11 Simulation Modalities for Obstetrics and Gynecology

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Introduction

Simulation is a key teaching modality used in obstetrics and gynecology (Ob/Gyn) at various levels of training across the country. Obstetrics, in particular, is a field in which emergency situations frequently arise, requiring the cooperation of various players in the healthcare model to deliver high-quality patient care [1]. As such, teamwork training is especially important in this field, as it provides the opportunity for multidisciplinary training and can be used to improve communication between a diverse group of learners. In contrast with teamwork training, skills-based simulation is important for providers to hone procedural skills outside the clinical setting. The simulators used to teach such skills can range from low-fidelity models made with common household items to high-fidelity models sold by various biomedical companies that closely approximate human anatomy.

A diverse group of healthcare providers are involved in providing care in this field, including medical students, residents, nursing staff, advance practice clinicians (e.g., physician assistants, nurse practitioners), and attending physicians. Simulation education in this field thus must endeavor to reach a wide range of learners at differing skill levels. While simulation has been demonstrated to be beneficial to medical education at all levels of training, there are certain considerations that limit the widespread implementation of simulation in Ob/Gyn. Financial constraints are of particular importance, as some simulators can exceed $100,000. Additionally, there may be space limitations at many institutions that restrict the ability of educators to establish and maintain a dedicated space for simulation training. Finally, there is the issue of availability of knowledgeable staff members who are trained in assessment, debriefing, and design and implementation of a simulation curriculum.

In this chapter, we will review the various modalities of simulation in Ob/Gyn. Task and box trainers, while more simplistic in their design, allow the learner to focus on specific skills, while full-body mannequins can be used together with multidisciplinary teamwork training to emphasize communication and teamwork. Virtual reality and robotic trainers are high-fidelity task trainers that more realistically resemble clinical scenarios to improve skills and technique. The use of cadavers, a fundamental part of the general medical school curriculum, allows the learner to hone surgical skills and

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acquire a better understanding of human anatomy. Finally, standardized patients provide learners with the opportunity to interact with a live person to role-play specific scenarios ranging from obtaining a history to delivering bad news.

Key Learning Points
This chapter will demonstrate the wide range of simulation modalities that exist for medical education and training, allowing instructors to teach virtually any skill or competency. The specific simulator used will depend on the goal to be achieved and can be selected based on available resources at an institution.

Body

Background

While initially used in aviation and military training, simulation-based training has quickly become a key training modality in most medical disciplines [2]. Removing live patients to focus on clinical skills allows the learner to make mistakes in a risk-free environment. Simulation has been identified as a useful tool to help prevent medical errors and improve patient safety. Simulation also allows for repetition as a teaching skill, permitting the learner to develop motor skills and muscle memory necessary for many common tasks while protecting real patients from the risk of novice learners. Additionally, it can be used as an assessment tool, aiding observers in the evaluation of learners of various skill levels [3].

Simulation and Medical Training

Simulation-based training has been shown to be effective at various levels of medical training [3]. For medical students who otherwise would have their first patient encounters on the wards, simulation allows honing of technical skills and interpersonal communication prior to an in situ clinical interaction. Simulation creates a safe learning environment in which errors are not life-threatening and controlled clinical interactions can be used as a teaching device through the use of reflection and discussion [4]. A standardized teaching environment also allows learners to complete tasks and demonstrate proficiency in a reproducible clinical setting that does not vary based on individual patient characteristics. Medical students exposed to simulation training prior to the start of their clinical Ob/Gyn clerkship have demonstrated better technical skills, higher scores on cumulative examinations, and increased levels of confidence compared to students who received traditional lecture-based instruction [5–7]. This confidence translates into increased participation on the clinical side, with simulation-trained students demonstrating more active involvement in real-life clinical encounters [8]. Specifically, high-fidelity models have been shown to improve students' understanding of the pathophysiology of labor and of intrapartum procedures, when compared to low-fidelity models [9].

In graduate medical education, work hour restrictions have limited the clinical exposure residents receive, especially for rare but high-risk events. The use of simulation allows residents to acquire the skills and knowledge necessary to manage infrequent clinical scenarios that require quick intervention [10]. Ob/Gyn residents taught with the use of simulation have been found to be better equipped to handle obstetric emergencies including postpartum hemorrhage and shoulder dystocia [3, 11]. The use of box trainers has similarly shown improved surgical performance in the operating room [12]. Simulation can also be used for evaluation of technical skills in consideration of promotion to the next year of training [13]. Additionally, simulation has been utilized for remediation during residency training, and it has been considered for integration into licensure and reentry programs for attending providers [14].

Implementation of a Simulation Program

Several key elements are necessary prior to the implementation of a simulation program. Identifying and securing a facility in which to carry out simulation training is one of the first steps. While task and box trainers take up relatively little space, full-body mannequins and cadavers must have dedicated storage space and skilled maintenance staff. Virtual reality and other high-fidelity models require regular upkeep and system upgrades from time to time. If training is to be carried out in situ, there remains the issue of storage and maintenance of materials.

A dedicated simulation team is also an important consideration in creating a simulation program. Trained and motivated faculty members are a necessity to develop and conduct simulation training sessions properly. Since simulation is a teaching modality that can be applied to a diverse group of learners, it is important to create a robust curriculum that includes modules ranging from novice to expert level. In addition to faculty, a simulation center benefits from trained staff that are knowledgeable about assembling modules, conducting simulation programs, leading debriefs, and maintaining equipment. A regularly scheduled program (i.e., monthly sessions) and protected time, both for faculty and learners, are also helpful to provide adequate exposure to and opportunity to use the available devices.

Cost remains a significant barrier to widespread implementation of simulation training in undergraduate and graduate medical education. Equipment can be purchased from any of a number of large simulation companies. Low-fidelity models have the benefit of being affordable, requiring little or no maintenance, and being simple to understand and use. High-fidelity models, on the other hand, such as full-body mannequins that can respond to interventions such as medication administration, are often prohibitively expensive and require high-level familiarity with the device to properly execute its functions [2].

Research on the effectiveness of simulation in improving patient safety may be limited by quantity of quality studies, but several of those in the literature undeniably support the use of simulation to improve patient safety. Draycott et al. showed that neonatal outcomes improved following simulation-based training for shoulder dystocia. They were able to show a positive effect of simulation-based training on patient safety through a 51% reduction in the 5-min Apgar <7 [15]. Phipps et al. reviewed an 18-month period after simulation-based team training and saw improvements in patient outcomes, teamwork, and communication, in addition to enhanced perceptions in patient safety [16]. Another example of quality research comes from Pratt et al., who did a Joint Commission study that prospectively collected perinatal morbidity and mortality data from three hospitals, one of which implemented TeamSTEPPS only, one that implemented TeamSTEPPS with simulation, and one that did not implement a safety program at all. For the hospital that did TeamSTEPPS with simulation, there was a statistically significant and persistent reduction of perinatal morbidity by 37% when comparing pre- and post-intervention data [17].

Simulation Modalities in Ob/Gyn

Various models, ranging from low-cost box trainers to sophisticated virtual reality devices, exist for the simulation of skills in medicine, a wide variety of which can be applied to obstetrics and gynecology.

Task Trainers

Task trainers represent the most basic of simulation modalities yet can reliably teach specific procedural tasks to both new providers and those wanting to improve upon existing skills. Commonly used task trainers in Ob/Gyn include the use of a hemi-pelvis for teaching delivery techniques such as vacuum and forceps application, beef tongue or chicken breast for practicing cervical conization procedures, and papayas for simulating manual vacuum aspiration procedures. While often simplistic in their construction, these training devices are inexpensive and intuitive, and many of the supplies can be purchased at easily accessible stores such as grocery stores and craft stores.

Box Trainers

Box trainers approximate the surgical field as a low-fidelity model and provide a setting in which laparoscopic skills can be practiced and enhanced. From simple skills such as peg transfer to more complex techniques like intracorporeal knot tying, learners can gain a number of important skills and additionally benefit from repetition of action. Such trainers allow for the use of real laparoscopic instruments, which helps to replicate the clinical environment with haptic feedback and depth perception. Like task trainers, box trainers can often be created at home using inexpensive items including a box, light bulb, webcam, and home PC or laptop.

Box trainers provide the benefit of being small and portable, allowing learners to practice at home or in the hospital at their own convenience. Performance on box trainers, however, is limited by external evaluation by qualified staff members, and individual scoring is thus vulnerable to inter- and intra-observer differences [18]. Additionally, box trainers tend to have lower anatomic and haptic fidelity than other modalities.

Virtual Reality Trainers

Virtual reality (VR) trainers incorporate both a physical handpiece and a computer-based program to mimic surgical procedures. Utilizing sophisticated software, VR trainers register all movements and are able to provide precise and objective results, aiding evaluation of a trainee's performance. This feedback allows trainees to monitor their performance and focus on self-improvement. VR trainers emphasize hand-eye coordination, manual dexterity, and economy of motion while providing familiarity with instruments and surgical sequence of events [2].

VR can be used to teach basic surgical skills, including laparoscopic suturing and knot tying, and to simulate full clinical scenarios when employed with an anatomically correct mannequin. Haptic feedback can be incorporated into the handpiece but has not been widely utilized to date [19]. Several iterations of VR trainers exist, which each generation incorporating different levels of sophistication. First-generation VR simulators involve the manipulation of abstract objects in space for the development of physical skills, while second-generation trainers incorporate anatomic structures, thereby making the simulation more clinically relevant. Third-generation VR trainers combine advanced software programs with an anatomic mannequin to create a more realistic model that approximates a surgical setting. Finally, fourth-generation VR trainers combine didactic instruction with hands-on skills practice to create an all-encompassing model to improve surgical competence, including both physical skills and decision-making [2]. These include the commercially available models LapSimGyn® (Surgical Science Sweden, Göteborg, Sweden), SimSurgery® (Simsurgery, Oslo, Norway), and Simbionix® (Simbionix-Baker, Cleveland, OH, USA). Hybrid models incorporate box trainers with VR technology to enhance the training environment with real instruments and physical materials, such as ProMIS® simulator (Haptica, Boston, MA, USA).

VR trainers have demonstrated performance differences between intermediate and expert surgeons, lending construct validity to these models [20]. The same study showed improvement of learners' skills, leading to shortened procedure time. A randomized controlled study by Larsen et al. also demonstrated shorter time to achieve competency when trainees used VR combined with traditional clinical training, compared to traditional training alone [21]. Additionally, a Cochrane review suggested that VR training leads to shorter operating time, fewer errors, and better economy of motion in novice laparoscopic surgeons [22]. Studies have not, however, demonstrated a specific benefit to VR trainers, as learners have been noted to perform at a similar level on the less expensive box trainers with regard to task completion times and number of errors made. Further research remains to be done to determine the predictive validity of these systems.

A limitation to VR devices remains with regard to cost, as such devices are extremely expensive (in excess of $100,000). Additionally, such models require maintenance and periodic upgrades, both of which incur additional expenses.

Robotic Simulators

As robotic laparoscopic surgery becomes more common, there is a need for specific simulation training in this modality. Robotic equipment differs from traditional laparoscopy in that it provides a three-dimensional view and surgeons utilize a console at which one can sit while operating [23]. Robotic instruments provide greater range of motion compared to laparoscopic instruments and eliminate the fulcrum effect, in which surgeons move in directions opposite to that of the instrument. Robotic surgery eliminates haptic feedback, however, which represents a significant disadvantage for those familiar with traditional methods. Additionally, achieving master-level skills in robotics requires a significant investment of time in training [24]. Some of the robotic system manufacturers do provide a simulator of sorts for training purposes. This is often an additional pack that can be placed on the actual robotic system that allows for simulated practice. The cost of such add-ons to the robotic system represents an additional barrier, as the baseline da Vinci Surgical System® (Intuitive Surgical, Sunnyvale, CA, USA) costs over $1 million.

Mannequin Trainers

Full-body mannequins can be employed in Ob/Gyn simulation training. Specifically, they can be used to simulate obstetric emergencies before, during, and after delivery, including such as a maternal code, postpartum hemorrhage, and eclampsia. The system includes vital sign and external fetal monitoring systems. Other mannequin-based systems can be used to simulation gynecologic clinical scenarios, such as intraoperative hemorrhage. These high-tech devices exist in wireless forms, can be programmed for a particular clinical scenario, and are fully responsive to interventions [2]. Mannequin trainers have the benefit of more closely approximating the natural clinical setting compared to less sophisticated modules. Such mannequin-based devices can be cost prohibitive, however, with expenses exceeding $100,000, and require a dedicated storage location, given their large size. Portable devices are becoming increasingly common, which allows for more widespread access to training drills using these mannequins.

Part-task trainers (PTTs) represent a mannequin-based simulation device that replicates an anatomic structure to practice a specific procedural skill, such as cervical cerclage or labor cervical examination [25]. These devices have the advantage of lower cost and smaller size compared to full-body mannequins. PTTs vary in their fidelity, depending on the materials used in their construction.

Cadaveric Trainers

Cadavers, a mainstay of medical education since the sixteenth century, have been deemed the gold standard of surgical training prior to clinical encounters. Cadaveric training is similarly used in Ob/Gyn for ex vivo procedural skill practice, including lymph node dissection and repair of pelvic floor disorders. These models have the benefit of exact representations of human anatomy but are limited by cost, availability, degradation, and the possibility of disease transmission [2]. There are also limitations to the storage and usage of human tissue in some simulation labs, thus creating another barrier. The physical space that stores and utilized human cadavers must be to a certain standard regarding handling of human tissue.

Standardized Patients

Standardized patients (SPs) are trained individuals who portray a patient to teach and evaluate clinical skills in a simulated environment. Commonly used in medical schools nationwide and a prominent part of the United States Medical Licensing Exam (USMLE), SPs help trainees to perfect their bedside manner and exam technique through feedback from an impartial observer [2]. Interactions with SPs can also be used to explore difficult topics and practice counseling techniques for less common clinical scenarios. These encounters can also be videotaped and later reviewed by a larger group in a debriefing session.

The use of SPs is advantageous in the authentic nature of interacting with a live human while protecting real patients. Additionally, SPs are able to simulate a diverse array of clinical scenarios, lending wide applicability of this simulation modality [2]. SPs can provide immediate feedback and are highly standardized, allowing for reduced bias in evaluation. Limitations to the use of SPs include cost (both for training and employment of SPs in an evaluative scenario) and restricted fidelity with regard to specific physical conditions.

Teamwork Training

In previous decades, efforts to improve patient outcomes typically focused on the individual provider level. However, many studies have demonstrated that complications and sentinel events most commonly result from communication failures [1, 15]. The Institute of Medicine's report *To Err is Human* recommended the use of simulation to promote a culture of patient safety and reduce errors [26]. In addition to promoting an individual's skill development, teamwork training has been demonstrated to improve communication between members of the healthcare team and improve overall team performance. Multidisciplinary team-based training, involving inter- and intraprofessional teamwork, can be carried out in a variety of settings to identify lapses in knowledge and training and determine best practices for specific units [27]. Implementation of such trainings on perinatal units, with or without simulation training, has been shown to decrease perinatal morbidity [17]. While most programs to date have focused on obstetrics, there also exists a need for teamwork training in a gynecologic surgery setting.

Summary

Simulation in Ob/Gyn is an exciting field with an active focus on developing new approaches to medical education and training. With a wide range of teaching modalities available, the opportunities for small group, multidisciplinary, and in situ simulation sessions are quickly expanding. While establishing curriculum and purchasing equipment can be a daunting prospect, simulation has repeatedly been shown to be beneficial at all levels of training while simultaneously promoting patient safety through improved communication and teamwork.

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