Original Publication

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A Novel Abdominal Hysterectomy Simulator and Its Impact on Obstetrics and Gynecology Residents' Surgical Confidence

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Citation: Stickrath E, Alston M. A novel abdominal hysterectomy simulator and its impact on obstetrics and gynecology residents' surgical confidence. *MedEdPORTAL*. 2017;13:10636. https://doi.org/10.15766/mep_2374-8265.10636

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Abstract

Introduction: The number of abdominal hysterectomies (AHs) performed by OB/GYN residents has decreased dramatically. Thus, there is a need for simulation training to complement operating room experience. **Methods:** A low-fidelity AH simulator was constructed from craft-store supplies costing less than \$40. OB/GYN residents in a single academic program completed the simulation between July and September of 2015. The 1-hour simulation experience included a pretest, a 5-minute presentation, the simulation, and a posttest. On the pre- and posttests, participants rated their confidence with the steps of AH as not at all, somewhat, or very confident. **Results:** Eighty-six percent (32 of 37) of possible residents completed the session, with even representation from all levels of training (nine PGY 1, seven PGY 2, eight PGY 3, and eight PGY 4 residents). Knowledge of the steps of the procedure and instrumentation improved for all levels of trainees ($p < .001$). One hundred percent (16 out of 16) of the PGY 1 and PGY 2 residents rated their confidence as increased afterwards, while only 25% (four out of 16) of the PGY 3 and PGY 4 residents did so. Ninety-four percent (30 out of 32) rated the session as very helpful on a scale of not at all, somewhat, or very helpful. **Discussion:** A low-fidelity, low-cost simulator showed an increase in trainee confidence with AH, particularly in the first- and second-year trainees. Nearly all participants found the exercise helpful, suggesting that it may be beneficial to incorporate into OB/GYN training programs nationwide.

Keywords

Simulation, Gynecology, Simulator, OB/GYN, Abdominal Hysterectomy, Low Fidelity

Appendices

- A. Pretest.docx
- B. Abdominal Hysterectomy Simulation Didactic.ppt
- C. Posttest.docx
- D. Abdominal Hysterectomy Simulation Guide.doc

All appendices are peer reviewed as integral parts of the Original Publication.

Educational Objectives

By the end of this session, learners will be able to:

1. Outline the steps of an abdominal hysterectomy AH.
2. List the necessary instrumentation to perform an AH.
3. Perform the steps of an (AH) on the simulation model.
4. Improve preprocedure confidence for (AH).

Introduction

The number of abdominal hysterectomies (AHs) performed by U.S. OB/GYN residents is decreasing. From 2010 to 2014, the number of AHs performed by graduating residents fell by 29%.¹ As a result of these decreasing numbers, residents overall have less exposure to the procedure, with the largest impact occurring in early learners. Many residents will see or even perform a laparoscopic or vaginal hysterectomy without having had exposure to the traditional abdominal approach. Additionally, given work-hour restrictions within graduate medical education, the opportunity to second assist in surgery is decreasing. Thus, residents may be performing their first AH without observing any in the assistant role. As a result of the decreasing exposure to AH, a simulator is needed to expose residents to this surgical approach before they are in the operating room for their first AH.

Mastering a new surgical skill requires the learner to progress through various stages, as initially proposed in Fitts and Posner's three-stage theory of motor skill acquisition.^{2,3} The first stage involves step-by-step performance with a focus on each individual movement, without thinking more globally about the procedure. In the second, integrative phase, the learner is still thinking about the mechanical steps but is able to move through the steps more smoothly. In the third, autonomous stage, the learner is able to move fluidly through the mechanics without thinking about them and can concentrate on other aspects of the procedure. Simulators may provide learners with the opportunity to practice new skills outside of the operating room, thereby moving through the initial phases of motor skill development without needing high surgical volumes to do so. A learner who has been exposed to a simulation is more ready to move through stages two and three with an overall smaller volume of operative cases than is a nonexposed resident learner.

Low-fidelity simulators have been shown to reduce error and improve performance, and have been considered to be comparable to higher fidelity models, particularly with less experienced learners.^{4,5} Although the referenced data were published in the general surgery literature, simulation in gynecologic surgery has also been shown to be beneficial. These models have demonstrated improved outcomes related to pre- and posttesting, rating of surgical skills by observers, and operator confidence levels.⁶ Most of the simulation data in gynecology surround laparoscopic and vaginal procedures. There has been only one small study published on AH simulation, in which 15 residents from the second and fourth years of training were exposed to the simulation.⁷ This resource looks to add to these data by evaluating the simulator's impact on surgeon confidence. Given that AH is a potentially lifesaving procedure in the setting of obstetrical or gynecologic hemorrhage, it is a necessary skill for all OB/GYNs. In the climate of decreasing numbers of AH cases for trainees, additional development and testing of AH simulators is needed. Ideally, if residents enter the operating room to perform an AH having already completed simulation education, they will be further along in their motor skill acquisition process, allowing the available surgical experience to be more educationally rich.

The aim of this project was to develop an inexpensive model for AH with the goal of improving resident surgeon confidence with the procedure.

Methods

This is a prospective cohort study. This study was deemed exempt by the institutional review board and did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. All residents in the University of Colorado Obstetrics and Gynecology Residency Program were approached for participation in the study between July and September of 2015. The simulation experience consisted of a 1-hour session with a pretest, a 5-minute presentation covering instrumentation and basic steps of the procedure, the simulation itself, and a posttest. The pretest (Appendix A) requested consent to participate in the study, asked the resident's level of training, and included seven multiple-choice questions. Three questions assessed residents' experience and confidence with the procedure by asking how many AHs they had done, how confident they were with the steps of the procedure, and how confident they were with the instrumentation needed to complete the procedure. The pretest also contained two knowledge questions regarding the correct order of steps of the procedure and two questions in which learners were asked to identify commonly used instruments. Following the pretest, the 5-minute presentation covering the steps of the procedure and commonly used instruments (Appendix B) was reviewed. Once the AH simulation was completed, the posttest (Appendix C) was administered. The posttest included questions regarding how helpful the simulation experience was on a scale of not at all, somewhat, or very helpful. The posttest also asked what portion of the experience the learners found most helpful and their perceived confidence with the procedure. The posttest then repeated the knowledge-based questions from the pretest. To protect resident identity, there were no identifiers on any of the tests other than the level of training.

The low-fidelity AH simulator was constructed from supplies purchased at a craft store for \$40. This provided enough supplies to remake the simulator for all 32 participants. Please see the attached simulation guide (Appendix D) for step-by-step instructions and photographs. The uterus was made of red fabric sewn across the top and then stuffed with fiberfill. A thin piece of fabric was tied around the lower uterine segment to delineate the cervix. Tape was used to hold the uterus together at the level of the cervix. A fabric vagina was created and sewn loosely onto the cervix. Yarn was attached with tape to create fallopian tubes, utero-ovarian vessels, round ligaments, and uterine arteries. Small balls of yarn were used to represent the ovaries and fimbria and were attached to the utero-ovarian vessels. An additional piece of yarn was taken out laterally to create the infundibulopelvic ligament. The uterus was then attached by tying these yarn pieces to a milk crate in the correct anatomic orientation. A small balloon with yellow yarn was attached to represent the bladder and ureters. A layer of self-sealing plastic wrap was then placed posterior to the whole model, and a small piece of the plastic wrap was placed on top of the uterine arteries, ureters, and cervix/lower uterine segment to represent the parametrial tissue. A small amount of fiberfill was dispersed throughout the broad ligament area, and another layer of plastic wrap was placed on top of the entire model and sealed. A labeled image of the completed model can be found in the simulation guide (Appendix D).

Two residents worked together to complete the simulation, with one faculty member instructing. All necessary surgical instruments and suture were borrowed from the operating room and used to complete the steps of the hysterectomy. The two surgeons stood on either side of the simulator to mimic operating position for the actual procedure. The simulation started with tying off and ligating the round ligament. The outer layer of plastic wrap surrounding the round ligament with the intervening fiberfill allowed for dissection of the broad ligament and creation of the bladder flap. The simulator allowed for demonstration of both ovarian removal and preservation. Residents were instructed to remove the ovary on one side of the model and preserve the ovary on the other to demonstrate both techniques. After addressing the adnexa, the residents proceeded with the remainder of the hysterectomy. When a pedicle was taken, the residents were clamping, cutting, and suturing plastic wrap–encased yarn representing vessels and the surrounding tissue. The final curved clamps were placed under the cervix across the fabric vaginal tissue, and the uterus was removed.

The simulator took about 45 minutes to make initially and was reconstructed in about 15 minutes after each use. The only necessary steps in the reconstruction were quickly sewing a new piece of fabric around the cervix to represent vaginal tissue, taping new yarn pedicles to the uterus, attaching it to the milk crate, and reapplying the plastic wrap with the intervening fiberfill. The uterus, fimbria, ovaries, bladder, and ureters remained intact with this model.

Equipment

This list contains adequate materials to initially make two models and to remake each model at least 25 times.

- Red fabric—half yard.
- Yarn—100-gram skein of red, yellow, and white.
- Needle and thread.
- Fiberfill—one small bag.
- Red adhesive tape—one roll.
- Small balloon—two.
- Milk crate—two.
- Self-sealing plastic wrap—one roll.
- AH instruments—two sets (see Appendix D for list of instruments).
- O-Vicryl pop-off needles—two packs of eight sutures for each model use.

Personnel

Personnel included two learners and one faculty instructor per model, or one faculty instructor and one learner per model.

Assessment

The pre- and posttest knowledge questions were graded out of 4 possible points to obtain a knowledge score, and the answers to the qualitative questions were tallied. Learners were grouped based on level of training. Descriptive statistics were used to compare the knowledge scores on the pre- and posttests. The learners were then grouped into PGY 1 and PGY 2 and compared to PGY 3 and PGY 4 via a Student *t* test to evaluate if a significant difference existed between lower and upper level residents.

- Pretest (Appendix A).
- Real-time feedback from faculty member during model use.
- Posttest (Appendix C).

Results

There were 37 eligible residents, 32 of whom completed the simulation session (86%). The remaining five residents did not complete the simulation due to scheduling conflicts. There was near-even representation across all four levels of training, with nine PGY 1, eight PGY 2, seven PGY 3, and eight PGY 4 residents completing the study.

This study was conducted at the beginning of the academic year; therefore, surgical exposure prior to the simulation was minimal. At pretest most residents reported feeling not at all or somewhat confident with the steps of the procedure (26 out of 32), and most felt not at all or only somewhat confident with the instrumentation (23 out of 32). The pretest results can be found in [Table 1](#).

Table 1. Pretest Results

Question	n (%)			
	PGY 1	PGY 2	PGY 3	PGY 4
Number of hysterectomies performed				
0	9 (100%)	5 (63%)	1 (14%)	0 (0%)
1-5	0 (0%)	3 (37%)	2 (29%)	0 (0%)
5-15	0 (0%)	0 (0%)	4 (57%)	6 (75%)
16+	0 (0%)	0 (0%)	0 (0%)	2 (25%)
Confidence with the steps of the procedure				
Not at all	9 (100%)	8 (100%)	1 (14%)	0 (0%)
Somewhat	0 (0%)	0 (0%)	5 (72%)	3 (37%)
Very	0 (0%)	0 (0%)	1 (14%)	5 (63%)
Confidence with the instrumentation				
Not at all	6 (67%)	5 (63%)	2 (28%)	0 (0%)
Somewhat	3 (33%)	3 (37%)	3 (44%)	1 (13%)
Very	0 (0%)	0 (0%)	2 (28%)	7 (87%)
Knowledge score: <i>M</i> (range)	2.30 (1-4)	2.75 (1-4)	3.40 (2-4)	2.75 (2-4)

On the posttest ([Table 2](#)), virtually all residents (30 out of 32) rated the experience as very helpful. All 32 residents stated that they felt somewhat or very confident with the steps of the procedure after the simulation. Additionally, all 32 reported feeling somewhat or very confident with the instrumentation. Although all had high confidence after the simulation experience, the difference in confidence was most notable in the early years of training. One hundred percent (16 out of 16) of the PGY 1 and PGY 2 residents rated their confidence as increased after the session, while only 25% (four out of 16) of the PGY 3 and PGY 4 residents did so. The knowledge of the steps of the procedure and instrumentation improved for all levels of trainees ($p < .001$).

Table 2. Posttest Results

Question	n (%)			
	PGY 1	PGY 2	PGY 3	PGY 4
How helpful was the simulation experience				
Not at all	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Somewhat	0 (0%)	0 (0%)	1 (14%)	1 (13%)
Very	9 (100%)	8 (100%)	6 (86%)	7 (87%)
Confidence with the steps of the procedure				
Not at all	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Somewhat	8 (89%)	8 (100%)	5 (71%)	1 (13%)
Very	1 (11%)	0 (0%)	2 (29%)	7 (87%)
Confidence with the instrumentation				
Not at all	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Somewhat	9 (100%)	5 (63%)	4 (57%)	0 (0%)
Very	0 (0%)	3 (37%)	3 (43%)	8 (100%)
Knowledge score: <i>M</i> (range)	3.20 (0-4)	3.75 (3-4)	4.00 (4-4)	3.88 (3-4)

Since the initial study period, there have been several requests from residents to use the model again prior to an upcoming surgical rotation. To make this model more uniformly available, the decision was made to incorporate it into resident educational activities at the beginning of each gynecology rotation.

Discussion

This AH simulation session and associated didactic were effective in improving the confidence of participating residents. All residents demonstrated improved knowledge following the session, and the experience was extremely well received with 94% rating it as very helpful. The noted impact on resident confidence with AH was greatest in the PGY 1 and PGY 2 years, which is plausible given that these residents were the least experienced with the procedure prior to the session.

It is clear from published data that practicing a skill in a simulation environment is well received by learners, and reduces errors.⁴ We believe that efforts need to be made to develop and validate AH simulation models so that learners can move more quickly through the stages of procedural learning. Low-fidelity models are of particular value given that they are easier to implement without financial constraints.⁵ This model accomplishes the desired goal of improving surgeon confidence through a low-fidelity simulation experience.

A strength of this study is that the described model is inexpensive and easy to assemble and reassemble, and can be implemented in any training setting. Another strength of the study is that we were able to evaluate its impact across all levels of training within a relatively large training program, giving us data on 32 residents' experiences. Additionally, the entire session was only 1 hour long, making the simulation easy to incorporate into scheduled resident education sessions.

A limitation of the study is that the only participating residents were from a single residency training program, making the results potentially limiting generalizability. Also, we measured confidence, which is a subjective measurement. It would have been possible to have an observer rate the skills performed; however, this type of evaluation is limited in the low-fidelity environment. Furthermore, we sought to measure the impact of the model on the residents' confidence with the procedure because we hypothesized this would best reflect the residents' preparedness for the operating room.

An area for future research would be to evaluate the utility of the AH simulation as a teaching tool. The impact of the simulator on senior residents' confidence was not as great as it was on that of the junior-level residents, but the simulator may be a great tool for senior-level residents to practice their teaching skills, thereby further solidifying their procedural knowledge. Additionally, faculty could evaluate the authenticity of the model to add to the validity of the simulator experience.

In conclusion, this low-cost, low-fidelity model showed increased resident surgeon confidence with the steps and instrumentation needed to complete an AH, particularly in the junior years of training. This model could be implemented in most training settings and could assist in the development outside the

operating room of skills that can help learners progress more quickly in their operative learning. This is particularly valuable given the nationwide decreasing exposure to AH during residency training.

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Disclosures

None to report.

Funding/Support

None to report.

Ethical Approval

This publication contains data obtained from human subjects and received ethical approval.

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Received: May 15, 2017 | **Accepted:** September 8, 2017 | **Published:** September 29, 2017