

Use of a Postpartum Hemorrhage Simulator for Instruction and Evaluation of Residents

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Abstract

Objective Postpartum hemorrhage is a common and potentially life-threatening obstetric emergency. We sought to create a realistic simulation and validate a standardized grading form to evaluate competency in the management of postpartum hemorrhage.

Methods Residents from 3 programs underwent training with a postpartum hemorrhage simulation using a standard obstetric birthing model equipped with an inflatable uterus to simulate uterine atony. All simulations were graded by staff physicians with a standardized grading sheet constructed from the current literature on the topic. Residents were expected to recognize the hemorrhage and take appropriate steps, including asking the assistant to administer medications, to correct the problem. Objective and subjective performance was measured with standardized grading sheets, and results were analyzed for reliability using Cronbach α and

intraclass correlation coefficients. This project was conducted in accordance with the hospital Institutional Review Board policies at each institution.

Results Forty residents from 3 institutions underwent simulation training. The majority were unable to correct the hemorrhage within 5 minutes and almost half also made at least 1 error, either the dose or route, in the medications they requested. Reliability was evaluated with Cronbach α and demonstrated the grading sheets were valid and had good interrater reliability.

Discussion A simulated postpartum hemorrhage scenario can identify important deficiencies in resident knowledge and performance, with no risk to patients. The standardized grading form worked well for our purposes and was reliable in our study. Further testing is needed to evaluate whether the training improves performance in real-life hemorrhages.

Introduction and Hypothesis

Postpartum hemorrhage is a common obstetric emergency and occurs in 4% to 6% of all deliveries. The increased blood supply to the term uterus may allow for the loss of up to 500 mL of blood per minute, which can result in the rapid decompensation of even a young, healthy patient,

which is why postpartum hemorrhage is the number 1 cause of maternal death worldwide, resulting in 140 000 deaths per year, or 1 death every 4 minutes.¹

The Joint Commission on Accreditation of Healthcare has recently addressed the management of maternal hemorrhage and stated that “clinical drills to enhance the management” of this emergency should be performed, although it does not specify exactly how they should be done.²

Simulation training in obstetrics is a relatively new field that holds great potential for improving patient care, especially for high-risk scenarios where correct and rapid interventions are required. This training has already been shown to improve resident performance with simulated shoulder dystocia deliveries.³ Another major benefit of simulation training in obstetrics is that it may be accomplished with absolutely no risk to the patient or unborn fetus and allows residents to practice and review their performance before being faced with a live patient.

The goal of this study was to use a birthing simulator to teach and evaluate resident performance during a simulated postpartum hemorrhage as well as to validate the grading forms.

Simulation is becoming a key component of resident education and is increasingly being used and even recommended by accreditation bodies as a means to

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†Our friend and colleague, Lynn S. Mandel, passed away December 14, 2007, after a long and courageous battle against cancer. Lynn was a devoted member of the Education Division of the Department of Obstetrics and Gynecology at the University of Washington for many years. She was a very warm and generous person who was always willing to help. She will be greatly missed.

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improve patient care and safety.⁴ There is also recently published evidence that simulation training for another obstetric emergency, shoulder dystocia, may significantly decrease the risk of permanent brachial plexus injuries.⁵ Although there is a previous publication that describes the use of a birthing simulator for instruction in postpartum hemorrhage, the only metrics reported in that study were self-reported perceived technical competence and stress hardness after training.⁶

Experimental Methods

During a 3-month period, all residents from the obstetrics-gynecology residencies at Madigan Army Medical Center, Georgetown University Hospital, and the University of Washington Hospital underwent training with a standardized postpartum hemorrhage simulation as part of their regularly scheduled academic training. All of the residencies used simulation training as part of their curriculum, although they had not been evaluated on the management of postpartum hemorrhage using simulation. Residents were excused from the simulation if they were on leave, at an off-site rotation, or could not attend because of 80-hour work week restrictions. This study was conducted in accordance with the hospital Institutional Review Board policies of each institution.

For the training, we designed a postpartum hemorrhage simulation scenario using the Noelle birthing mannequin (Gaumard Scientific, Miami, Florida) and the uterine hemorrhage model included with it. The model includes a reservoir with a pressure bag that can be easily concealed during the simulation that holds up to 1000 mL of simulated blood that is delivered through the cervix and into the vaginal vault that will then flow out onto the perineum. The model also contains an inflatable uterus that can be made boggy to simulate uterine atony and then pumped up with a handheld pump to become firm if the correct interventions are made.

Prior to beginning the simulation, residents were given a case scenario describing the patient's clinical situation that involved an uncomplicated, multiparous patient who had just delivered a 4000-g infant and was continuing to have some bleeding despite oxytocin being administered in her intravenous fluids. They were then brought into the room and had to address the active bleeding that was coming from the vagina.

Vital signs were given to the resident upon entering the room, and then the resident was verbally given progressively worsening (tachycardia and hypotensive) vitals at specified intervals of 30 seconds, 60 seconds, and 2 minutes into the scenario.

Additional participants in the simulation included the staff physician who controlled both the bleeding and the uterine "tone," as well as a "nursing assistant," who conveyed the vital signs and was able to give medications or carry out other instructions from the residents. Neither the

staff nor the person playing the nursing assistant was able to answer questions about medications that could be used or the dose or route of administration.

The simulation ended when the resident had performed an appropriate physical examination, fundal massage, and administered 2 medications in the correct dose and route, which resulted in the bleeding stopping, or when a total of 5 minutes had expired. The correct medications and doses that could be given to stop the hemorrhage were chosen from the recent American College of Obstetricians and Gynecologists practice bulletin on the topic and included methylergonovine (Methergine), 15-methyl prostaglandin F (Hemabate), and misoprostol (Cytotec).⁷

Both objective and subjective evaluation sheets with which to evaluate the resident's performance and give feedback were created by using standard obstetric textbooks and the current literature and were reviewed by the staff providers, including 3 maternal-fetal medicine specialists. The subjective grading forms used a 10-point Likert scale and included 3 questions that addressed how quickly the resident addressed the complication and gave medications, as well as the resident's overall preparedness and performance.

All staff involved in the simulation training participated in the creation of the scenario, and the simulation was rehearsed prior to bringing in the residents to ensure uniformity of training. Simulations were digitally recorded, and at least 2 staff evaluators were present to assess the resident's performance using the standard evaluation forms.

After the simulation exercise ended, the residents were shown their grading sheets, and additional feedback and instruction were given regarding their performance and the timeliness of their interventions. Best practices were reviewed at this time as well.

When all residents had been trained, data were entered into a computerized database for analysis. Descriptive statistics were compiled for the objective performance of all participants, and subgroup analysis was performed with regard to year level of training and training institution. The objective and subjective grading forms were evaluated using Cronbach α to evaluate the validity and internal consistency of the form.

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Results

A total of 40 residents from 3 institutions participated in the study. There were 18 junior postgraduate year 1 (PGY-1) and PGY-2 and 22 senior (PGY-3 and PGY-4) residents. TABLE 1 illustrates the division of the residents by year level of training.

Only 45% (18 of 40) of the residents were able to correct the hemorrhage within the 5-minute time frame. In addition, nearly half of the residents (47.5%; 19 of 40)

TABLE 1 RESIDENTS BY YEAR LEVEL OF TRAINING	
PGY Level of Training	No. of Residents
PGY-1	9
PGY-2	9
PGY-3	10
PGY-4	12

Abbreviation: PGY, postgraduate year.

made some form of medication error, either dose or route of administration, during the simulation exercise. The specific errors can be seen in TABLE 2.

When subgroup analysis was performed, there was no difference in how likely the senior residents (PGY-3/PGY-4) were to correct the hemorrhage compared with the junior (PGY-1/PGY-2) residents (10 of 22 [45%] vs. 8 of 18 [44%]; $P = .95$). In addition, there was no difference between the institutions regarding the residents' ability to successfully stop the bleeding ($P = .96$).

The subjective grading form was found to have good internal consistency or reliability as measured with the Cronbach α , with a result of 0.92.

Interrater reliability was calculated using intraclass correlation coefficients for both the objective checklist and the subjective grading forms and was found to be reliable for each of the 3 subjective questions, as well as for the total subjective score. These results are summarized in TABLE 3.

Discussion

The standard approach to the patient with a postpartum hemorrhage includes a physical examination to determine the etiology, which is most commonly uterine atony, the performance of fundal massage, and the administration of standard medications. It is very important to have a stepwise approach to this emergency and to know the appropriate medications to give, what the correct dosages are, the route of administration, and how often they may be repeated; if they are given incorrectly, they may cause significant morbidity to the patient. In addition, during an emergency, such as a postpartum hemorrhage, the

physician cannot always rely on other providers or nurses to know the correct steps and medication doses to give, because the other providers may be unavailable or inexperienced.

In this study of residents from 3 separate institutions, almost half of the residents (47.5%) evaluated made at least 1 medication error, and fewer than half (45%) were able to correct the postpartum hemorrhage within the 5-minute time limit. Performance was not different between junior and senior residents or the institutions, which suggests that this may be a common issue. This finding, while somewhat surprising, is consistent with other studies that evaluated provider performance for obstetric emergencies. In a study by Crofts et al⁸ on the management of shoulder dystocia, they found that only 43% of providers were able to complete a simulated shoulder dystocia delivery before training. Although it is possible that the artificiality of the simulation may have contributed to residents not correcting the hemorrhage in a timely manner, especially with regard to performing fundal massage or evaluating for lacerations, we do not feel that this should have influenced the incidence of medication errors that we observed.

Regarding medication errors, these were not limited to a single medication and included errors in both dose and route without a specific pattern being evident. Based on these findings, we have incorporated simulation training for postpartum hemorrhage management into our annual simulation curriculum. Specifically, our goal is to ensure that our junior residents are exposed to and competent in the management of this emergency prior to being allowed to work on labor and delivery. In addition, we have begun to conduct the simulations on the actual labor and delivery unit in an attempt to decrease medication errors and improve patient care.

Moving this training to the actual labor and delivery unit has allowed us to train the entire team as well as investigate potential systems problems that can occur during this emergency, and we have described this comprehensive program in a recent publication.⁹ Training on the actual ward also permits us to evaluate our residents in additional areas, such as leadership and communication, and ensure that the nursing staff understands the current best practices for this emergency as well.

TABLE 2 SPECIFIC MEDICATION ERRORS ^a				
Medication	Residents Who Gave Medication, % (no.)	Correct Dose Given, % (no.)	Correct Route, % (no.)	Gave Medication Correctly, % (no.)
Methylergonovine (Methergine)	95 (38 of 40)	76 (29 of 38)	86 (33 of 38)	68 (26 of 38)
15-Methyl prostaglandin F (Hemabate)	80 (32 of 40)	68 (22 of 32)	93 (30 of 32)	63 (20 of 32)
Misoprostol (Cytotec)	43 (17 of 40)	59 (10 of 17)	100 (17 of 17)	59 (10 of 17)

^a Although some residents made a single error, others made multiple ones. The overall rate of at least one medication error was 47.5% (19 of 40).

TABLE 3 RESULTS OF RELIABILITY INDICES FOR GRADING FORMS (CRONBACH α)

Grading Forms	Interrater Reliability Indices
Objective checklist	0.91
Administered medications in a timely manner	0.77
Overall preparedness for postpartum hemorrhage	0.88
Overall performance	0.91
Total score for Likert scale questions	0.92

Although the Joint Commission has recommended clinical drills be conducted for providers to prepare for maternal hemorrhage during delivery, it has not provided specific direction as to how they should be accomplished. The simulation protocol that we have developed uses currently available simulation technology that is relatively inexpensive and simple to use. The grading forms we used also worked well and demonstrated good interrater reliability in the simulations.

We chose to target uterine atony with our simulation exercise because this is the most common cause of postpartum hemorrhage, although there are others, such as lacerations, retained products of conception, and coagulopathies. In our simulation, we required that the resident evaluate for lacerations, but the model does not allow for actual exploration of the uterine cavity. A limitation of the Noelle postpartum hemorrhage model is

that it can currently only simulate uterine atony. The ability for future models to be able to simulate a cervical laceration and permit evaluation of the uterine cavity for retained products of conception would allow for an even more realistic and robust simulation training to be conducted.

Our study demonstrated a significant number of medication errors were made during a simulated postpartum hemorrhage, even among the senior residents. By allowing our residents to practice these drills and providing additional instruction, as well as doing additional training with the actual team on labor and delivery, we hope to improve their performance and patient safety during actual emergencies.

References

- 1 AbouZahr C. Global burden of maternal death and disability. *Br Med Bull*. 2003;67:1–11.
- 2 The Joint Commission. Preventing infant death and injury during delivery. Sentinel Event ALERT No. 30. Available at: http://www.jointcommission.org/SentinelEvents/SentinelEventAlert/sea_30.htm. Accessed October 15, 2009.
- 3 Deering SH, Poggi S, Macedonia C, Gherman RB, Satin AJ. Resident competency in the management of shoulder dystocia improves with simulation training. *Obstet Gynecol*. 2004;103(6):1224–1228.
- 4 Macedonia CR, Gherman RB, Satin AJ. Simulation laboratories for training in obstetrics and gynecology. *Obstet Gynecol*. 2003;102:388–392.
- 5 Draycott TJ, Crofts JF, Ash JP, et al. Improving neonatal outcome through practical shoulder dystocia training. *Obstet Gynecol*. 2008;112:14–20.
- 6 Pliego JF, Wehbe-Janek H, Rajab MH, Browning JL, Fothergill RE. OB/GYN boot camp using high-fidelity human simulators: enhancing residents' perceived competency, confidence in taking a leadership role, and stress hardiness. *Simul Healthc*. 2008;3:82–89.
- 7 ACOG Educational Bulletin Number 76, Postpartum hemorrhage. *Obstet Gynecol*. 2006;108(4):1039–1047.
- 8 Crofts JF, Bartlett C, Ellis D, Hunt LP, Fox R, Draycott TJ. Training for shoulder dystocia: a trial of simulation using low-fidelity and high-fidelity mannequins. *Obstet Gynecol*. 2008;108(6):1477–1485.
- 9 Deering SH, Rosen MA, Salas E, King HB. Building team and technical competency for obstetric emergencies: the Mobile Obstetric Emergencies Simulator (MOES) system. *Simul Healthc*. 2009;4:166–173.