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Simulated Crisis in Obstetric Anesthesia: Design and Evaluation of a Distance Education Presentation

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Abstract

Patient simulators are useful tools for training residents and all levels of medical personnel. Simulator usefulness, in small group sessions, is limited by the costs of training large numbers of people. We present an interrupted methodology designed to involve a large group at a location remote from the simulator. The goal was to enable the remote participants to take part in decision making while under time pressure.

Two volunteers were chosen as hands-on participants while eighteen remaining anesthesiology residents observed from a lecture room via a closed circuit audio/video feed. A series of five crises in obstetric anesthesia was presented. After each crisis the simulation was paused and the observers were given three minutes to formulate a differential diagnosis and plan to be carried out. At the end of the session facilitators led a debriefing session with all participants.

Surveys completed after the simulation indicated that most residents felt personally involved in the simulation, despite being physically removed from it. Surveys also showed that residents believed they learned more from this format than they would have from a lecture. Residents recalled an average of 3.4 crises two days after the session.

This paper presents a model for distance education using a simulator and shows that residents believed remote, interrupted, interactive simulator training is valuable. The interrupted nature and involvement of remotely located peers differentiate this methodology from a passive viewing of a remote session. Further study is warranted to quantify the effectiveness of group and/or distance training with a simulator.

Keywords: Simulation, Simulator, Education, Residents, Distance Education

Introduction

Patient simulators have been shown to be useful tools for training residents and other medical personnel[1]. The human simulator (Medical Education Technologies, Inc. – METI — Sarasota, FL) is conceptually

similar to the flight-simulators developed by the aviation industry. It is a programmable, computer-driven, driven, adult size mannequin allowing the application of previously learned principles into principles into simulated clinical practice. Programmable systemic and pulmonary vascular resistances, left and right heart, pulmonary shunt, as well as blood volume, venous capacitance, and cardiac valve resistances. The dependent features, such as blood pressure and cardiac output, are mathematically calculated based on the programmable physiologic parameters. The simulator responds appropriately to more than fifty medications as well as to inhaled gas mixtures (e.g.: hyperoxic, hypoxic, volatile anesthetic). Simulator features available to clinicians for examination and assessment include radial and carotid pulses, normal and abnormal heart and lung sounds, and chest movements caused by breathing. Standard monitors that may be selected include pulse oximetry, non-invasive blood pressure measurement, electrocardiogram, heart and respiratory rates, capnography, and temperature. Invasive monitors and waveform displays including arterial blood pressure, cardiac output, central venous pressure, and pulmonary artery pressure, may also be selected.

The simulator at the Penn State Milton S. Hershey Medical Center is housed in the Simulation Development and Cognitive Science Laboratory, which is supported by the Departments of Anesthesiology, Nursing, and Surgery. It is a 2,000 square foot dedicated learning laboratory designed to provide a realistic training environment. It houses a full-scale human simulator as well as anesthesia, operating room, and intensive care unit monitoring equipment.

The laboratory plays a role in the training of residents, particularly in the early stages of training. However, because of cost and time constraints, it is difficult to train large numbers of people with a simulator. Previous studies have addressed this problem. Cooper, et al.[2] presented a teleconferenced medical simulation to a large group. The group interacted with trained actors in the simulation laboratory as the simulation unfolded. Tooley, et al.[3] describe a tele-medicine/tele-education project intended to provide access to a simulation facility's resources in four distinct phases, one of which includes remote user participation in simulation but does not address group participation. Neither of the above mentioned studies focus on design aspects of simulation sessions; rather, they emphasize technical aspects of data transfer to remote sites and audience evaluations.

In this pilot study we aimed to address various design aspects of remote simulator sessions, and to see if resident participants would perceive such sessions as valuable. Differing from the methodology of Cooper et al.,[2] we used unrehearsed simulator volunteers, interrupted crisis scenarios and involved remote observers by compelling them to make diagnoses and management decisions under time pressure.

Methods

The present simulator session was presented as part of a series of weekly lectures on obstetric anesthesia to 20 residents in anesthesiology, ranging from the clinical base (CB) to the third clinical anesthesia (CA-III) years. Only one hour was available for the simulation. The residents were gathered in a lecture room adjacent to the simulator laboratory. Faculty facilitators were present in both rooms, which were connected by real-time audio and video. Two resident volunteers were taken to the laboratory to participate hands-on in the simulation session. Faculty, a registered nurse, and an anesthesia technician acted the parts of other operating room personnel. The participants in the lecture room were able to see and hear the comments of the participants in the laboratory as well as those of the facilitators, who verbalized blood pressures as they

were taken. Lecture room participants could also see and hear the mannequin and monitors. All facilitators used a separate wireless communication system with headsets and microphones to coordinate the simulation.

An actor, playing an anesthesiologist who had to leave the operating room because of a family crisis, gave a brief presentation of the scenario to the participants. The participants played the role of anesthesiologists assuming the care of a healthy parturient with an epidural having a Caesarian-section for failure to progress. Participants managed the anesthetic as five crises were presented (Table 1). After each crisis was presented, but before the participants in the laboratory could act, the simulation was paused, the audio and video links were suspended, and the two facilitators in the lecture room moderated a discussion among the residents in the lecture room. The residents and faculty in the laboratory had a similar discussion. In this three-minute period, residents were asked to develop a differential diagnosis, state the most likely diagnosis, and suggest actions to be taken. The information from the lecture room was relayed to the participants in the laboratory who then carried out the plan.

At the conclusion of the simulator session all residents were debriefed, and learning issues were discussed. On the second day following the session residents were asked to fill out surveys to evaluate the usefulness of the session (see Appendix 1). They had not been informed that these surveys would be distributed.

Results

The simulation was completed as planned, and survey questionnaires were completed by all twenty residents on the second day following the session. Not all questions were completed by all residents and totals therefore do not always equal twenty.

The response to survey question #1 is shown in Table 2. In response to question #2, “Please list the five obstetrical crises presented,” the residents remembered an average of 3.4 ± 0.8 scenarios (mean ± S.D.). The exact distribution of responses is shown in Figure 1. Half-points were given for answers which were partially correct (i.e. - mention of “a blood pressure problem” without specific reference to hypo/hypertension).

Responses to the survey questions shown in Table 2 were highly positive. Comments on the changes in practice mentioned by the residents included, “How to manage failed epidural with emergency switch to general anesthesia in labor and delivery setting.” “Don’t let surgeons distract you.” “Reinforced past experiences in obstetrics.” One resident wrote, “I have never seen an anesthetic crisis before. Now I have a much better idea how to approach it.”

The residents suggested a variety of other areas where they felt simulation scenarios to be useful. These included airway emergency (8), trauma (6), lithotripsy (1), outpatient surgery (1), pediatrics (1), cardiac (1), vascular (1), operating room emergency/code (1), ENT – airway fire (1). The number of residents suggesting each scenario appear in parentheses.

The answers to the question, “How interested are you in writing and participating in presenting a simulation scenario?”, elicited on a five-point descriptive scale, had the widest divergence (see Figure 2), but not a single resident was completely unwilling to participate.

Discussion

While fewer facts can be presented during a simulator session than during a lecture, practical demonstrations are thought to be effective teaching tools. Cognitive science teaches that presentation of multi-modality sensory data can affect learning positively, and that similarity between the environment in which learning takes place and that in which it is remembered can enhance recall.[4,5,6]

Traditional simulation sessions allow small groups to interact directly with the simulator. With large groups or with distance simulation, this is not possible. Less interaction and removal from the simulated environment could have a negative impact on the advantages of a simulator session compared to a lecture. Our simulator sessions were conceived as a method to train a large group of residents in a limited time period. The original plan was to have residents participate in small groups. As is the case in many simulation centers, our faculty and residents have only a limited amount of time available for didactic education. The session format was therefore modified so that a large group would be observing volunteers. To enhance realism we provided both audio and visual cues to the remote participants. We involved them as part of the decision making process by pausing the scenario and asking them to give advice within a three minute time limit. This was intended both to increase interactivity for remote participants and to avoid potential embarrassment of the hot seat volunteers. Feedback from the participants indicates that they agreed that the simulation was an effective learning experience. The planners were pleased that participants remembered so many (mean=3.4) of the crises presented two days after the session. Based on our (AJLS, WBM) previous experience of discussions with residents after Grand Rounds lectures, we had predicted most residents would only remember one or two with a maximum of three key points. Although a formal comparison with another teaching modality was not made, one might speculate that the number of scenarios remembered could indicate that remote simulation teaching is memorable.

Each crisis was designed to teach participants about differential diagnosis and treatment of selected problems encountered in obstetric anesthesia (Table 1). The crises were also designed to stimulate thinking and develop concepts that could apply outside of obstetric anesthesia. Responses to the survey suggest that the above goals were met. Individual remarks by residents were also favorable. For instance, one junior resident, who had not encountered a crisis event during residency, indicated that his/her level of comfort in dealing with one had increased. While this appears to be a positive response, “comfort” or “confidence” should be understood in the context of the trainee’s understanding of the clinical challenge.

Another goal of the simulation was to provide a realistic experience, even for those who did not participate hands-on. The results indicate that most residents (90%) felt personally involved in the scenario. Facilitators in the library noted that discussions were animated and that there was a sense of urgency in the decision making process. The residents who did feel out of the picture in the lecture room (14%) tended to be more senior residents who had had clinical experiences similar to those presented in the simulation. In the future it may be useful to have senior residents act as assistant moderators based on the notion that teachers often learn more than students. This might help them to become involved and prepare them for their future roles as teachers.

The planners discussed the use of rehearsed (“actors”) versus unrehearsed hands-on participants while developing the session. We chose to use unrehearsed participants in order to increase the realism and to minimize the time required for preparation of the session. While most participants indicated that they agreed with this approach (Table 2), it should be noted that they had no experience with a similar format using rehearsed hands-on participants. Residents might gain more from a more highly structured format.

For instance, some mistakes could be pre-planned in order to bring out teaching points.

There was also discussion regarding the use and length of interruptions in the session. Planners considered completing the simulation first with only the hands-on volunteers, then debriefing based on a videotape of the session. The use of breaks and discussion was chosen because it allowed the residents in the lecture room to participate during the session rather than critique after its completion. The breaks were purposefully short in order to introduce a sense of urgency and realism.

One of the weaknesses of the study was the questionnaire. A pilot study to test its wording would have been useful. Furthermore, the assessment of learning and interactivity during simulation should optimally include a more detailed set of probes. One of the questions asked residents about their willingness to design and participate in future scenarios. In retrospect, this question is confusing and seems to ask two questions. We advise against the use of questions containing two concepts unless they are closely related.

There are several other improvements that the authors would suggest for future sessions. Although most (94%) of the residents indicated that they learned something that would change their practice, some of the very new residents (CB and CA1) felt that they did not get the full value of the session because they had little theoretical and no practical experience with the crises and solutions. Bloom[7] outlined a hierarchy of educational objectives (Appendix 2). This simulator session assumed basic knowledge and understanding of anesthesiology and of obstetric anesthesiology in particular. It required participants to apply their knowledge to analyze a crisis and to synthesize what they know and observed in order to develop a plan. Because this session addressed higher Bloom's cognitive levels, it may have been better to pre-select participants who had more basic knowledge of the obstetric problems presented. We look forward to identifying residents who would be willing to help write new and follow-up scenarios; they should benefit substantially because as teachers they must learn the subject more thoroughly than the student.

There were also suggestions made by the participants during the debriefing session. One frequent comment was that participants in the lecture room could not see the patient monitors well via the video feed. Future simulations should include either a separate monitor in the lecture room or a dedicated video feed showing only the simulator lab's monitor displays.

Our experience with a remote simulator session designed to teach selected issues in obstetric anesthesia suggests that this teaching modality may hold promise for other topic areas in anesthesiology residency training. It enabled a larger group of residents to participate as active learners than would have been possible using more traditional small group sessions. The participants in this study believed that this was a valuable mode of education. Further study is warranted to determine whether sessions such as this are effective when compared to a lecture only format and to compare cost-effectiveness between the two learning formats.

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Appendix 1

This survey was completed by residents on the second day after the simulation; where applicable the available choices for answers are listed.

1. What was your impression of the overall usefulness of the presentation?

◦ None, little, ho-hum, not bad, do it again (scored 1–5)

Please list the five obstetrical crises presented.

Did you learn something that will change your practice?

◦ Yes/No with comments

Should unrehearsed residents be used as actors/participants?

◦ Yes/No

Should we break the presentation for discussion or wait until it ends?

◦ Break/Wait

Did you feel personal involvement in the outcome of the simulation?

◦ Yes/No

Was this more effective than OB lectures you have heard?

◦ Yes/No

Did you feel out of the picture because you viewed from the lecture room?

◦ Yes/No

Suggest two other areas in which you think this kind of simulation would be useful.

How interested are you in writing and participating in presenting a simulation scenario?

◦ no way, maybe, if I must, why not, let’s do it

Appendix 2

Bloom's Taxonomy: hierarchy

1. Factual knowledge
2. Understanding
3. Application
4. Analysis
5. Synthesis
6. Evaluation

To demonstrate the use of Bloom's Taxonomy, consider the example of these levels of knowledge applied to the treatment of hypotension.

- Factual knowledge: I know the dose of phenylephrine.
- Comprehension: Phenylephrine increases blood pressure because it is a direct acting alpha agonist.
- Application: I am faced with a hypotensive patient. I know that phenylephrine is designed to increase the blood pressure. I will use phenylephrine to treat this patient.
- Analysis: Hypotension has more than one potential etiology. In order to appropriately treat my patient I must fully assess the patient and then address the correct etiology.
- Synthesis: I have never seen a severe hypotensive episode, but I have treated mild hypotension with phenylephrine. My patient now has severe hypotension, so I will treat him with a larger dose of phenylephrine.
- Evaluation: Phenylephrine only temporarily raised my patient's blood pressure, but a fluid bolus kept it up. The next time, I will try fluids first.

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Figures and Tables

Table 1

The five crises presented during the simulation and their etiology.

Crisis	Etiology
1) Hypertension and pain	1) Poorly functioning epidural
2) Hypotension and loss of consciousness	2) High epidural
3) Hypotension followed by hives	3) Anaphylaxis
4) Low Apgar scores in infant	4) Fetal distress, pediatrician unavailable
5) Hypotension	5) Uterine hemorrhage

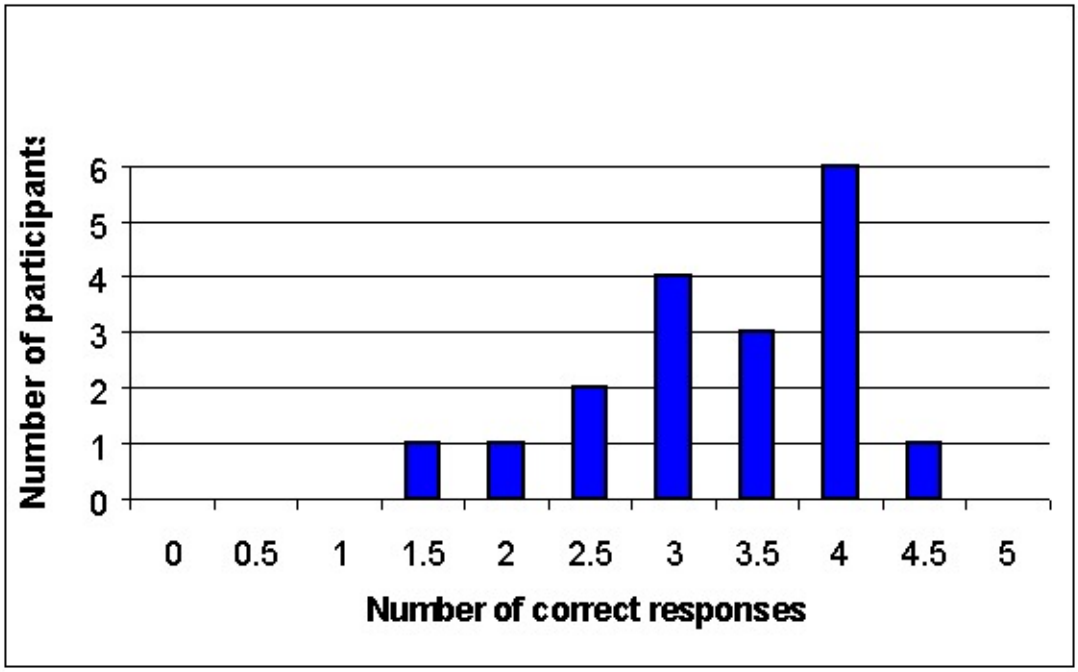
Table 2

Responses to survey questions (from Appendix 1).

Question	Yes	No
Did you learn something that will change your practice?	17	1*
Should unrehearsed residents be actors/participants?	17	2
Did you feel personal involvement in the outcome of the simulation?	18	2
Was this more effective than obstetric anesthesia lectures you have heard?	15	1#
Did you feel out of the picture because you viewed from the lecture room?	2	14
Were the breaks appropriate?	15	3

*The single “no” answer to this question was qualified by the remark, “Nothing to change yet – not yet working in the obstetric suite.”
#Three residents responded that both lectures and simulator sessions were necessary.

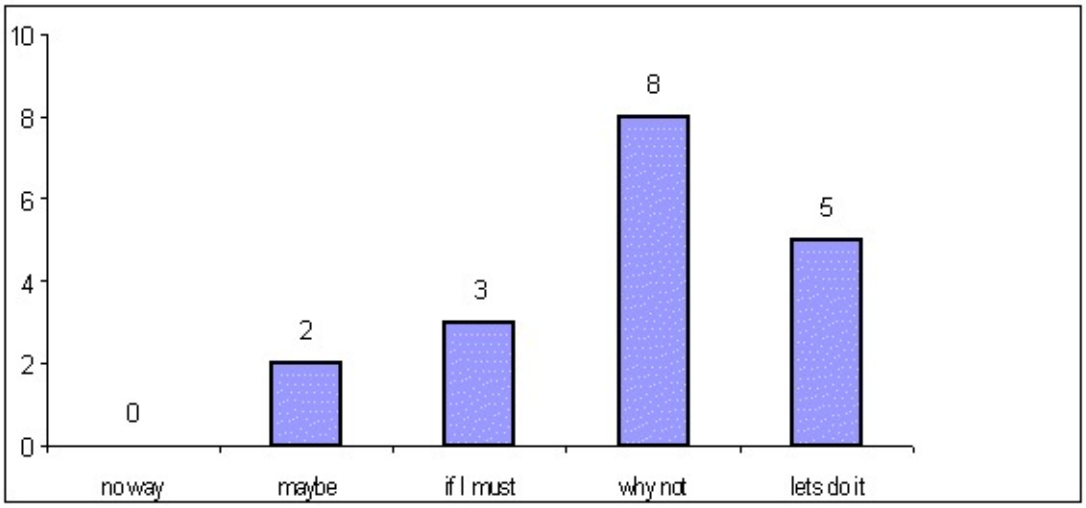
Figure 1



Number of simulated crises remembered by residents.

The graph shows the number of participants who had a given number of correct responses. The person who only remembered 1.5 crises arrived 45 minutes after the session began. Based on experience with lectures, the instructors believed that more than two to three sessions remembered would indicate an improvement attributable to simulation.

Figure 2



Participant willingness to write and participate in presenting future simulation scenarios.

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