

Creation of Simulation-Based Curriculum of Perioperative Emergencies for Residents in Anesthesiology

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Abstract

Introduction: Crisis management is difficult to practice and evaluate for resident learners and leadership given the rarity of these events in clinical practice. However, simulation provides a medium to bridge this gap. We identified a need for simulation in our anesthesiology residency program to help residents learn to treat perioperative emergencies.

Objective: To describe the process of curriculum development, content, and early outcomes of a simulation-based curriculum for the management of perioperative emergencies for all levels of anesthesiology learners.

Materials and methods: Curriculum development began in the Spring of 2019 and simulations began in August 2019. All anesthesiology residents rotating at a single center through December 2020 were eligible. Each resident was given their own simulation scenario detailing a specific perioperative emergency and then debriefed as a group afterward. All residents participating in the scenario were given a post-simulation survey assessing the value of the educational experience, relevance to their level of training, and quality of learning environment.

Results: Out of 90 eligible residents, 79 participated in the study (87%). Overall, 100% of participants completed the post-simulation survey; 100% of residents reported that the curriculum was useful to their education; 98% of residents reported that the curriculum was relevant to their training level; 99% of residents reported that the simulation was an engaging learning experience.

Conclusion: A simulation-based curriculum of perioperative emergencies for anesthesiology residents is feasible to implement, viewed as worthwhile by trainees, and can foster education in a different learning environment.

Categories: Anesthesiology

Keywords: simulation in medical education, crisis management, academic anesthesiology, simulation education, operating room

Introduction

The use of simulation-based training in graduate medical training programs has become widespread over the last decade [1-2]. This is especially true in the field of anesthesiology, where simulation-based education is used as a method to prepare trainees to handle perioperative emergencies that happen so rarely they may not experience them in clinical practice during their training [3-5]. An anesthesiology residency program that offers simulation, in combination with a traditional curriculum involving didactic lectures and clinical time, can better prepare trainees to be independent and comfortable managing any perioperative pathology [5].

The Accreditation Council for Graduate Medical Education (ACGME) has affirmed the value of simulation in anesthesiology education by including it in the Milestones project, which is used to evaluate residents' progress through residency [6-8]. The American Board of Anesthesiology (ABA) has echoed this sentiment by adding the Objective Structured Clinical Examination (OSCE) to the requirement for board certification [7-9]. High fidelity simulation helps faculty evaluate residents along the milestones, provides residents a safe environment to learn, and introduces them to the modality they will be tested on during the OSCE [7-9].

In the fall of 2018, the need for high fidelity simulation in the educational experience for anesthesiology residents was identified at our institution. To address this educational need, we proposed a simulation-based curriculum for the management of perioperative emergencies for all levels of training. We aim to describe the process of curriculum development, content, and early outcomes of the first eighteen months of implementation. This data was previously presented as a meeting abstract at the 2021 International

Review began 05/26/2021

Review ended 05/30/2021

Published 06/07/2021

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How to cite this article

Kazior M R, Ianchulev S, Nguyen J, et al. (June 07, 2021) Creation of Simulation-Based Curriculum of Perioperative Emergencies for Residents in Anesthesiology. Cureus 13(6): e15509. DOI 10.7759/cureus.15509

Anesthesia Research Society Meeting on May 15, 2021.

Materials And Methods

The Central Virginia Veterans Affairs Health Care System (VA) is an affiliate site for the training of residents in anesthesiology from Virginia Commonwealth University (VCU) Health. The Department of Anesthesiology at VCU Health has fourteen residents in each of the categorical anesthesia years, post-graduate year (PGY)-2 through PGY-4. The VA hosts five residents every rotation block from this pool; three PGY-2 residents, one PGY-3 resident, and one PGY-4 resident.

A group of stakeholders from the Department of Anesthesiology came together to develop the curriculum in the spring of 2019. The goals for this experience were to create a novel educational experience for the residents, be relevant to the residents at their specific level of training, and to provide a non-judgmental environment to facilitate learning.

To ensure a novel experience, we developed the curriculum around perioperative emergencies. Other than traditional didactics and clinical experience, nothing prepared the residents for these in the residency program. Simulation is the perfect environment for learning without the threat of real patient harm. This also meets several ACGME anesthesiology milestones, primarily Situational Awareness and Crisis Management (Patient Care [PC] 7), but also the Application and Interpretation of Monitors (PC3), Intra-Operative Care (PC4), Airway Management (PC5), and Post-Operative Care (PC8).

Scenarios for the PGY-2 residents included anaphylaxis, malignant hyperthermia, and myocardial infarction. Scenarios for the upper level residents (PGY-3 and PGY-4) included venous air embolism, local anesthetic toxicity, and obstetric hemorrhage.

Each resident was given their own scenario and entered the simulated environment while the other residents watched from the debriefing room and could be called in to help if needed. Our simulation center employs the SimMan 3G (Laerdal Medical, Wappingers Falls, NY) and utilizes the ASL 5000 Breathing Simulator (IngMar Medical, Pittsburgh, PA) to give better functionality with the anesthesia machine. A Standard Operating Guide (SOG) was utilized for each scenario for uniformity.

Each simulation scenario ended with a formal debriefing with the simulation faculty and all participating residents. Debriefing was at the discretion of each faculty member but the Debriefing with Good Judgement model was encouraged [10]. This allowed faculty to assess the ACGME resident milestones of Reflective Practice and Commitment to Personal Growth (Practice Based Learning and Improvement [PBLI] 2), Interprofessional and Team Communication (Interpersonal and Communication Skills [ICS] 2), Foundational Knowledge (Medical Knowledge [MK] 1), and Clinical Reasoning (MK2).

At the end of the simulation session, each resident filled out a survey (supplemental) to give feedback on the new curriculum on a 5-point Likert scale (1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree). Additional comments were welcomed. Study questions sought to assess the relevance of the curriculum and the quality of the learning environment (Figures 1-2). This survey was developed in house at the VA for this purpose with no collection of validity evidence. This study was exempt from review by the VA Institution Review Board (IRB).

Please rate the following statements about the SESSION using the following scale:
 1 – Strongly Disagree 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly Agree

The objectives of the training session were clearly defined.	1	2	3	4	5
The content covered was relevant to me or my position.	1	2	3	4	5
The instructor was knowledgeable about the training topics.	1	2	3	4	5
The instructor was well-prepared to teach this course.	1	2	3	4	5
The training objectives defined were met.	1	2	3	4	5
The time allotted for this training was sufficient.	1	2	3	4	5
This training experience will be useful in my line of work.	1	2	3	4	5
The instructor set the stage for an engaging learning experience.					
<ul style="list-style-type: none"> The instructor introduced him/herself, described the simulation environment, what would be expected during the activity, and introduced the learning objectives. The instructor explained the strengths and weaknesses of the simulation and what I could do to get the most out of simulated clinical experiences. The instructor attended to logistical details as necessary such as toilet location, food availability, schedule. The instructor made me feel stimulated to share my thoughts and questions about the upcoming simulation and debriefing and reassured me that I wouldn't be shamed or humiliated in the process. 	1	2	3	4	5
The instructor maintained an engaging context for learning.					
<ul style="list-style-type: none"> The instructor clarified the purpose of the debriefing, what was expected of me, and the instructor's role in the debriefing. The instructor acknowledged concerns about realism and helped me learn even though the case(s) were simulated. I felt that the instructor respected participants. The focus was on learning and not on making people feel bad about making mistakes. Participants could share thoughts and emotions without fear of being shamed or humiliated. 	1	2	3	4	5
The instructor structured the debriefing in an organized way.					
<ul style="list-style-type: none"> The conversation progressed logically rather than jumping around from point to point. Near the beginning of the debriefing, I was encouraged to share my genuine reactions to the case(s) and the instructor seemed to take my remarks seriously. In the middle, the instructor helped me analyze actions and thought processes as we reviewed the case(s). At the end of the debriefing, there was a summary phase where the instructor helped tie observations together and relate the case(s) to ways I can improve my future clinical practice. 	1	2	3	4	5
The instructor provoked in-depth discussions that led me to reflect on my performance.					
<ul style="list-style-type: none"> The instructor used concrete examples—not just abstract or generalized comments—to get me to think about my performance. The instructor's point of view was clear; I didn't have to guess what the instructor was thinking. The instructor listened and made people feel heard by trying to include everyone, paraphrasing, and using non-verbal actions like eye contact and nodding, etc. If someone got upset during the debriefing, the instructor was respectful and constructive in trying to help them deal with it. 	1	2	3	4	5
The instructor identified what I did well or poorly – and why.					
<ul style="list-style-type: none"> I received concrete feedback on my performance or that of my team based on the instructor's honest and accurate view. The instructor helped explore what I was thinking or trying to accomplish at key moments. 	1	2	3	4	5
The instructor helped me see how to improve or how to sustain good performance.					
<ul style="list-style-type: none"> The instructor helped me learn how to improve weak areas or how to repeat good performance. The instructor was knowledgeable and used that knowledge to help me see how to perform well in the future. The instructor made sure we covered important topics. 	1	2	3	4	5

Additional Questions On Reverse Side

FIGURE 1: Post-Simulation Survey Page 1

Simulation Center Course Evaluation

**IMPORTANT DIRECTIONS
FOR MARKING ANSWERS**

- Use black ink or #2 pencil only.
- Make heavy black marks that fill the circle completely.
- Erase cleanly any answer you wish to change.
- Make no stray marks on the answer sheet.

Examples

Wrong


1 X ○ ○ ○ ○ ○

Wrong

1 ○ ○ ○ ○ ○

Right

1 ● ○ ○ ○ ○



Hunter Holmes McGuire
Center for Simulation &
Healthcare Innovation

Please rate the following questions about the SIMULATION CENTER using the following scale:
1 – Very Poor 2 – Poor 3 – Average 4 – Good 5 – Very Good N – N/A

How was the condition of the simulator or equipment used during your visit?	1	2	3	4	5	N
How was the appearance of the simulation center?	1	2	3	4	5	N
How helpful was the simulation center staff?	1	2	3	4	5	N

Please answer Yes or No to the following questions if your training was conducted at the simulation center. Skip this section if your training was conducted in your unit.

Did you feel that the simulation center offered a safe learning environment?	Y	N
If you had a choice of where to conduct your training, would you return to this simulation center?	Y	N

Please provide any additional comments in the shaded area below. Please do not write outside the shaded area.

If you would like a response or follow-up from the simulation center regarding this session, have a suggestion that requires a follow-up, or have a complaint about an instructor that you would like to resolve, please provide follow-up information below.

All comments will be reviewed by the Simulation Director and Simulation Operations Specialist for quality improvement purposes. Disclosure of identifying and contact information is voluntary, however, nondisclosure of identifying and contact information will impact our ability to follow-up with any concerns you may have.

(OPTIONAL)

Name:

E-mail:

Address:

Phone:

Additional Questions On Reverse Side

FIGURE 2: Post-Simulation Survey Page 2

Results

The first simulations under this new curriculum began in August 2019 and are still currently running as of March 2021. Data presented is through December 2020. Out of 90 eligible residents rotating at the VA during this time period, 79 participated in the study (87%). There was a three-month break from March 2020 to June 2020 out of an abundance of caution due to the COVID-19 pandemic. During this time period, we completed nineteen simulation sessions involving seventy-nine residents for a total of three-hundred fifty-nine resident training hours.

Several survey responses recorded an average Likert scale of 5.00 and included “the instructor was knowledgeable about the training topics”, “the instructor was well-prepared to teach this course”, “this training experience will be useful in my line of work”, and “the instructor provoked in-depth discussions that led me to reflect on my performance.” The response that received the lowest Likert score was “the objectives of the training session were clearly defined” with a 4.79 score (Figure 3).

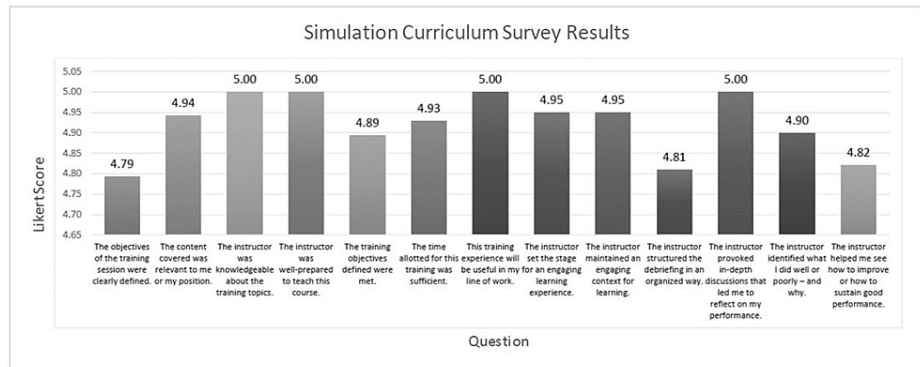


FIGURE 3: Simulation Curriculum Results

The above questions were present on a post-simulation survey the residents were asked to fill out. A 5-point Likert scale (1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree) was used to score the feedback. Average response values are seen above each bar.

Additional positive comments provided by participants included “it was a good learning environment, low pressure and educational” and “I felt comfortable throughout, I did not feel like I was being judged, it was a safe space to discuss the cases, the scenarios will help me be more comfortable in the operating room.” Additional negative feedback received included “frantic at times, slightly confused about the different ventilator that I am not used to.” (Table 1).

Comment:
It was a good learning environment, low pressure and educational.
The simulation experiences, both low and high fidelity, were realistic, timely, and relevant to anesthesia bootcamp. Instructors were encouraging and approachable, and stress was minimal, which all promoted learning.
It was very fun and good learning. High fidelity. We should do more.
Frantic at times. Slightly confused about a different ventilator than I am used to. Overall comfortable with the simulation.
I felt comfortable throughout. I did not feel like I being judged. It was a safe space to discuss the cases. These scenarios will help me be more comfortable in the OR.
I was able to learn and further tune my knowledge base and skills which at the end of the day had a positive impact on my confidence.
very educational experience good team building, motivated and challenged.
It was a great experience. Very fun and useful for providing how to work through problems in the OR as well as the educational debriefings.
I thought the simulation was appropriate for our current level of training and allowed us to trouble shoot the problems in a safe and educational environment.
Encouraged to keep learning.
Great facility, excellent learning opportunities.
Beneficial debriefing and not only going over the medicine aspects of the sim, but what steps should be taken to stabilize the patient / grabbing help sooner.

TABLE 1: Additional Comments Provided on Simulation Curriculum

Discussion

The high level of resident participation shows the creation of a novel educational program. The post-simulation survey results provide evidence that we created a curriculum that was relevant to the residents and an educational environment where they could effectively learn.

We learned a lot throughout this process of building a simulation program at an affiliate educational site. One of the biggest hurdles was getting the residents out of clinical duties without disrupting workflow in the operating rooms. Having support from departmental leadership to provide non-clinical time for faculty and residents is essential. It also takes buy in from faculty colleagues to participate in the simulation and support the changes to workflow.

The technical difficulties and troubleshooting underlined the importance of having an experienced and reliable simulation operations specialist. Without this support the simulation curriculum product would not have been as streamlined or simply would not have happened.

The main limitation of this educational project is that it is a small, single-center review which limits generalizability. No pre-curriculum test was performed in this study which also limits further statistical analysis of the data. Evaluation by the residents who participated in these simulations only assessed level one Kirkpatrick [11] scores and the evaluation survey was not tested for validity. Given the nascent stages of the project, we felt that this represented the best place to start because we were primarily concerned with feasibility.

We plan on continuing this simulation program and want to grow by developing new scenarios for the perioperative emergency curriculum. As the curriculum is developed, we seek to incorporate more rigorous data collection, assess higher Kirkpatrick level scores, and incorporate pre and post-simulation surveys. Developing better feedback and evaluations to assess the higher Kirkpatrick scores will be useful for elucidating the effect that this education has on resident performance and patient outcomes. Simulation can also help supplement many more areas of resident education and assess their progression through training based on the ACGME milestones.

Conclusions

Preliminary data shows the simulation-based curriculum around perioperative emergencies met our goals. With the break in simulation activities for COVID-19, more than one simulation session occurred every month and all the anesthesia residents in the residency program had exposure to simulation. This shows that we met our goal of creating a novel educational program that did not exist prior to this venture. The post-simulation survey results provide evidence that we achieved our other goals of creating a curriculum that was relevant to these learners and that they had an educational environment where they could effectively learn the material. Future directions are to develop new scenarios for perioperative emergency curriculum, create new curricula for different resident education needs (advanced cardiovascular life support in the operating room), and determine a better way to evaluate residents after they have participated in the simulation.

Additional Information

Disclosures

Human subjects: All authors have confirmed that this study did not involve human participants or tissue.

Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue.

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

Michael Czekajlo, M.D., Ph.D Department of Surgery, Central Virginia VA Healthcare System Robert Isaak, D.O. Associate Professor, Department of Anesthesiology, University of North Carolina at Chapel Hill

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