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Updates on Simulation in Obstetrical Anesthesiology Through the COVID-19 Pandemic



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KEYWORDS

- Obstetrical anesthesiology • High-fidelity simulation • Multidisciplinary team training
- Partial task trainers • Quality improvement • Competency assessment

KEY POINTS

- Simulation remains essential in the training and assessment of individuals and multidisciplinary teams in obstetric anesthesiology.
- Simulation plays an increasing role in evaluation of work environments, processes, and tools for patient care.
- The challenges presented to caring for obstetric patients during the COVID-19 pandemic revealed the utility of simulation in both training and workflow development.

INTRODUCTION

Simulation has played a critical role in medicine for decades as a pedagogical or assessment tool utilized at the levels of the individual, multidisciplinary team, and institution. The labor and delivery unit provides an ideal setting for leveraging the advantages provided by simulation given the variety of technical and clinical skills required by health care providers, the collaborative nature of patient care, the potential for unanticipated patient emergencies, and the consistent emphasis on quality improvement in patient care. A useful conceptual model for a survey of simulation in the field of obstetric anesthesiology discriminates the domains of training and assessment along an expanding continuum of learner cohorts: the individual, the patient care team, and the health care organization or environment. Prior reviews of this topic consistently have utilized this approach in surveying the literature on this topic.^{1–6} Given rapid advances in simulation technology and education, an update of simulation in obstetric anesthesiology is in order every few years. Simulation as a tool for training and assessment, however, has proved its utility during the COVID-19 pandemic as training programs and health care systems have been forced to navigate a radically altered learning and patient care environment requiring novel approaches to training and

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Anesthesiology Clin 39 (2021) 649–665
<https://doi.org/10.1016/j.anclin.2021.08.001>

anesthesiology.theclinics.com

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team-based care. This review continues in the tradition of surveying the newest literature on simulation training and assessment for individuals, teams, and systems while also providing a specific overview of the role of simulation in obstetric anesthesiology in the context of the COVID-19 pandemic and the shift toward the virtual learning environment accelerated by social distancing requirements during the pandemic.

SIMULATION-BASED INDIVIDUAL TRAINING AND ASSESSMENT

The practice of obstetric anesthesiology requires the acquisition of both technical skills and complex nontechnical clinical skills that extend beyond those to which anesthesiology trainees are exposed in the general practice of anesthesiology. Simulation technology can serve as a strategy for this skill acquisition. Partial task trainers (used to address a specific psychomotor or technical skill) and high-fidelity mannequin-based or virtual reality-based simulation (used to address clinical scenarios requiring complex multidomain skill acquisition) are both well described in the obstetric anesthesia simulation literature.

A variety of partial task trainers for spinal or epidural neuraxial technique training have been described and made available to educators. These have ranged from a simulator constructed from a balloon, intubation pillow, and slice of bread,⁷ to anatomically accurate manikin-based or computer-driven or haptic feedback-driven models allowing for trainee practice.⁸ A 2013 review comparing 17 manikin-based simulators to 14 computer-based models by Vaughan and colleagues⁸ notes that although manikin-based simulators are inexpensive, portable, and maintain a higher fidelity as a physical simulation of patient anatomy, computer-based models utilizing haptics provide real-time 3-dimensional screen-based visual feedback combined with a higher fidelity in the loss of resistance technique and better simulating tactile feel of encountering the ligaments, tissues, and bone involved in neuraxial technique. The ideal partial task trainer for neuraxial technique training would combine the physical and anatomic fidelity of manikins with the visuospatial feedback advantages and tactile fidelity found in computer-based models. More recently, haptics have been incorporated with virtual reality and gamification features^{9,10} in an effort to enhance skill acquisition and trainee motivation. The use of a virtual environment now can achieve a higher degree of fidelity in recreating the clinical environment while retaining the fidelity in the tactile sensation of spinal or loss of resistance technique that haptics can provide. Gamification (scoring points and achieving increasing experience levels) increasingly is incorporated into both partial task simulation training and more complex multidomain clinical skills acquisition.¹¹ Capogna and colleagues¹² asked novice trainees engaged in simulated epidural technique training to wear eye-tracking glasses. Although epidural procedure duration and number of attempts decreased following a simulation-based training tutorial, they also found a positive correlation between the number of needle-insertion attempts and gaze fixation counts along with a negative correlation between epidural attempts and gaze duration.

Over the past decade, an increasing volume of research has supported the use of high-fidelity manikin-based simulation for the anesthetic management of the maternal airway and obstetric emergencies. Exposure to high-fidelity simulation in conjunction with traditional lecture-based learning has been shown to enhance trainee performance in emergency management of an obstetric emergency requiring general anesthesia to the competency normally only seen in a fully trained faculty member utilizing a previously validated scoring system with significant retention 8 months following the initial assessment.^{13,14} A large volume of scenarios for anesthesia training for obstetric emergencies has been published for educators, including high spinal anesthetic level,¹⁵

maternal cardiac arrest,¹⁶ and a variety of other conditions.^{5,17,18} Clinton and Minehart provided a roadmap in 2020 for the development of comprehensive simulation curriculum for advancing clinical skills with the inclusion of sample scenarios (Table 1).

Simulation-based training has continued to show effectiveness in learning and retention of skills essential for the practice of obstetric anesthesiology, such as airway management during emergent cesarean delivery,¹⁹ recognition and management of high neuraxial blockade,²⁰ and management of a general anesthetic for cesarean delivery.²¹ The instruction of communication skills increasingly has been addressed through the use of simulation-based training. Raemer and colleagues²² explored the role of simulation in overcoming the traditional hierarchical mode of communication within the health care workspace. To promote the ability of residents to speak up on identification of inappropriate clinical behavior on the part of faculty obstetricians, anesthesiologists, and labor and delivery nursing staff, 2 simulated clinical scenarios were provided to allow for the practice of the advocacy-inquiry and 2-challenge inquiry techniques. They found an increase in appropriate challenging behavior from 27% to 67% following post-simulation exposure.²² More recently, Szmulewicz and colleagues²³ utilized interdisciplinary simulation-based training for the disclosure of a medical error to patients. This work showed trainees' improvement in both verbal and nonverbal communication skills with retention up to 6 months following the intervention.²³

Table 1
Sample obstetric anesthesia simulation scenario⁵

Characters	Narrative	Vital signs	
High spinal 1. Patient (mannequin) 2. Primary registered nurse 3. Primary physician Time, 0:00–2:00 min	32-year-old healthy G2P1 at 39 wk in labor, status post recent epidural placement	Blood pressure, 110/60 Heart rate, 90 Respiratory rate, 20 SpO ₂ , 98% on room air	[] Engage patient. [] Assess for pain or discomfort.
II Above, + Anesthesia Backup obstetrician Second registered nurse Resource nurse Time, 2.00–4.00 min	Patient begins to feel anxious and is having trouble breathing	Blood pressure, 100/60; dropping to blood pressure 60s/40s over 2 min Heart rate, 110; drops to 45 over 2 min Respiratory rate rises to 30 over 2 min SpO ₂ , 98%–88% Fetal late decelerations	[] Patient distress [] Call for help/backup. [] Verbalize hypotension, hypoxemia. [] Communicate critical event. [] Emergency manual examination and vital signs verbalization to group [] Shut off epidural pump. [] Initiate treatment of hypotension, hypoxemia.

(continued on next page)

Table 1 (continued)			
Characters	Narrative	Vital signs	
III Above, + Additional registered nurse support Second anesthesia Second obstetric provider Any available additional help Time, 4:00–8:00	Patient unresponsive, unconscious Event pause and discuss situation (mini-debrief) to ensure proper treatment (optional)	Blood pressure, 55/30 Heart rate 45; drops to 30 if not treated Respiratory rate falls to 0 when systolic blood pressure drops below 60 SpO ₂ , 88%; falls rapidly to 40% if not bag- mask ventilated and then intubated Fetal heart rate, prolonged deceleration	<input type="checkbox"/> Support hypotension/ anaphylaxis kit <input type="checkbox"/> Ambu bag and ventilate <input type="checkbox"/> Ventilation support/ hypotension management with epinephrine infusion or other appropriate available α -/ β -agonists <input type="checkbox"/> Communicate patient is unconscious (to team). <input type="checkbox"/> Verbalize fetal intolerance of hypotension. <input type="checkbox"/> Establish event manager. <input type="checkbox"/> Communicate possible causes of loss of consciousness and initiate plan for immediate care. <input type="checkbox"/> Code cart, defibrillator <input type="checkbox"/> Emergency manual
IV All team members Time, 8.00–10.00	Recovery with support	Blood pressure, 90/60 Heart rate, 70 Fetal recovery with restitution of maternal vital signs	End scenario with resuscitation and plan for supportive/ intensive care while spinal regresses

Advances in both Web-based and communication technologies increasingly have been integrated into simulation education for trainees, removing the need for both trainee and instructor to be in the same location. Telesimulation has become a tool to provide training of technical and nontechnical skills around the world. The use of telesimulation was described by educators in Canada to teach trainees in Botswana laparoscopic surgical technique with nothing more than a simple trainer box, a Web camera, and a laptop computer.²⁴ A randomized trial conducted by Sorenson and colleagues²⁵ in 2017 compared simulation-based obstetric anesthesia training in clinical management of an emergency caesarean section and a postpartum hemorrhage (PPH) scenario with in situ simulation versus off-site simulation. They found similar individual and team outcomes in patient safety attitudes, stress, motivation, perceptions of the simulations, and team performance while those receiving in situ simulation training did find a greater degree of fidelity than those receiving remote training. Given the success found in telesimulation-based training in both technical and nontechnical

clinical skills acquisition, remote teaching may be an exciting frontier for the teaching of neuraxial technique or anesthetic management of obstetric emergencies by international experts to trainees around the world. Recent work by Lim and colleagues,²⁶ showing that mental imagery training can be used to develop epidural anesthesia technical skills as effectively as low-fidelity haptic simulators, even may suggest that effective remote education could be provided with only a Web camera.

Simulation-based skills assessment has continued in line with advances in training. Kiwalabye and colleagues²⁷ assessed preparedness of anesthesia interns in managing a failed obstetric intubation following their anesthesiology rotation. They observed a pass rate of only 40% despite prior exposure to an Essential Steps in Managing Obstetric Emergencies training module, leading them to propose that this gap in skill acquisition discovered by simulated scenarios can be remedied through the use of simulation-based education during their training. An additional area in which simulation increasingly has been used in assessment lies in credentialing of those who have graduated from anesthesiology training programs. Since 2018, the American Board of Anesthesiology has included Objective Structured Clinical Examinations (OSCEs) as part of the APPLIED examination, including simulated interactions with patients. Although the technical and clinical components of obstetric anesthesia practice currently are not among the topics included in the OSCEs, communication with the parturient is addressed in modules assessing informed consent and communication of medical errors. This has led many programs to integrate OSCE training into their residency curriculum to better prepare trainees for the process of credentialing. Dabagh and colleagues²⁸ found an increase in the relative annual pass rate of anesthesiology residents following the integration of a preparation program, including mock OSCEs prior to the National Board of Anesthesiology certifying examination.

SIMULATION-BASED MULTIDISCIPLINARY TEAM TRAINING AND ASSESSMENT

Multidisciplinary team training for obstetric care and crisis resource management (CRM) has been well described in the simulation literature.²⁹ Although confidence in this approach as a means to improve patient outcomes has been shown by stakeholders, such as insurance companies, there has long been effort to link the utilization of simulation for team training to improvements in patient outcomes.³⁰ A recent review of simulation team training, including human factors components, has provided some insight into this long-standing goal of those engaged in the field. Five single prospective site studies investigating multidisciplinary obstetric simulation training, including CRM and reported outcomes in high-resource and low-resource countries, were identified.³¹ Two showed a 34% reduction in maternal mortality and 3 a 41% to 50% reduction in blood transfusion, whereas cluster analysis revealed a 17% reduction in PPH incidence and a 37% reduction on weighted obstetrics adverse outcomes. Furthermore, there was a 15% reduction in maternal mortality in favor of trained teams and a reduction of neonatal deaths from 24 weeks during the first 24 hours of 83% in intervention sites compared with an 18% increase in control sites. Lutgendorf and colleagues³² conducted 16 multidisciplinary simulated scenarios, including PPH over 2 days to assess team performance and operational readiness. A comparison of PPH incidents in their institution revealed a decrease in the time to prepare blood products over the course of simulation training and a trend toward a reduction in the incidence of PPH.³² These important results only increase the need for further work exploring the impact of simulation-based team training on obstetric patient and neonatal outcomes.

Although work continues in the field of developing simulation-based team training curricula,³³ several studies have investigated team behavior through the use of

simulation. A recent prospective observational study utilized individual personality testing to find associations with overall assessments of teamwork and communication in simulated management of PPH. The investigators discovered that a high degree of neuroticism among individual team members led to increased communication in a manner that was detrimental to overall team performance whereas other personality traits yielded no associations.³⁴ Capogna and colleagues³⁵ had team leaders of a simulated PPH scenario wear eye-tracking glasses to find associations between eye-tracking metrics of 27 selected areas of interest and team performance evaluated by a PPH checklist. Their group found that high-performance leader groups were associated with a greater duration of visual fixations as well as a more uniform distribution of gaze on team members compared with the low-performance leader groups. Methods of evaluating teams during obstetric emergencies, such as PPH, continue to evolve as more evidence is brought to bear on the importance of nontechnical skills, such as cognitive and social factors. Toward this end, Cheloufi and colleagues³⁶ employed a multidisciplinary Delphi method consisting of 4 cycles with 16 experts, including obstetricians, midwives, and anesthesiologists to create the Obstetric Team Performance Assessment Scale to be utilized during assessment of team performance during high-fidelity simulation exercises. This scale, based on expert consensus, emphasized the value of nontechnical skills, such as situational awareness and requesting help from the anesthesia team, in addition to traditionally identified checklist items, such as intravenous access and prompt activation of transfusion protocols. This work reflects the increased emphasis on the psychometric and social factors in the role of team performance being better understood through simulation.

SIMULATION-BASED ASSESSMENT OF THE WORK ENVIRONMENT AND PRACTICE METHODS

Hemorrhage remains a leading cause of death in parturients and an area of interest in developing protocols for quantification and management of blood loss. Simulation has been used effectively to assess the accuracy of different methods of blood loss quantification. The use of a pictorial guide as a means to assess blood loss during a simulated cesarean delivery was evaluated by Homcha and colleagues³⁷ comparing assessments of blood loss prior to and after use of the guide. Prior to use of the pictorial guide, they observed a more than 25% overestimation of blood loss, whereas use of the guide revealed an increase from 7% to 24% of accurate estimation defined as an estimate within 5% of the actual volume lost. Piekarski and colleagues³⁸ sought to compare a mobile colorimetric application for blood loss estimation with visual and gravimetric methods utilized by 53 anesthesiologists exposed to a simulated PPH scenario. They found the least deviation in estimates from the actual volume of blood loss among the colorimetric estimation followed by gravimetric and visual methods, whereas overestimation of blood loss occurred most in the visual estimation followed by the gravimetric and colorimetric methods.

The risk of chlorhexidine contamination of materials introduced to the neuraxial space motivated Taylor and colleagues³⁹ to conduct a simulated study to identify the incidence of transfer of chlorhexidine from the lumbar region to standard surgical gloves in a study simulating standard lumbar region antiseptic preparation. Their findings revealed an incidence of primary transfer above 99% up to 10 minutes following chlorhexidine application to the lumbar region of volunteers, with a 68.9% incidence of secondary transfer from gloves to another surface. To evaluate the effectiveness of current Society for Obstetric Anesthesia and Perinatology (SOAP) Patient Safety Committee proposals to utilize a cap and run approach (capping epidural and intravenous

lines to prevent tangling prior to transfer) to facilitate transport of patients from the labor room to operating theater during emergency cesarean deliveries. Mhyre and colleagues⁴⁰ utilized a prospective randomized in situ simulation study. They found no statistically significant difference in the time from decision to proceed with cesarean delivery to readiness for general anesthesia between groups, although qualitative analysis during debriefing did reveal some perceived advantages, such as bed maneuverability and a decrease in tangled lines.

Efforts in low-income and middle-income nations to decrease maternal mortality hold great promise, given the ongoing discrepancy with rates observed in high-income nations. Simulation continues to play a large role in both education and developing or assessing initiatives aimed at improving maternal care. Alexander and colleagues⁴¹ used the simulated setting to pilot test a context-relevant safe anesthesia checklist for cesarean delivery in East Africa. By comparing anesthesiologists providing care for a variety of conditions in the simulated environment with and without a checklist developed in conjunction with East African health care professionals, they found a significant increase in the completion of critical actions in the setting of preeclampsia and PPH. Gallardo and colleagues⁴² utilized the simulated environment and a randomized crossover design, including 10 trainees, to compare the performance of trainees in simulated high-resource and low-resource environments managing PPH from uterine atony. They found a significant decrease in performance by those exposed to the simulated low-resource environment, including both technical and nontechnical skills, including leadership, resource utilization, and communication.

SIMULATION IN OBSTETRIC ANESTHESIOLOGY DURING THE COVID-19 PANDEMIC

The COVID-19 pandemic has radically altered the landscape for clinicians and educators across the world, and the invaluable role of simulation came to the fore in the field of obstetric anesthesiology. With direct patient contact and in-person teaching limited by social distancing requirements and infectious risk mitigation, simulation provided opportunities for medical students and anesthesiology trainees to learn both technical and nontechnical clinical skills. To accelerate education for management of critical events in the context of patients infected with COVID-19, high-fidelity simulation-based individual and team training proved invaluable. Most importantly, with the need to develop new work environments and processes, simulation technology served to test their feasibility and prepare health care systems and medical staff.

Trainees found their ability to attain obstetric anesthesiology skills and knowledge limited by the fact that patient care brought a level infectious risk not previously common to the labor and delivery unit. In-person teaching also was impacted by requirements for social distancing imposed on training programs. Although the surgical volume elsewhere in hospitals decreased profoundly by the cancellation or delay of all but the most urgent surgical procedures, such measures could not be taken in labor and delivery units, and the need for clinical care remained relatively unaffected. Training programs leveraged simulation technology, such as partial task trainers, to provide exposure to neuraxial technique given the need for personal protective equipment (PPE) during patient interactions and limited exposure to parturients with known or suspected COVID-19.⁴³ Simulation also was described as a mechanism for training difficult airway management, PPE protocols, aseptic technique, and airway management. Virtual reality with gamification features also was described as a tool for approaching the maternal airway.

Previously routine interactions with patients changed dramatically during the pandemic, necessitating rapid training of health care providers to mitigate the risk of infection to providers and patients. Professional societies turned to in situ

multidisciplinary simulation as a resource for physicians and other health care professionals early in the pandemic. The American College of Obstetricians and Gynecologists Simulations Working Group created 4 standardized scenarios for use to guide multidisciplinary teams in patient interactions during the pandemic: (1) an obstetric patient with suspected COVID-19 presenting in labor; (2) an obstetric patient with suspected COVID-19 progressing in labor to spontaneous vaginal delivery, (3) an

COVID19 LABOR TO CESAREAN DELIVERY: CASE FLOW AND FACILITATOR'S GUIDE

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Notes to facilitators:

- Please feel free to drill any relevant part(s) of this and omit those parts that are not relevant.
- Please modify anything that does not align with your institutional guidelines.
- Consider holding small sessions (≤6 people) and/or hosting virtual sessions using filmed footage to talk through considerations with a larger team
- Consider prioritizing PPE when holding drills for the first time, and adding in additional components later (such as the support person, etc.)
- Please note that the focus of this packet of drills is not to be physiologically representative of any particular clinical situation; rather, it is meant as a platform to practice teamwork and organizational skills

SCENARIO Synopsis to orient participants:

- Cori Vidman is a 30 yo G2P1 female at 37w2d who presents to triage in active labor after ROM.
- Her PMH includes asthma, h/o rapid first labor, and recent onset of cold-like symptoms. No known COVID19 exposures.
- She is requesting labor analgesia but has not been seen by an obstetrics/midwife provider yet (if starting in triage).
- She needs evaluation, assessment, and treatment.

Equipment needed:

- Mannequin or standardized patient/actor (for mother); (optional: standardized patient/actor for support person for Part 4)
- Neonatal mannequin/trainer (if doing neonatal scenario)
- Space for using as triage bed, labor room, OR as needed
- Plan for PPE—consider using props (e.g., handkerchiefs or facial tissues/Kleenex taped to ears for masks, patient robes worn backwards for gowns, likely can use gloves as these are not generally on shortage—otherwise, consider miming all donning/doffing or using lanyards to denote PPE items)
- Appropriate monitors for settings, appropriate equipment for OR (can mime for surgical equipment, but will likely need anesthetic equipment if possible, and airway equipment if performing intubation/extubation)

OVERALL FLOW

Time		Key Scenario Points	Ideal Actions
Pre-drill	Orient Participants to patient in triage area	<ul style="list-style-type: none"> • Patient is in triage bed (mannequin vs standardized patient/actor) 	<ul style="list-style-type: none"> • Orient team members to drill environment • Discuss use of props/miming to conserve PPE and other equipment
Part 1: Triage eval	<p>Patient in active labor</p> <p>Participants involved (as per institution): OB/CNM, RN, anesthesia provider to assess respiratory status</p>	<ul style="list-style-type: none"> • Patient coughing, in active labor • (Patient may have mask on if available through regular entry points) <p><u>Maternal baseline vitals:</u> BP: 120/50 HR: 112 O2 Sat: 92% on RA (goes to 95% on any O2) RR: 21 Temp: 99.9F; FHR: Category I tracing</p> <ul style="list-style-type: none"> • Relevant history: symptoms started a week ago; her toddler had a playdate around that time and maybe the other 	<p>Clinical:</p> <ol style="list-style-type: none"> 1. Correct donning of PPE outside of triage room according to institutional guidelines (**consider practicing with props or having people mime steps rather than using actual PPE**) 2. (Correct contactless passing of mask to patient if she has no mask on; again, consider practicing with props or miming) 3. Confirm patient identity and perform focused history and physical exam (may discuss airway exam depending

Fig. 1. Covid 19 labor to cesarean delivery: case flow and facilitator's guide. BP: blood pressure, BPH: Beats per minute, CNM: Certified Nurse Midwives, C/D: cesarean delivery, Cm: centimeters, ETT: Endotracheal tube, EtCO2: End tidal carbon dioxide, EBL: Estimated blood loss, F: Fahrenheit, FHR: Fetal Heart Rate, GA: General Anesthesia, HR: Heart rate, NICU: Neonatal intensive care unit, NMB: Neuromuscular blocking agents, OB: obstetrician, O2 sat: Oxygen saturation, OR: operating room, O2: oxygen, PAPR: Powered Air Purifying Respirators, PPE, personal protective equipment; MP: Mallampati, RN: registered nurse, RR: Respiratory Rate, RSV: Respiratory syncytial virus, RA: Room air, TOF: Train of four.

		<p>family has some people with colds. Otherwise, she feels her asthma is exacerbated recently, and thinks it may be due to allergies.</p> <ul style="list-style-type: none"> • Relevant physical exam: cervical exam is 6cm/90%/-1 station (hand paper with written exam to OB/CNM). Airway exam (if done—this may be a point of discussion) shows MP 3, otherwise favorable airway features. Lung exam demonstrates diminished sounds at right base. Other findings normal. • During contractions, once surgical or oxygen mask is placed, patient may occasionally remove surgical/oxygen mask but will respond to replace mask if asked by staff <p>PAUSE AND DISCUSS AT ANY POINT DURING CASE TO HIGHLIGHT GOOD BEHAVIORS OR HAVE PARTICIPANTS REDO</p>	<p>on institutional guidelines)</p> <ol style="list-style-type: none"> 4. Apply oxygen to patient 5. Obtain influenza, RSV, coronavirus swabs <p>Behavioral:</p> <ol style="list-style-type: none"> 1. Clear communication between staff members to coordinate entry into triage room 2. Clear role delineation and plan to move patient to labor room 3. Updates to labor room to coordinate receiving patient 4. Encourage patient to keep mask on (perhaps even designate someone to watch this to limit spread) 5. Clear communication to others at an institutional level that a patient with possible COVID19 is present (per institutional policies) 6. (Optional: Team can Name/Claim/Aim to orient participants to situation and organize their team's activities)
<p>Part 2: Triage to labor room</p>	<p>Patient needing transport</p> <p>Participants (as per institution): [insert appropriate participants]</p>	<ul style="list-style-type: none"> • Patient being transported to labor room, needs to be counseled to keep mask on (surgical or oxygen mask, depending on what has been placed—can be discussed that oxygen mask may not protect others) • (Optional: Patient's support person arrives on labor floor, is a close contact of patient) <p><u>Maternal vitals in labor room:</u> BP: 131/72 HR: 125 O2 Sat: 92% on RA (goes to 95% on any O2) RR: 21 Temp: 99.9F; FHR: Category 2 tracing</p> <ul style="list-style-type: none"> • Patient still contracting, will remove mask if not counseled • Patient arrives in labor room, requests anesthesia provider for neuraxial placement • Cervical exam on entry to room is 7cm/100%/0 station <p>PAUSE AND DISCUSS AT ANY POINT DURING CASE TO HIGHLIGHT GOOD BEHAVIORS OR HAVE PARTICIPANTS REDO</p>	<p>Clinical:</p> <ol style="list-style-type: none"> 1. Correct transport with minimal patient/personnel exposure in clinical environment 2. Correct donning of PPE outside of labor room with providers either awaiting patient inside room or outside room (according to institutional guidelines) 3. (Optional: Correctly giving support person a surgical mask) 4. (Abbreviated anesthesia consent is appropriate here for sake of time with the drill) <p>Behavioral:</p> <ol style="list-style-type: none"> 1. Clearly defining limited staff on entry to room 2. Encouraging patient to continue to keep mask on 3. (Optional: Team can Name/Claim/Aim to orient participants to situation and organize their team's activities)
<p>Part 3: Fetal brady, transfer to OR</p>	<p>Patient with recent neuraxial analgesia, getting comfortable, with nonreassuring fetal status</p>	<ul style="list-style-type: none"> • Patient now getting comfortable after neuraxial placement, still with some discomfort (low suprapubic) 5 minutes after anesthetic initiation • FHR then drops to 80 BPM with recurrent late decelerations (Category 3 tracing) without uterine hyperstimulation 	<p>Clinical:</p> <ol style="list-style-type: none"> 1. Early dosing of neuraxial for C/D to avoid need for intubation 2. Correct donning of PPE for all providers necessary for care 3. Correct transport and personnel involved in moving patient into the OR while minimizing exposure of others

Fig. 1. (continued).

	Participants (as per institution): [insert appropriate participants]	<p><u>Maternal vitals at this time:</u> BP: 108/50 HR: 126 O2 Sat: 92% on RA (goes to 95% on any O2) RR: 21 Temp: 99.9F; FHR Category 2→3</p> <ul style="list-style-type: none"> • Cervical exam is 8cm/100%/0 station <p>PAUSE AND DISCUSS AT ANY POINT DURING CASE TO HIGHLIGHT GOOD BEHAVIORS OR HAVE PARTICIPANTS REDO</p>	<p>4. Consider the role of preparing to use N95/PAPR for the entire team in case of general anesthesia/intubation</p> <p>Behavioral:</p> <ol style="list-style-type: none"> 1. Clear communication to teams to ready equipment in the OR 2. Clear role delineation when organize to move patient 3. (Optional: Team can Name/Claim/Aim to orient participants to situation and organize their team's activities)
Part 4: STAT C/D and conversion to GA with intubation	<p>Patient with inadequate level of anesthesia, needing to convert to GA with intubation</p> <p>Participants (as per institution): [insert appropriate participants]</p>	<ul style="list-style-type: none"> • Patient in OR, fails level (level at T10 bilaterally) *or* patient with adequate level but complains of pain with incision <p><u>Maternal vitals at this time:</u> BP: 108/50 HR: 126 (goes to 100 with any phenylephrine) O2 Sat: 92% on RA (goes to 95% on any O2→ can go to 99% on 100% O2 with preoxygenation, over 8 breaths) RR: 21 Temp: 99.9F; FHR Category 3 (still 80 BPM if checked)</p> <ul style="list-style-type: none"> • Cervical exam is 8cm/100%/+1 station • (Optional, depending on institutional policies): Patient's support person needs a plan—whether this person is already in the OR by now, or whether this person needs to be updated is up to the facilitators <p>PAUSE AND DISCUSS AT ANY POINT DURING CASE TO HIGHLIGHT GOOD BEHAVIORS OR HAVE PARTICIPANTS REDO</p>	<p>Clinical:</p> <ol style="list-style-type: none"> 1. Correct PPE of ALL TEAM MEMBERS prior to preoxygenation (according to institutional guidelines) 2. Correct equipment ready to prepare for any difficulty in intubation (e.g., videolaryngoscopy) 3. Preoxygenation with lowest O2 flows possible, and with HEPA filter 4. ETT cuff inflated prior to positive pressure ventilation <p>Behavioral:</p> <ol style="list-style-type: none"> 1. Clear communication around the time of intubation to coordinate help and steps 2. Clear role delineation when initiating general anesthesia 3. Clear communication of now-contaminated areas, with steps to minimize further contamination of personnel 4. (Optional: Description of conversation with support person, and clear communication to support person in labor room, or removal of support person from OR) 5. (Optional: Clear communication with support person of isolation protocols for neonate, per institutional guidelines) 6. (Optional: Team can Name/Claim/Aim to orient participants to situation and organize their team's activities)
Part 5: Neonatal resuscitation and transport	<p>Patient under general anesthesia, neonate requiring resuscitation and transport to NICU/isolation (per institution)</p> <p>Participants (as</p>	<ul style="list-style-type: none"> • Patient stable during delivery, under general anesthesia <p><u>Maternal vitals at this time:</u> BP: 108/50 HR: 107 (goes to 100 with any phenylephrine) O2 Sat: 97% on 100% O2→ 94% if nitrous oxide used RR: (set by ventilator)—can be 15, EtCO2 is 28 Temp: 99.9F EBL: 800mL, good uterine tone</p>	<p>Clinical:</p> <ol style="list-style-type: none"> 1. Correct PPE of all team members in OR and caring for neonate 2. Correct neonatal resuscitation personnel available in OR 3. Correct equipment and isolation procedures demonstrated while preparing to transport neonate (per institutional guidelines) 4. Correct transport out of OR while minimizing contact with neonate (per institutional guidelines)

Fig. 1. (continued).

	per institution): [insert appropriate participants]	<p>Neonate at delivery: Color: Blue/dusky color Heart rate: 80 Reflex irritability: No response Muscle tone: Limp Respiration: Absent</p> <p>APGARs at 1 & 5 minutes (with any resuscitation): Color: Acrocyanotic Heart rate: 130 Reflex irritability: Grimace Muscle tone: Some flexion Respiration: Weak Cry/Hypoventilation</p> <ul style="list-style-type: none"> • Neonate needs transportation/isolation (per institutional guidelines) <p>PAUSE AND DISCUSS AT ANY POINT DURING CASE TO HIGHLIGHT GOOD BEHAVIORS OR HAVE PARTICIPANTS REDO</p>	<p>Behavioral:</p> <ol style="list-style-type: none"> 1. Clear communication within neonatal team regarding care of neonate 2. Clear role delineation when caring for neonate 3. (Optional: Team can Name/Claim/Aim to orient participants to situation and organize their team's activities)
Part 6: Extubation, recovery, and disposition of patient	<p>Procedure complete, patient stable</p> <p>Participants (as per institution): [insert appropriate participants]</p>	<ul style="list-style-type: none"> • Cesarean delivery completed <u>Maternal vitals at this time:</u> BP: 128/70 HR: 125 O2 Sat: 97% on 100% O2 RR: (breathing spontaneously)—can be 21, EtCO2 is 28 Temp: 99.9F TOF: 0.9 (if additional nondepolarizing NMBs used) • At start of Part 6, all anesthetic agents are turned off, patient is making some movements indicative of emergence (but not following commands yet) • Patient then emerges normally, needs extubation (vitals do not change dramatically after extubation—SpO2 can drop to 95% on 100% O2 by oxygen mask) <p>PAUSE AND DISCUSS AT ANY POINT DURING CASE TO HIGHLIGHT GOOD BEHAVIORS OR HAVE PARTICIPANTS REDO</p>	<p>Clinical:</p> <ol style="list-style-type: none"> 1. Minimize personnel who are unnecessary during extubation 2. Correct PPE use (with N95/PAPR) 3. Consider decreasing oxygen flows during extubation or placing anesthesia machine on standby (per institutional guidelines) 4. Correct limiting of spreading contamination on surfaces related to anesthesia workstation 5. Correct moving of patient to appropriate recovery area (per institutional guidelines) <p>Behavioral:</p> <ol style="list-style-type: none"> 1. Clear communication and organization of team during extubation with warning others to stay back in case of patient coughing 2. Anticipating and planning for gathering all equipment needed for extubation and sequestering it prior to extubation 3. Clear communication of plan in case of airway obstruction 4. Clear communication of recovery and disposition plan with team (per institutional guidelines) 5. (Optional: Team can Name/Claim/Aim to orient participants to situation and organize their team's activities)
Post-drill	End Case	Clearly state, "Thank you so much—we are concluding this drill and will now focus on our debrief of the whole session."	
COVID19 Debriefing (suggested structure)			
Location: can be <i>in situ</i> or	<p>DEBRIEF Case:</p> <ul style="list-style-type: none"> • Reactions Phase 		

Fig. 1. (continued).

in a separate location	<ul style="list-style-type: none"> ○ "one word" to describe elicited emotion ● Move to "Plus/Delta" debrief <ul style="list-style-type: none"> ○ Two columns to discuss: Under "Plus" column are things that the team feel they did well, and under "Delta" column are things that the team could change or improve ○ Facilitators should find a few things that the teams did well to highlight to them, as participants are usually hard on themselves (and under a great deal of stress right now) ○ Facilitators can also make a column of "unanswered/new questions" that need to be addressed at an institutional level, with a promise to circle back with participants ● Move to "Take-aways" phase <ul style="list-style-type: none"> ○ Ask participants what they are taking away from the session today (this will serve as useful feedback for facilitators, and identify anything about the session that should be changed for the future) ○ Thank participants for joining ● Finally, pass out evaluations and collect them once everyone fills them out
End debrief	Thank them for participating!

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Fig. 1. (continued).

obstetric patient with suspected COVID-19 in labor requiring cesarean delivery; and (4) an obstetric patient with suspected COVID-19 requiring intensive care unit transfer due to worsening respiratory symptoms.⁴⁴ SOAP provided a scripted simulation scenario designed to guide teams through meeting a parturient with suspected COVID-19 team in triage, transport to a labor room and placement of a labor epidural, emergency cesarean delivery, induction, and recovery from a general anesthetic (Fig. 1).¹⁸ Simulation has been proposed as a mechanism for addressing novel scenarios brought about by the pandemic, such as donning and doffing of PPE, transport of infected obstetric patients, management of a second obstetric emergency when the team currently is caring for an obstetric patient, approaches to the delay of an emergency cesarean delivery due to infection prevention and control measures, and communication with patients or families about visitation policies impacted by infection prevention and control measures.⁴⁵ Simulation scenarios also have been described to include not only multidisciplinary care of the obstetric patient but also neonatal care based on variable maternal COVID-19 status and symptomatology and gestational age at the time of delivery.^{46,47}

The COVID-19 pandemic required major changes to not only workflow but also patient care areas in efforts to maximize infection prevention and control while providing patient care. Simulation served as the means for testing and revising these changes in real time throughout the world. Lie and colleagues⁴⁸ reported the use of plan-do-study-act cycles incorporating simulation to identify process threats, infection control threats, and equipment or PPE issues and then modified their COVID-19 patient care workflow based on their findings. Wong and colleagues⁴⁹ utilized

simulated drills to test the feasibility of changes to their operating room setup and workflow. Findings based on these drills led to the designation of an operating room coordinator to ensure adherence to the protocol they had developed. Muhsen and colleagues⁵⁰ describe major changes made to their maternity ward floor plan, introduction of radio communications, and increases in staffing following simulation training sessions in preparation for care of COVID-19 infected obstetric patients. Other groups describe the use of simulation as part of the development of anesthetic care-specific checklists and protocols, including labor analgesia, neuraxial anesthesia for cesarean delivery, conversion of a labor epidural to cesarean delivery, and general anesthesia for the obstetric patient.⁵¹ One group incorporated actual obstetric patients into live simulation drills by providing their care as if they were patients infected with COVID-19, to test preliminary protocols designed for care of obstetric patients infected with COVID-19, and cited positive reactions from the patients involved.⁵²

THE FUTURE OF SIMULATION IN OBSTETRIC ANESTHESIOLOGY

Although the COVID-19 pandemic served as a crisis that showcased the value simulation brings to education, training, and preparedness in the field of obstetric anesthesiology, the limits placed on human interaction due to social distancing requirements accelerated the shift in learning and communicating to the virtual environment. The seeds of this evolution in the world of simulation existed prior to the pandemic, and recent literature provides a rough sketch of the world of simulation that may come into existence in the future. A recent review of alternatives to high-fidelity simulation by Delisle and colleagues⁵³ describes many of the modalities that do not require in-person training with partial task trainers or high-fidelity manikin-based simulation. Tel-esimulation allows for remote observation of a simulation scenario with live remote debriefing extending the geographic reach of a single simulation session for learners separated by vast distances. Screen-based simulation removes the need for a live instructor through the use of automated facilitation and feedback mechanisms. Game-based simulation, much like screen-based simulation, removes the requirement of a live instructor but also incorporates motivational aspects that exist in popular single-player or multiplayer videogames and can incorporate both technical and nontechnical skills. Improvements in virtual reality technology will allow game-based simulation increasingly to approach or surpass the fidelity of existing manikin-based simulation technology. Benda and colleagues⁵⁴ utilized an obstetric scenario to compare the educational effectiveness of serious game training to high-fidelity manikin-based training. Groups randomized to manikin-based or serious game-based training prior to an assessment of performance in a high-fidelity manikin-based simulation scenario showed no difference in overall performance.

SUMMARY

Although the role of simulation in training and assessment of individuals, multidisciplinary teams, and the work environment in obstetric anesthesiology continued at the end of the second decade of the twenty-first century, the COVID-19 pandemic provided the ideal circumstances to reveal the unparalleled value simulation brings to training and preparation for emergencies, both locally and globally. Ironically, this turbulent period of pandemic health care, in which high-fidelity, team-based simulation has shone so brightly, likely will accelerate the transition toward alternative modes of simulation-based training and assessment through the increased use and capability of virtual platforms and screen-based learning environments.

CLINICS CARE POINTS

- Simulation in obstetrical anesthesia should continue to be utilized to teach and to assess the competencies of the individual, the group and the institution at large.
- The COVID-19 pandemic showcased the ability of simulation in obstetrical anesthesiology to evolve and to address new and unprecedented emergencies within the obstetric unit.
- Simulation in obstetrical anesthesia will continue to evolve as technology advances and as the world encounters new medical challenges.

DISCLOSURE

The authors have nothing to disclose.

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