learners improved significantly after training. These findings are consistent with other studies evaluating simulation-based training in obstetric care (19–25). However, pass rates of the skills test in our study were low. Singhal et al. (24) present similar results after HBB simulation-based training in neonatal resuscitation. In spite of the fact that pass

Table 2. Theoretical knowledge of facilitators and learners before and after training.

		Before training			After training			
	n	mean %	SD	Pass %[a]	mean %	SD	Pass %[a]	p- Value[b]
Facilitators	7	83	2.6	71	92	2.3	100	0.055
Learners	84	74	2.6	63	80	3.0	75	<0.001
Clinicians	9	82	2.4	89	93	1.9	100	0.001
Nurses	59	76	2.2	75	81	2.7	81	<0.001
Medical attendants	10	63	1.9	10	70	2.0	50	0.047
Ambulance drivers	6	63	1.6	0	67	3.4	50	0.332

[a]Criterion referenced pass score is ≥70% correct answers.
[b]Paired-samples t-test (two-tailed) comparing mean scores.
n, number; SD, Standard Deviation.

Table 3. Simulated practical skills of facilitators and learners before and after training.

	Before training			After training			
	mean %	SD	Pass %	mean %	SD	Pass (%)	*p*- Value[a]
Facilitators (*n* = 7)							
Basic delivery	66	1.4	28.6	71	1.8	28.6	0.289
Management of PPH	73	1.4	28.6	67	1.2	0	0.283
Bimanual uterine compression	38	2.0	Not rated	72	0.5	Not rated	0.068
Learners (*n* = 29)							
Basic delivery	43	3.7	0	51	3.1	3.4	0.012
Management of PPH	38	3.4	6.9	51	2.5	3.4	0.002
Bimanual uterine compression	18	1.3	Not rated	43	0.5	Not rated	<0.001

[a]Paired-samples *t*-test (two-tailed) comparing mean scores.
SD,Standard Deviation; PPH, Postpartum Hemorrhage.

Table 4. Evaluation of helping mothers survive bleeding after birth by facilitators and learners (*n* = 88).

	Strongly disagree	Disagree	Neither agree nor disgree	Agree	Strongly agree	Missing
The time allotted for this training was enough to learn how to prevent, identify, and manage bleeding after birth	11.4%	4.5%	10.2%	42.0%	31.8%	0
There was enough time for theory during the training	7.9%	13.6%	2.3%	45.5%	28.4%	2.3%
There was enough time to practice with the simulator (Mama Natalie) during the training	4.5%	11.4%	11.4%	30.7%	39.8%	2.3%
The mix of teaching, discussion and practice was appropriate	5.7%	4.5%	3.4%	31.8%	53.4%	1.1%
I understood the concepts of the graphics in the Flipbook regardless of my ability to read English	6.8%	1.1%	3.4%	39.8%	45.5%	3.4%
The Flipbook helps me to learn how to manage bleeding after birth	6.8%	0	2.3%	39.8%	51.1%	0
The materials in the Facilitation Guide are easy to understand	5.7%	1.1%	7.9%	40.9%	39.8%	4.5%
The Facilitation Guide helps me to learn how to manage bleeding after birth	7.9%	2.3%	3.4%	31.8%	54.5%	3.4%
I can use the Action Plan to help me prevent and manage bleeding after birth regardless of my ability to read English	8.0%	2.3%	3.4%	45.5%	39.8%	1.1%
The Action Plan helps to learn how to manage bleeding after birth	4.5%	3.4%	6.8%	36.4%	48.9%	0
The simulator (MamaNatalie) is a good tool to teach this information	5.7%	2.3%	1.1%	37.5%	50.0%	3.4%
The program materials (Flipbook, Facilitation Guide, Action Plan, MamaNatalie) are acceptable in English	6.8%	4.5%	11.4%	42.0%	31.8%	3.4%
The program materials (Flipbook, Facilitation Guide, Action Plan, MamaNatalie) are culturally appropriate	6.8%	6.8%	9.1%	36.3%	37.5%	3.4%
The training can be accomplished with the resources currently available in Haydom	8.0%	1.1%	5.7%	50.0%	29.5%	5.7%
The training is practical and fits the current situation of maternal health care	4.5%	1.1%	4.5%	39.8%	45.5%	4.5%
The training complements the current emergency obstetric care training	5.7%	0	0	34.1%	55.7%	4.5%
The training is appropriate for the current scope of practice for birth attendants	6.8%	1.1%	4.5%	44.3%	38.6%	4.5%
There were enough facilitators for the number of learners	3.4%	4.5%	6.8%	33.0%	47.7%	4.5%
I liked that there were different provider types training together	4.5%	3.4%	3.4%	37.5%	44.3%	6.8%
The training will contribute to reducing maternal mortality related to PPH	8.0%	0	2.3%	26.1%	60.2%	3.4%
The training will equip birth attendants with appropriate knowledge, attitude and skills of managing PPH	4.5%	0	3.4%	38.6%	50.0%	3.4%
I would like to do training with the simulator (MamaNatalie) in the future	6.8%	2.3%	1.1%	38.6%	50.0%	1.1%
I would recommend the training to another birth attendant	5.7%	1.1%	1.1%	37.5%	52.3%	2.3%

PPH, Postpartum Hemorrhage.

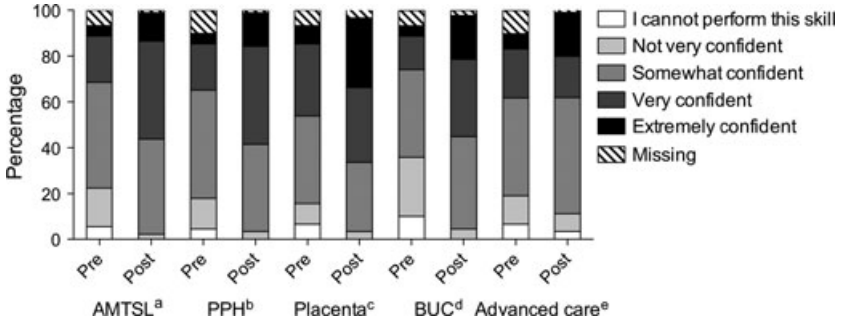

Figure 3. Distribution of confidence of learners in performing procedures before and after training (n = 89). [a]AMTSL: Active Management of Third Stage of Labor, p = 0.001. [b]PPH: Postpartum Hemorrhage, p = 0.001. [c]Placenta: Determine completeness of placenta, p = 0.001. [d]BUC: Bimanual Uterine Compression, p = 0.001. [e]Advanced care: Ability to access advanced care, p = 0.007.

rates for skills testing were low after HBB simulation-based training, perinatal outcome improved after HBB training in India and Tanzania (26,27). Other studies show an increase in mean score of skills after training compared with before training, but they did not use a global (pass/fail) rating (19,23,25,28).

We do not know the reason for the low pass rate on the skills test, compared with the high pass rate on the knowledge test, but several factors could be of importance: the educational system of Tanzania, the level of competence of learners before the intervention, the length of the training, the familiarity with the simulator, the level of competence of facilitators, the ability of the skills checklist to measure effect, and the effectiveness of HMS BAB for skills training.

First, the philosophy of the educational system of Tanzania differs considerably from the philosophy of facilitation (29). In the educational system of Tanzania, teaching is directed one way, and there is little interaction between teachers and students, whereas facilitation requires action and reaction from learners. More time may be needed to adapt to this new way of learning. Secondly, most clinicians and nurse-midwives received pre-service training of AMTSL and management of PPH, but medical attendants and ambulance drivers had not received any schooling before entering their job. Also, in-service coverage of training in AMTSL and management of PPH was poor. Thirdly, in the evaluation, both facilitators and learners stated that there was too little time allocated for theory and practice during the training. Facilitators had a full day to master skills and had taught on two occasions or more; learners had only a half-day to learn basic delivery care and management of PPH. The low pass rate on the skills test may indicate that time for practical training was too short to master the required skills. Furthermore, most of the facilitators and learners did not have any previous exposure to simulation-based training, even though the simulator was introduced to them. Time to become familiar with the tool may have been too short. Moreover, facilitators may not have been competent enough to teach learners. Selection of facilitators should take place after participation in training. Facilitators should receive more training and mentoring before becoming a facilitator. In addition to that, knowledge and skills testing of facilitators was done after they had finished teaching learners. Future facilitators should pass both knowledge test and skills test before becoming a facilitator, as is the case in similar courses (Advanced Life Support in Obstetrics and Managing Obstetric Emergencies and Trauma). Another contributing factor could be that the global (pass/fail) rating was invalid. The K for rating basic delivery ranged between 0.53 and 0.73, indicating moderate to substantial inter-rater agreement (30). For rating management PPH, K ranged from 0.22 to 0.37, indicating fair inter-rater agreement. Lastly, HMS BAB training may have been ineffective for skills training in itself, or as a result of above mentioned items.

Self-assessment alone is an inadequate measure for performance assessment (31,32). This is reinforced by our research in which a significant increase in confidence of facilitators and learners after training, did not match the results from the skills testing (facilitators did not improve their skills, as measured during the skills assessment after training, and the pass rate for the skills test, which ranged from 0% to 29%). Therefore, performance should not be appraised by self-assessment alone, but also by peer-assessment, such as validated knowledge and skills tests. Moreover, Kirkpatrick level 1 and 2 do not necessary relate to Kirkpatrick level 3 and 4. In a sister study at the same hospital in Tanzania, an intervention with neonatal resuscitation training was evaluated according to the four levels of Kirkpatrick (33). That study showed that increased levels of knowledge and skills did not translate in change of behavior in labor ward or improved patient outcome. Similar findings are reported by Siassakos et al. (34,35) who did not find a relationship between knowledge, skills and

attitude of individuals, and team performance, suggesting that working as a team may have an important effect on the way individuals apply their knowledge and skills.

Future research should therefore also focus on the clinically relevant third and fourth level of the Kirkpatrick model. Furthermore, retention of knowledge and skills after simulation-based training, and the frequency and implementation of retraining should be addressed.

A limitation to our study was that many facilitators and learners did not have previous exposure to simulation-based training. Although we tried to reduce confounding by introducing the mannequin and explaining the concept of simulation to every health care worker before skills testing, this may have influenced the results of the skills test. Secondly, assessment of the skills test was challenged because assessors did not speak Kiswahili, or only very slightly. This did not hinder most observations, as physical actions were concerned. Most terms that were used were universal, such as "oxytocin", "10 IU" and "antibiotics". Thirdly, the group of facilitators was small ($n = 8$); however, results were presented to show the capability of the facilitators. Furthermore, we have analyzed many different variables (knowledge, skills, and confidence). It is possible that one of the results is significant by random chance alone; this is also referred to as multiple testing. Therefore it is important to focus on the overall trend of the results, without too much attention to p-values alone. Lastly, evaluation was done in writing, with the opportunity to enclose open remarks only at the end of the evaluation. Semi-structured interviews or focus group discussions may have revealed more details about acceptability and feasibility of the training.

In conclusion, there is a clear need for in-service training in this low-resource setting. HMS BAB training was considered feasible and acceptable and significantly improved learners' knowledge, skills, and confidence. However, pass rates for skills tests of both facilitators and learners were low. There is a gap between performance in knowledge and skills, which indicates the need for more practical training such as simulation-based training. To improve training, we would recommend that HMS BAB training take a full day, instead of a half-day, and that teaching materials are translated into the local language. Eligible facilitators must pass both knowledge test and skills test before becoming a facilitator. Monitoring and evaluation with validated tests is recommended, and should be part of training. According to our results, global (pass/fail) rating may not be appropriate for skills tests as it showed moderate inter-rater agreement. If these issues are addressed, HMS BAB simulation-based training has great potential to help increase the number of skilled birth attendants regarding basic delivery, prevention of PPH, and management of PPH.

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