ORIGINAL RESEARCH ARTICLE

Low-fidelity simulation for management of postpartum haemorrhage in a Ghanaian teaching hospital

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Abstract

We conducted a pre/post study of a post-partum hemorrhage (PPH) simulation exercise at Korle Bu Hospital, using a low-fidelity birthing simulator and questionnaires. We aimed to evaluate low-fidelity simulation as a feasible and effective method of improving resident knowledge and confidence in a low-resource setting. Knowledge and confidence in PPH management were measured before and after using 5-point Likert scales and multiple-choice questions. A feedback survey was administered. Descriptive statistics were calculated to summarize demographics, confidence, and knowledge, with frequencies, means and standard deviations reported. Statistical significance of the change in scores was assessed using paired *t* tests. Statistically significant improvements in knowledge and confidence in managing PPH were evident following the simulation exercise. All participants agreed the simulation was educational, relevant and realistic, and 94% felt it could be incorporated into their training. *(Afr J Reprod Health 2022; 26[4]: 57-64).*

Keywords: Postpartum hemorrhage; medical education; simulation training; obstetrics; global health; Ghana

Résumé

Nous avons mené une étude pré/post d'un exercice de simulation d'hémorragie post-partum (HPP) à l'hôpital Korle Bu, en utilisant un simulateur d'accouchement basse fidélité et des questionnaires. Nous avons cherché à évaluer la simulation basse fidélité comme une méthode faisable et efficace pour améliorer les connaissances et la confiance des résidents dans un environnement à faibles ressources. Les connaissances et la confiance dans la prise en charge de l'HPP ont été mesurées avant et après à l'aide d'échelles de Likert à 5 points et de questions à choix multiples. Un sondage de rétroaction a été administré. Des statistiques descriptives ont été calculées pour résumer les données démographiques, la confiance et les connaissances, avec des fréquences, des moyennes et des écarts-types rapportés. La signification statistique de la variation des scores a été évaluée à l'aide de tests t appariés. Des améliorations statistiquement significatives des connaissances et de la confiance dans la prise en charge de l'HPP étaient évidentes à la suite de l'exercice de simulation. Tous les participants ont convenu que la simulation était éducative, pertinente et réaliste, et 94 % ont estimé qu'elle pouvait être intégrée à leur formation. *(Afr J Reprod Health 2022; 26[4]: 57-64).*

Mots-clés: Hémorragie du post-partum; éducation médicale; formation par simulation; obstétrique; santé mondiale; Ghana

Introduction

Nearly all (99%) of maternal deaths worldwide occur in low- and middle-income countries (LMICs), and sub-Saharan Africa alone accounts for 66%[1,2]. Postpartum hemorrhage (PPH) is the leading cause[2,3]. Most of these deaths are preventable, as is highlighted by the large disproportion of deaths among the rich and poor. The lifetime risk of maternal death in developed countries is 1 in 4900, compared to 1 in 180 in developing countries[1]. Although maternal mortality rates have declined in sub-Saharan Africa by half since 1990, they remain unacceptably high. In Ghana, the World Health Organization's (WHO) most recent estimate is 308 maternal deaths/100,000 live births (WHO, 2017). This is significantly higher than the global ratio of 211 deaths/100,000 live births. The WHO and International Federation of Gynecology and Obstetrics (FIGO) strongly recommend that efforts to improve skills of birth attendants are crucial to reducing maternal mortality, and access to evidence-based and effective training in PPH

management are a priority[2,4]. FIGO guidelines specifically state training should be context appropriate, and that a priority for research in low-resource settings is identifying efficient and effective means of teaching PPH skills to birth attendants[4].

When it became clear that the target reduction in maternal mortality set by the Millennium Development Goals (MDGs) would not be met by 2015, the WHO undertook an international research prioritization exercise to identify global research priorities that would improve maternal and perinatal health from 2015 to 2025[5]. This exercise showed that one of the highest-ranking research priorities, among many international stakeholders, policymakers, and clinician researchers, was to evaluate the effectiveness and cost of training interventions for healthcare workers managing obstetric hemorrhage. Emphasis was placed on implementation of more cost-effective versions of existing interventions, including active management of the third stage, access to uterotonics, training and awareness, and the presence of skilled birth attendants[5].

Simulation in medical education has increased in popularity over the past decade. It has been shown to be an effective training modality in many studies[6-14] and has been heralded as particularly useful for teaching rarely encountered obstetric emergencies[15]. However, the majority of studies showing benefit of obstetric simulation thus far were using high-fidelity simulators in high-resource settings. These are high-cost, complex tools that are not sustainable options for many institutions in the developing world, as cost has been cited as a major barrier to implementing obstetric simulation programs, even in high-resource countries[7]. Additionally, very few simulation studies have been conducted in LMICs, and it is inappropriate to assume transferability of results among countries or regions, as each individual setting has unique challenges and contextual factors.

Our study was developed to respond to the research priorities recommended by WHO and FIGO, while contributing to filling gaps in the current literature. Before developing and incorporating simulation programs in LMICs, it is important to evaluate their impact and assess feasibility. Our objective was to estimate the change in obstetric resident knowledge and confidence in managing PPH with low-fidelity simulation training at a large teaching hospital and to describe residents' feedback regarding feasibility of incorporating it into their training program.

Methods

We conducted a pre/post study following a simulation exercise, using questionnaires. Questionnaires were designed to collect demographic information, assess confidence and knowledge before and after a simulation, and collect feedback. Consent, questionnaires and simulation training were conducted in English, the official language in Ghana. The IWK Research Ethics Board and Korle Bu Teaching Hospital Institutional Review Board granted approval (IWK-REB project # 1024948; KBTH-STC 000117/2019). Potential participants included active residents in the postgraduate Obstetrics and Gynecology training program at Korle Bu Teaching Hospital (KBTH), a 2,000-bed tertiary center in Accra, Ghana. The Obstetrics and Gynaecology Department is a referral center for southern Ghana, which has a population of over 10 million. It serves as the foremost training facility for medical students, residents and allied health professionals. From 2012-2016, the maternal mortality rate at KBTH was 702 maternal deaths/100,000 live births, and 19% were directly caused by PPH. In 2017, 26% of the 42 maternal deaths were caused by PPH [personal communication from KBTH, representing data from annual reports].

The study was carried out in November 2019 at KBTH. A total of 40 residents (in postgraduate training years 1-3) were active in the Department at the time. They were contacted in advance and informed of the research study by a local co-investigator. They were made aware the simulation would be an obstetrical emergency but were not provided details. It was made clear that participation was voluntary, would not be used for

academic assessment, and could be withdrawn at any time. Written informed consent was obtained for all participants. Once consented, the participant was assigned a unique study ID to anonymize the data.

The study employed six questionnaires (Appendix A-D) per participant: demographics, knowledge (pre-and post-), confidence (pre- and post-), and feedback. Questionnaires were developed with input from researchers and clinicians at the IWK Health Centre and Korle Bu Teaching Hospital. The demographics questionnaire did not collect identifying information. The confidence and knowledge pre- and post- assessments were modified versions of validated tools used by Jhpiego in the *Helping Mothers Survive: Bleeding After Birth* workshop[16]. The knowledge assessments included ten multiple-choice items, and the confidence assessments requested participants to rate their level of confidence in six skills related to PPH management on a 5-point Likert scale. The post-simulation feedback survey used a 5-point Likert scale to assess participant perception of the usefulness, feasibility, and acceptance of simulation as an educational tool at their institution. An option to provide additional comments was included.

The simulation scenario (Appendix E) was a PPH case recently developed as part of a national standardized Canadian Obstetrics and Gynecology Simulation curriculum[17]. It was modified for the local context, based on input from local co-investigators.

MamaNatalie® (Laerdal Global Health, Tanke Svilandsgate 30, P.O. Box 377, N-4002 Stavanger, Norway) was the low-fidelity task trainer used (Figure 1). It is worn by a simulated patient (an individual pre-trained and provided with a script to simulate a set of symptoms), and allows simulation of severe bleeding, uterine atony, and retained placenta.

Participants were scheduled for a simulation training session at their convenience during a one-week period. Each resident was scheduled for a 90-minute session with a skilled facilitator. The simulation scenario required a midwife confederate (an individual who is scripted to play the role of the midwife) and a simulated patient wearing MamaNatalie®. We employed two local midwives to act as midwives and two local nurses to act as simulated patients, and we ran two sessions simultaneously. The confederates and simulated patients received an orientation to the task trainer and additional supplies, were trained in the basic principles of simulation (such as confidentiality, fiction contract, etc.), and were provided a script. The scenario was rehearsed in advance to ensure consistency. The facilitators also used the same pre-brief script and de-brief checklist to maintain consistency.

Each participant began their session by completing pre-simulation questionnaires (demographics, confidence, and knowledge). They continued to a pre-brief led by the facilitator, which included an orientation to the task trainer, space, as well as tools and personnel available to them. The pre-brief emphasized the safe learning space, importance of confidentiality, formative purpose, limitations of simulation, as well as the fiction contract. Each participant was then engaged in a PPH simulation for approximately 20 minutes. Throughout the scenario, the facilitator completed a checklist and made written observations, to be used for debriefing purposes.

Following the scenario, a debrief was led by the facilitator, for approximately 20-30 minutes. This was scripted to include uniformity in covering key teaching points on PPH management, but individual areas in which the resident performed well and areas for improvement were also discussed.

Finally, participants completed their post-simulation questionnaires (confidence, knowledge, and feedback).

Data analyses were done using SPSS version 25 software. P-values < 0.05 were considered significant. Descriptive statistics were calculated to summarize participant demographics, confidence, and knowledge, with frequencies, percentages, means and standard deviations (SD) reported. The mean difference between pre- and post-simulation confidence scores was estimated, with 95% confidence intervals (CI), and the statistical significance was assessed using a paired t-test. The

number and percentage of residents who had each knowledge item correct pre- and post-simulation were calculated and the statistical significance of the change was assessed using the McNemar paired test. The change in the total number correct across all knowledge items was assessed with a paired t-test. Post hoc analyses were conducted to explore if the mean change in confidence was heterogeneous by mean baseline confidence score (≤3.5 vs >3.5) and by year of training (1 vs ≥2). Similarly, we explored if the mean change in knowledge was heterogeneous by mean baseline knowledge (≤8 vs >8 correct answers) and by year of training (1 vs ≥2).

Results

Demographics of the 35 participants are summarized in Table 1. They ranged in age from 29 – 39, with a median (25%ile, 75%ile) of 33 (32, 34). Most had previous exposure to at least 10 cases of PPH management in a clinical setting, whether as an observer (57.1%) or primary physician (51.4%), but few had simulation experience (14.3%). Residents rated their confidence with clinical skills relevant to PPH management more highly after the intervention (Table 2, Figure 2).

The skill that yielded the greatest increase in reported confidence was insertion of intrauterine balloon tamponade (mean 1.5, 95% CI 1.2 – 1.8). Participants' mean confidence across all clinical skills increased from 3.5 (SD 0.5) to 4.6 (SD 0.4) for a mean increase of 1.0 (95% CI, 0.9 – 1.2). The increase in confidence was greater among residents with a lower baseline level of confidence ($p < 0.001$) and among residents in their first year of training ($p = 0.010$) (Table 3). Confidence increased in all subgroups examined.

Regarding knowledge assessment, greater than 90% of participants answered six out of the ten multiple choice questions correctly even before the intervention. Of the remaining questions, the percentage of participants answering correctly increased with the intervention for three knowledge items (definition of PPH, the length of time to leave an intrauterine balloon tamponade in place, and the appropriate dose of misoprostol for PPH), but not the question regarding the indication for manual removal of placenta (Table 4). Overall, the mean number of knowledge questions answered correctly increased by 1.3 (95% CI, 0.9 – 1.6). The increase was greater among those with lower baseline knowledge ($p < 0.001$) but did not differ significantly by year of training ($p = 0.536$) (Table 3).

Table 1: Demographics of participants (N = 35)

	n (%); median (IQR[a])
Female	11 (31.4)
Age, years	33 (32, 34)
Year 1 of postgraduate training	22 (62.9)
Year 2 of postgraduate training	10 (28.6)
Year 3 of postgraduate training	3 (8.6)
Previous exposure to PPH, ≥ 10 cases observed	20 (57.1)
Previous exposure to PPH, ≥10 cases as primary treating physician	18 (51.4)
Simulation experience	5 (14.3)

[a]IQR = Interquartile range

All participants agreed that the simulation session was educational, relevant and realistic, that instructions and expectations were clear, and that the debriefing session was an important learning opportunity. Ninety-seven percent (n=34) felt it was a safe learning environment. Ninety-four percent (n = 33) agreed it would be possible to incorporate simulation into their training program, and 97% (n = 34) communicated that they would enjoy simulation being a standard part of the curriculum. See Table 5 for a selection of direct quotations of collected feedback.

Additional qualitative feedback gathered during the debrief illuminated common teaching points that residents felt had been the most impactful lessons from the simulation exercise: techniques of bimanual compression and intrauterine balloon tamponade, review of medication dosing and route, and emphasis on teamwork.

Discussion

Low-fidelity PPH simulation was a feasible and effective educational experience in this low-resource setting. Knowledge and confidence of learners improved significantly after the simulation.

Table 2: Resident Confidence in postpartum hemorrhage management (N = 35)

Clinical skill	**Pre-test** Mean (SD)	**Post-test** Mean (SD)	**Difference** Mean (95% CI)	**p value**
Diagnosis of PPH	4.0 (0.6)	4.7 (0.5)	0.7 (0.4 – 0.9)	< 0.001
Management of PPH	3.6 (0.6)	4.5 (0.5)	0.9 (0.7 – 1.1)	< 0.001
Diagnosis and management of hemorrhagic shock	3.8 (0.4)	4.5 (0.5)	0.8 (0.6 – 1.0)	< 0.001
Performance of bimanual compression	3.1 (0.8)	4.5 (0.5)	1.4 (1.1 – 1.7)	< 0.001
Insertion of intrauterine balloon tamponade	3.1 (0.9)	4.6 (0.5)	1.5 (1.2 – 1.8)	< 0.001
Appropriate ordering and dosing of PPH medications	3.7 (0.6)	4.6 (0.5)	1.0 (0.8 – 1.2)	< 0.001
Mean of all items	3.5 (0.5)	4.6 (0.4)	1.0 (0.9 – 1.2)	< 0.001

Figure 1: MamaNatalie® (Laerdal Global Health, Tanke Svilandsgate 30, P.O. Box 377, N-4002 Stavanger, Norway). Image retrieved from: https://laerdal.com/ca/products/simulation-training/obstetrics-pediatrics/mamanatalie/

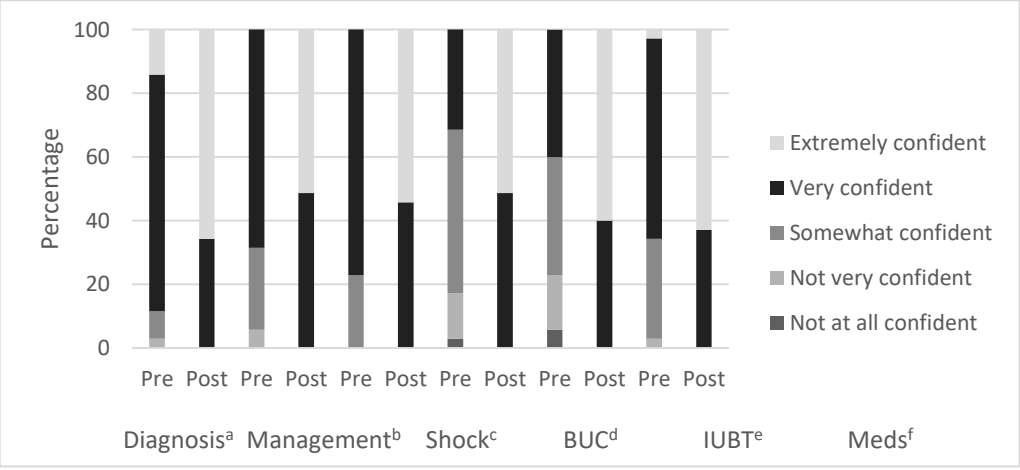

Figure 2: Distribution of residents' confidence before and after simulation (N = 35). [a]Diagnosis: Diagnosis of PPH, p < 0.001. [b]Management: Management of PPH, p < 0.001. [c]Shock: Diagnosis and management of hemorrhagic shock, p < 0.001. [d]BUC: Bimanual Uterine Compression, p < 0.001. [e]IUBT: Intrauterine Balloon Tamponade, p < 0.001. [f]Meds: Appropriate timing and dosing of PPH medications, p < 0.001.

Table 3: Resident confidence and knowledge in postpartum hemorrhage management, by subgroup (N = 35)

Outcome	**Subgroup**	**Difference (Pre to Post)** Mean (95% CI)	**p value**[a]
Confidence score	Baseline confidence ≤3.5	1.3 (1.1 – 1.5)	< 0.001
	Baseline confidence >3.5	0.7 (0.5 – 1.0)	
Confidence score	Year of training 1	1.2 (1.0 – 1.4)	0.010
	Year of training ≥2	0.7 (0.5 – 1.0)	
Knowledge score	Baseline knowledge ≤8	1.7 (1.4 – 2.1)	< 0.001
	Baseline knowledge >8	0.7 (0.3 – 1.1)	
Knowledge score	Year of training 1	1.2 (0.8 – 1.6)	0.536
	Year of training ≥2	1.4 (0.9 – 1.9)	

[a] P value for the heterogeneity of the mean pre-post difference in the outcome between the subgroups.

Table 4: Resident knowledge of postpartum hemorrhage (N = 35)

Item	**Pre-test** number correct (%)	**Post-test** number correct (%)	**p value** McNemar paired test
WHO definition of PPH	6 (17.1)	31 (88.6)	< 0.001
Main etiologies of PPH	35 (100)	35 (100)	[a]
Indication for uterotonics	35 (100)	34 (97.1)	[a]
Indication for bimanual compression	35 (100)	35 (100)	[a]
Diagnosis of shock	32 (91.4)	33 (94.3)	>0.99
Indication and dose of TXA	34 (97.1)	35 (100)	[a]
Appropriate length of time to leave IUBT in situ	23 (65.7)	32 (91.4)	0.004
Indication for manual removal of placenta	24 (68.6)	27 (77.1)	0.375
First line uterotonic	34 (97.1)	33 (94.3)	>0.99
Dose of misoprostol	27 (77.1)	34 (97.1)	0.039
Total number correct, mean (SD)[b]	8.1 (1.0)	9.4 (0.8)	< 0.001

IUBT, Intrauterine Balloon Tamponade; PPH, postpartum hemorrhage; SD, standard deviation; TXA, Tranexamic Acid; WHO, World Health Organization

Data shown are number correct (%) unless otherwise specified.

[a]The McNemar test cannot be calculated when all participants have answered the item correctly at either or both of the pre- or post-test.

[b]Mean difference (95% confidence interval): 1.3 (0.9 – 1.6)

Table 5: Select participant comments on the optional feedback survey

"Similar simulations in our facility would keep our knowledge and skill in the management of obstetric emergencies up to date and also improve our confidence in managing those emergencies in real life"
"It was a very good learning experience. I enjoyed and learned a lot from it. Thank you for the opportunity"
"The simulation exercise was done in a relaxed atmosphere, was interactive and exciting. I would recommend more of such simulations in this topic (PPH) and other obstetric emergencies."
"By far, the most educative session I have taken part in since the start of my training. Simulations of emergency management in obstetrics would go a long way to improve care of real patients and hence, would be a good addition to our training."

This is in keeping with other studies evaluating simulation of obstetric emergencies as a teaching method[6-14]. Significant educational benefit seemed to arise from practicing specific skills. For example, most residents identified the appropriate time to initiate bimanual uterine compression or insert an intrauterine balloon tamponade, but most either did not know how or required assistance to correctly perform the skills. Residents highlighted the ability to practice these skills in a safe environment as a unique benefit of simulation, and one that would enhance their confidence when treating real patients with PPH. Confidence is an important outcome of simulation, as developing confidence can reduce

feelings of stress and fear that are commonly encountered in emergencies[18-20]. Further, low self-confidence negatively influences patient-provider relationships and undermines clinical performance[20].

There was a clear desire from residents to have simulation training incorporated into their curriculum, and to have the opportunity to engage in simulations of other obstetric emergencies. Most residents felt it would be feasible to incorporate simulation into their training program, but those that did not were unable to provide reasons. Possible barriers could include lack of faculty buy-in and experience with simulation, and a lack of adequate simulation space and sustainable supply of equipment. We attempted to address these barriers by engaging local faculty and educational policy makers in the study design and implementation, as well as establishing long-term working relationships between simulation directors of both centers for ongoing collaboration on scenario development and equipment needs.

This study involved residents from a single large teaching institution in Ghana, thus the results may not be generalizable to all populations. Responses to Likert scale questions can also be susceptible to social desirability bias, and end-aversion bias. We aimed to minimize these biases by ensuring anonymity and confidentiality of the questionnaires. A logistical limitation is that the study occurred in a controlled environment outside of a clinical area, as opposed to in situ, which would have provided a more realistic setting. The clinical setting, however, was too busy to allow us to conduct this study in situ. Conversely, setting up the simulation environment the same way for each participant created consistency which should heighten reliability and replicability of results.

This research highlights the importance of working with local partners and stakeholders to address specific research priorities, needs and barriers. Authentic partnership is recommended by the Canadian Coalition on Global Health Research (CCGHR) to ensure global health research is ethical and equitable, and all researchers should place strong emphasis on this.

Training in PPH management and other obstetric emergencies should be context appropriate, therefore it is important that this research was carried out in an understudied context. The results help to fill a gap in the simulation literature regarding program feasibility in LMICs and efficacy of low-fidelity simulation, and our protocol may help guide future studies or program development.

An additional benefit of this study is that Korle Bu now has the tools and support required to further their goal of implementing a simulation curriculum into their postgraduate training program. This research demonstrates that low-fidelity simulation is effective at improving resident knowledge and confidence in PPH management, and that simulation is a feasible and acceptable educational tool in residency programs in LMICs. Further, when care provider knowledge and confidence are improved, improvements in clinical care and clinical outcomes should occur, but more data is needed to provide direct evidence of this. Future studies are recommended to evaluate cost-effectiveness of simulation program implementation, as well as the correlation between simulation training and improvements in high-value clinical outcomes, such as decreased maternal mortality.

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Contribution of authors

Emma Sumner – study conception and design, data collection and analysis, manuscript writing and editing

Catherine Craig – study conception and design, data collection
Jerry Coleman – study conception and design, data collection
Henry Kumi – participant recruitment and consent, data collection, manuscript editing
Heather Scott – study conception and design, data collection
All authors have reviewed and approved the manuscript.

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