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ORIGINAL ARTICLE

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Repeated simulation-based training for performing general anesthesia for emergency cesarean delivery: long-term retention and recurring mistakes

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ABSTRACT
Background: The percentage of women undergoing cesarean delivery under general anesthesia has significantly decreased, which limits training opportunities for its safe administration. The purpose of this study was to evaluate how effective simulation-based training was in the learning and long-term retention of skills to perform general anesthesia for an emergent cesarean delivery.
Methods: During an eight-week obstetric anesthesia rotation, 24 residents attended lectures and simulation-based training to perform general anesthesia for emergent cesarean delivery. Performance assessments using a validated weighted scaling system were made during the first (pre-test) and fifth weeks (post-test) of training, and eight months later (post-retention test). Resident's competency level (weighted score) and errors were assessed at each testing session. Six obstetric anesthesia attending physicians, unfamiliar with the simulation scenario, generated a mean attendings' performance score. The results were compared.
Results: At one week of training, residents' performance was significantly below mean attendings' performance score (pre-test: 135 ± 22 vs. 159 ± 11, $P = 0.013$). At five weeks, residents' performance was similar to mean attendings' performance score (post-test: 159 ± 21) and remained at that level at eight months (post-retention test: 164 ± 16). Of the important obstetric-specific tasks, left uterine displacement was missed by 46% of residents at eight months.
Conclusion: Following lectures and simulation-enhanced training, anesthesia residents reached and retained for up to eight months a competency level in a simulator comparable to that of obstetric anesthesia attending physicians. Errors in performance and missed tasks may be used to improve residency training and continuing medical education.
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Keywords: General anesthesia; Cesarean delivery; Simulation-based training

Introduction

The proportion of women undergoing cesarean delivery has increased significantly over the past decades,[1] while over a similar period the use of general anesthesia (GA) for cesarean delivery has decreased significantly.[2] There is concern that obstetric anesthesia training may not provide sufficient opportunities to master the technique.[3–5] Simulation-based training has been recommended to provide additional training opportunities.[6,7] Scavone et al. used a high-fidelity patient simulator to create a scenario for anesthesia residents on how to perform a GA for emergency cesarean delivery. A scoring tool was validated to evaluate the performance of residents during the scenario (Appendix A).[8] In a follow-up trial, the same group confirmed that this focused high-fidelity obstetric simulation resulted in improved competency 6–9 weeks after training than a non-obstetric scenario of rapid sequence induction for general anesthesia.[9]

Our department introduced a simulation scenario using the validated scoring system for second year anesthesia residents in 2010.[8] However, a score that measured competency in performing safe GA for urgent cesarean delivery was not determined, and it was unclear whether residents retain competency over time. Therefore, a longitudinal observational study was designed

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to both identify a mean attendings' performance score (MAPS) that assessed experts in the same simulation scenario, and to determine what levels residents reach and retain. Errors and areas of poor retention were identified to improve education.

Methods

This study was approved by the Institutional Review Board of the Office for Protection of Research Subjects of the University of Washington (IRB# 42712). In their second year of anesthesia training, 24–28 residents rotate through the Labor and Delivery Unit of the University of Washington Medical Center (UWMC). This is a low-volume, high-risk obstetric unit with 800 cesarean deliveries annually, of which up to 90% are unscheduled and only 3–5% are performed under GA; on average, each resident performs 1–2 GA for emergency cesarean delivery during their residency. The UWMC obstetric anesthesia rotation is of eight weeks duration, with four residents per rotation. Residents are supervised during day and night shifts by a team of obstetric anesthesia attending physicians (attendings). At the start of the rotation, residents are given reading material and attend a 45-min interactive presentation on how to perform a GA for an emergent cesarean delivery, and since 2010 also undergo a simulation-based training during the first week of the rotation. Simulations are conducted in a purpose-built simulated operating room environment that uses a high-fidelity computerized life-size human mannequin (Laerdal SimMan 3G, Laerdal Medical AS, Stavanger, Norway).

During 2010–2011, 24 consecutive second year anesthesia residents were informed that they would undergo simulation training and testing on how to perform a GA for an emergency cesarean delivery. Tests were performed during the first (pre-test) and fifth weeks (post-test) of the rotation, and a further test was performed eight months after the obstetric anesthesia rotation (retention post-test). Informed consent was given for use of anonymized data for educational research purposes; non-acceptance did not alter the teaching curriculum. Residents were not informed that the scenario would be the same at each session, nor that the scoring system was a validated tool that was published and accessible online. Residents were not given a copy of the list or their final score. Residents were further asked not to discuss the simulation session or the scenario itself with each other and were informed that their scores would not be used in any formal or informal evaluation of their clinical competence.

At the start of the session, each resident indicated the number of simulation trainings and rapid-sequence inductions that they had performed in non-obstetric and obstetric patients (none, 1–5, 6–10, 11–15, 16–20, > 20), and rated their comfort performing a GA for an emergency cesarean delivery using an 11 point numerical rating scale ($0 =$ not at all confident and $10 =$ extremely confident).

The training session started with an orientation to the simulator environment. The scenario started when the resident was paged to the simulation room where the obstetrician (training evaluator BR or CO) and a nurse (a staff member who also provided assistance to the resident), were waiting. The obstetrician called out the scenario: a woman in labor with an umbilical cord prolapse who required emergency cesarean delivery. A medical history was provided only if the resident specifically asked for it. A photograph of a patient's airway was presented if the resident enquired about airway status. Residents were expected to perform an equipment availability check followed by tasks that included seven specific to obstetric anesthesia (obtain an obstetric history, provide left uterine displacement, verify obstetric team readiness, notify obstetric team to proceed once airway secured, provide adequate O_2:N_2O ratio, timely administration of oxytocin, and appropriate reduction of inhaled volatile anesthetic).

After the scenario the evaluator and resident debriefed the session and reviewed performance on the 48 item scoring system. Each task is weighted on a scale of importance from 1 to 5, resulting in a maximal score of 198.5 points (Appendix A).[9] The importance of each missed task and error was specifically discussed with the resident. The score was calculated to derive a resident's weighted score. Scored data sheets were stored at the simulation center.

Obstetric anesthesia attending physicians who were not familiar with the scenario or simulation protocol were evaluated in the same way. The mean score of the attendings yielded the MAPS. The physicians are either fellowship trained in obstetric anesthesia or dedicate 50–100% of their clinical time to obstetric anesthesia. To be eligible for participation, attendings had to be familiar with the simulation environment in the same way as the residents, but unfamiliar with this specific scenario or the simulation protocol itself.

Statistical analysis

Sample size calculation was based on pilot data from eight second year anesthesia residents from 2009 to 2010, evaluated at one-week during their simulation-based training on the obstetric anesthesia rotation and all six eligible obstetric anesthesia attendings. Assuming an α-value of 0.01 and a β-value of 0.99, a total of 22 trainees was needed to show a progression from the mean residents score of 131 ± 13 during pilot sampling to the obstetric anesthesia attending competence level score of 159 ± 11. All 24 residents in 2010 were enrolled.

Examinations were graded by a single instructor (either BR or CO) and videotaped. Ten randomly selected sessions for each instructor (total of 20/78 ses-

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