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Identifying and Managing Intraoperative Arrhythmia: A Multidisciplinary Operating Room Team Simulation Case

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Abstract

Introduction: Resuscitation of a critically ill patient is challenging for both novice learners and experienced health care providers. During a critical event, not only is it important to identify the correct underlying diagnosis, it is equally crucial that the appropriate Advance Cardiac Life Support algorithm, medications, and defibrillator modality are implemented. This scenario features a 56-year-old female who presents for excisional biopsy of an inguinal lymph node to evaluate lymphadenopathy concerning for lymphoma. Intraoperatively, she goes into cardiopulmonary arrest. Participants must identify and manage three different scenarios: (1) ventricular fibrillation, (2) unstable ventricular tachycardia, and (3) bradycardia, including the use of the defibrillator. **Method:** Weekly simulation sessions were conducted in the in situ simulation operating room at Massachusetts General Hospital. Surgical residents, anesthesiology residents, nurses, and surgical technicians participated in a multidisciplinary operating room team. Each approximately 60-minute session included an orientation, the case, and the debriefing. Equipment included a simulation operating room with general surgery supplies, general anesthesia equipment, a high-fidelity SimMan patient simulator, a code cart, and a defibrillator. **Results:** Ninety-one multidisciplinary participants completed this scenario from September to December 2015. Participants reported that the scenario was applicable to their clinical practice (96%), promoted teamwork skills (88%), and encouraged interprofessional learning (94%). **Discussion:** Intraoperative cardiac arrest is a devastating event that can result in poor patient outcomes if the care team is not thoroughly prepared for crisis management. This simulation case scenario was implemented to train multidisciplinary learners in the identification and management of such an event.

Keywords

Simulation, Interprofessional, Intraoperative Arrhythmia, Defibrillator

Appendices

- A. Simulation Case.docx
- B. Teaching Points.docx
- C. Instructions for Philips Defibrillator.docx
- D. Sim Specialist Flow.docx
- E. Equipment Checklist.docx
- F. Introduction Slides.pptx
- G. Introductory Material.docx
- H. Luiz History Physical Lab Imaging.docx
- I. Debriefing Material.docx
- J. Evaluation Form.docx

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

Educational Objectives

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

1. Identify pulseless ventricular fibrillation, unstable ventricular tachycardia, and bradycardia and initiate their management according to Advance Cardiac Life Support (ACLS) guidelines.
2. Use the defibrillator to manage the bradycardia case according to ACLS guidelines.
3. Apply the core concepts of crisis resource management.

Introduction

Cardiopulmonary arrest is a rare event on the ward or in the intensive care unit, but it is even more infrequent in the operating room (OR). Although there are many available team-training simulations that incorporate cardiac arrest scenarios,¹⁻³ few programs focus specifically on education about the functionality of the defibrillator device. Advanced Cardiovascular Life Support (ACLS) courses offer cardiac resuscitation training to health care providers. In these courses, the modalities of the defibrillator are introduced and reinforced. However, training regarding the specific model of defibrillator and the nuances when using different defibrillators is not emphasized. Also, after the training session, health care providers have few opportunities to deliberately practice using the defibrillator. During a critical event, not only is it important to identify the correct underlying diagnosis, it is equally important to know the appropriate

modalities of the defibrillator in order to manage the patient. Our simulation relates to other scenarios published in *MedEdPORTAL* such as “Use of Simulation to Improve Cardiopulmonary Resuscitation Performance and Code Team Communication for Pediatric Residents”³ and “Sepsis in the Operation Room: A Simulation Case for Perioperative Providers.”⁴ In our simulation, we further emphasized crisis resource management to promote interprofessional skills and provided thorough detail for practical implementation at other institutions.

This interprofessional case was developed by a multidisciplinary team of surgeons, anesthesiologists, and nursing educators, with multifaceted teaching points geared towards each specific profession. The targeted learners were an interprofessional group made up of general surgery residents, anesthesiology residents, certified registered nurse anesthetists (CRNAs), OR nurses, and surgical technicians. The clinical scenario was developed as a result of surveying OR team members about educational gaps they had recently experienced. We then compared these gaps to national curricula available for surgery,⁵ anesthesia, and nursing trainees as well as reviewing institutional accreditation requirements. A scenario featuring an intraoperative arrhythmia met all of these criteria and was likely to occur in clinical practice with increased patient morbidity and mortality if not managed correctly. The case scenario involved an intraoperative cardiac arrest with management of three different ACLS algorithms: (1) ventricular fibrillation, (2) unstable ventricular tachycardia, and (3) bradycardia. The scenario engaged the learners to identify the ACLS algorithms^{6,7} and treat the arrhythmias accordingly using the defibrillation, synchronized cardioversion, or pacing modality of the defibrillator. Our defibrillator information was specifically modified for the type/model of defibrillator used in all of the Massachusetts General Hospital (MGH) ORs.

The case occurred in a simulated OR environment with all associated equipment. In the scenario, a 56-year-old woman presents with bilateral enlarged lymph nodes in her neck and groin. She has been scheduled for excisional biopsy of an inguinal lymph node under general anesthesia. No training prerequisites were required prior to the simulation session.

Methods

The case is provided for facilitators in the simulation case file (Appendix A), which includes a brief narrative description of the case, the learning objectives, and a list of critical actions to be performed by the learners. This file also includes information about the initial presentation of the patient, history, physical examination, and laboratory information. Moreover, there is a guide for case progression based on learner actions to drive the flow of the case scenario.

ACLS algorithms for ventricular fibrillation, unstable ventricular tachycardia, and bradycardia are provided in the teaching points document (Appendix B). The participants should be able to appropriately perform required actions using the defibrillator. This module has specific instruction about how to use the Philips defibrillator (Appendix C) utilized at MGH. Setup for the simulation session took approximately 30-60 minutes. A case flow sheet (Appendix D) is provided for simulation specialists as a guide to the initial setup. The equipment checklist for this scenario is provided in Appendix E.

The orientation session lasted approximately 10 minutes and ensured that the learners understood the purpose of the simulation and were ready to proceed. Orientation slides and the introductory material handout used at our institution are provided in Appendices F and G, respectively, and can be edited to fit other institutional setups. The purpose of the orientation is to inform learners about general issues such as background, objectives, rules, equipment (including vital sign monitor, code cart, IVs, medications, defibrillation, and record), the simulation environment, any special rules, and OR safety. Prior to the case, learners were given a history and physical examination sheet and laboratory results (Appendix H), including chemistry report, ECG report, imaging report, and urine report.

Learners were escorted by the faculty into the simulated OR where the case was underway. The actor who portrayed the anesthesiologist was already in the simulated OR. The nurse/scrub technician learners were

expected to enter the case as if they had been there the entire time. The surgery learners were expected to scrub into the case, and the anesthesia learners were expected to get a handoff from the anesthesia actor. Although the case scenario was projected to last approximately 20 minutes, the scenario featured several opportunities for a “pause and discuss” style of teaching that could take longer. During the simulation, we did not allow participants to leave the room as this might have disturbed others in the clinical OR complex. We also ensured at the end of each simulation session that the participants did not accidentally remove the simulated medications or equipment.

At the end of the scenario, learners and faculty moved to another room to debrief for approximately 30 minutes. A copy of our debriefing material is provided (Appendix I). This final debriefing session gave the faculty the opportunity to ensure that the learning objectives were achieved and encouraged the participants to analyze and possibly change their current clinical behaviors. Participants completed an anonymous evaluation form (Appendix J) prior to leaving the simulation space.

Equipment/Environment

The primary piece of equipment was a high-fidelity simulator (SimMan), which was set up as a patient who had been intubated with a 7.0 cuffed oral endotracheal tube, had two large-bore peripheral intravenous catheters placed, and had been surgically prepped and draped. The patient simulator had a typical hospital identification wristband with the patient’s name and medical record number. Vital signs such as blood pressure, pulse oximeter, and electrocardiogram set by instructors were monitored in real time with a standard simulated monitor.

Surgical equipment for this case included standard general surgery instruments, blue Weck clip applicators, closing suture, specimen jar, a disabled electrosurgical unit, appropriate paperwork, and an inguinal model. This in situ simulation took place at MGH in an actual clinical OR, which had a surgical bed, overhead lights, and cabinets with standard OR supplies; however, the simulation can be replicated in other locations outfitted as an OR.

For the anesthesiology setup, a functional anesthesia machine with no gases was placed in the room with standard airway equipment including Mac 3 and Miller 2 blades. Other equipment included endotracheal tubes, oral airways, suction tubing, ambu bag, and tape. Simulated medications included a variety of prepared syringes: propofol, succinylcholine, midazolam, fentanyl, vecuromium, phenylephrine, ephedrine, atropine, and epinephrine. In addition, room equipment included stepping stools for performing chest compressions and the *Stanford Emergency Manual*⁶ as a cognitive aid. A code cart with simulated code medications included epinephrine, atropine, calcium chloride, and bicarbonate. Audiovisual equipment included two video cameras and several microphones suspended from the ceiling. The instructors wore wireless headsets to communicate directions for the simulation session.

The debriefing room had enough space for the six participants and three instructors to sit in a circle facing each other. In addition, the debriefing room had a display screen with audiovisual capabilities to show both camera views and the anesthesiology monitors. These videos were sometimes used in the debriefing to replay scenes from the simulation. We also recorded the debriefing sessions to use for faculty debriefer development.

Personnel

We typically paired a senior surgery resident with a surgical intern, and a senior anesthesia resident with a junior anesthesia resident or a CRNA. Two OR nurses or one nurse and one surgical technician were recruited from active OR staff. A frequently encountered challenge was the absence of a learner due to the need for manpower in the clinical environment. Flexibility was required in situations where the exact number of participants was not available. In this case, one of the faculty assumed the role of the missing participant.

Our instructor team consisted of a multidisciplinary group involving a surgeon, four anesthesiologists, a nurse educator, three simulation specialists, two simulation administrators, and a PhD surgical educator. We recommend that the instructor team be as multidisciplinary as possible to ensure a multifaceted teaching approach geared towards the specific specialties.

Assessment

The primary goal of our simulation was for trainees to practice managing various types of life-threatening intraoperative arrhythmias while simultaneously developing crisis management skills that they can utilize during unexpected OR crises. Therefore, we did not evaluate our learners' clinical knowledge and skill. Our simulation environment was based on the assumption that everyone is intelligent, is capable, cares about doing his or her best, and wants to improve. We saw assessment as very formative and supportive in these sessions given the many limitations of the simulation sessions. The debriefing process allowed participants to assess their effectiveness and contemplate alternative actions/behaviors.

Debriefing

Debriefing was the most important part of simulation. Each debrief was done with two faculty: one lead debriefer and one co-debriefer. Often, the less experienced debriefer was the lead debriefer. We initiated the debriefing by asking the learners to express one word to describe how they were feeling right after the simulation or simply by asking them, "How do you feel?" This allowed participants to relieve any stress from the simulation and also allowed faculty debriefers to assess for any potentially upset participants. The debrief leader then explained the facts of the case and reviewed clinical topics such as the ACLS algorithm, the principles of crisis resource management, and the use of the defibrillator using an advocacy-inquiry approach.⁸ Topics to focus on during the debriefing could include, but were not limited to, principles of crisis resource management, the ACLS algorithm, the use of the defibrillator, allocation of resources, or the use of the *Emergency Manual*.^{6,7} Finally, the debriefing closed with faculty asking participants to state their take-home message and whether they would change anything if confronted with a similar situation in a real OR event. Before leaving the debriefing room, participants completed an anonymous evaluation form on tablet computers. Participants assessed their own performance and gave feedback about the session.

Results

This simulation case ran for about 3 months during the 2015 academic year, or 12 times, with a total of 91 participants, including 26 surgical residents, 29 anesthesiology residents, six surgical technicians, and 30 nurses. The majority of learners strongly agreed or agreed that working in an interprofessional team was important for their learning about these cases (94%) and that the simulation exercise was applicable to their own practice (96%). Moreover, most trainees agreed that the simulation helped them improve their teamwork skills (88%; see [Table](#)).

Table. Summary of Participant Evaluation (N = 91)

Question	% Responding						
	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
1. The simulation was realistic enough for me to engage in learning.	38	47	8	2	1	1	2
2. The simulation exercise helped me improve my teamwork skill.	1	61	26	10	0	1	1
3. The simulation exercise was clinically applicable to my practice.	69	27	3	1	0	0	0
4. I will change my practice because of this simulation exercise.	31	40	16	10	1	2	0
5. Working in mixed teams was important to my learning for this simulation exercise.	66	28	3	3	0	0	0

Comments from participants indicated how their practice would change because of this simulation exercise. For example, many participants said that they were more familiar with the defibrillator as a result

of the simulation and would now be able to use the defibrillator and pacer functionality correctly in case of an emergency. In addition, they realized that communication was key for effective teamwork, especially speaking up and closed-loop communication. Furthermore, they stated that defining roles and establishing situational leadership were necessary in a critical situation. In summary, participants found this case to be very useful, applicable to real practice, and likely to improve their teamwork skills.

At the end of the session, according to questions 3 and 4 on the evaluation form, the participants stated they were better equipped to recognize the arrhythmia and properly perform the therapeutic management according to the ACLS guidelines. With regard to the design and content of the simulation scenario itself, many participants agreed or strongly agreed that the simulation was realistic enough to engage in learning, found it to be an excellent session, and requested more scenarios.

Discussion

Intraoperative cardiac arrest is a devastating event that can result in poor patient outcomes if the care team is not thoroughly prepared for crisis management. We created an intraoperative team-training simulation involving an interprofessional team resuscitating a patient who goes through three cardiac arrest scenarios. There are several aspects that should be highlighted about the creation of this simulation.

First, an interprofessional team collaborated in the conception, design, and development of this scenario. A surgeon, several anesthesiologists, and an OR nurse collectively designed the case to highlight principles of crisis resource management from various teaching points. Nuances important to each professional group were identified and built into the scenario. This ensured that each professional group had something important to accomplish during the simulation and was not simply scenery. For example, we found that it was especially important to give the surgical residents a task to perform as the simulation started, just as they would in an actual OR.

In addition, it was important to think through every detail the way each participant would and be prepared to integrate those actions and responses into the scenario. In this particular scenario, we felt it was necessary to remove the attendings to ensure that participants would have to manage the situation themselves. Similarly, we made sure that there was a legitimate reason for the delay of help arriving in order to allow the team to continue managing the situation.

Finally, for this scenario, we tried a different teaching process where the case was interrupted to allow the faculty to give a mini-demonstration about the proper use of the defibrillator and then permit the participants to restart the simulation and apply their new knowledge. This use of just-in-time teaching was mostly appreciated, but some participants did not like the interruption. During the debriefing, participants realized how much of the ACLS guidelines they actually remembered, reflected on how to improve their knowledge about those algorithms, and thought about ways to apply them in their own practice.

Some lessons learned from the creation and implementation of this simulation include benefits and nuances of working in an in situ simulation environment, manpower issues, and troubleshooting of simulation equipment failures. We strongly believe that maximal skill transfer occurs when the practice environment closely mimics the real environment. An advantage of working in an in situ simulation OR is that the participants are familiar with the clinical environment where they train and work every day. They are relatively close to the OR, which facilitates easy access to the simulation session and quick return to work immediately after the simulation. However, working in an in situ environment with simulated medications and equipment poses unique challenges, and vigilance is necessary to ensure that none of the simulation equipment traverses into the clinical environment.⁹ We emphasized that all participants should empty their pockets of any supplies acquired during the simulation in order to avoid taking simulated medicines or equipment into the clinical ORs. Furthermore, we created a special phone number for use in the simulation OR to avoid disrupting actual operations. Because most of the nurses had

memorized the phone numbers of emergency response groups, we created a cardboard template for the phone in the simulation OR so that there was only one number they could dial.

Addressing the manpower issues with consistent availability of facilitators and debriefers was another challenge that we faced. Providing a schedule of the teaching sessions months in advance allowed our facilitators to arrange nonclinical and protected time to help teach the sessions. In addition, having a large team of simulation instructors and collaborators from different disciplines helped ensure that there was at least one surgical or anesthesia faculty and one nurse leading every teaching session.

Finally, simulation equipment malfunction is potentially inevitable in every complex high-fidelity scenario. We faced stumbling blocks such as audiovisual malfunction, monitors not registering vital signs, cardiac arrhythmia signals not responding to the defibrillation, and technical difficulties with the mannequin. However, after each simulation session, the whole simulation team, including the faculty and simulation specialists, would gather to debrief one another and specifically address what went well and what should be changed for the next run. This faculty development aspect was essential to help build teamwork, enhance teaching skills from peer-to-peer learning, and ensure that each successive simulation session improved upon the last.

This simulation case was implemented in the OR for the purpose of intraoperative team training for a multidisciplinary group of learners. Some limitations of the scenario were that it was implemented only in the OR, clinical knowledge assessment was not part of our evaluation, and the defibrillator described may differ from that at other institutions. A future direction for this simulation would be to implement it in team-training sessions outside of the OR. The scenario can be modified to provide other interprofessional groups of learners in the emergency department, intensive care unit, or hospital ward setting the opportunity to deliberately practice the modalities of the defibrillator.

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Disclosures

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Ethical Approval

Partners Human Research Committee at Massachusetts General Hospital, Partners Health Care, approved this study.

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