

Original Publication

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Sepsis in the Operating Room: A Simulation Case for Perioperative Providers

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Citation: Bronshteyn YS, Lemm J, Malinzak E, Ghadimi N, Udani AD. Sepsis in the operating room: a simulation case for perioperative providers. *MedEdPORTAL*. 2017;13:10563. https://doi.org/10.15766/mep_2374-8265.10563

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Abstract

Introduction: Sepsis should be included in the differential of any patient with unexplained organ dysfunction, whether or not an obvious infection is initially detected. Perioperative providers frequently care for patients with sepsis. This simulation case challenges participants to recognize and manage a presentation of postoperative sepsis, providing an opportunity to discuss the rationale behind sepsis management during debriefing. **Methods:** Assuming the role of an anesthesia provider, the participant takes over the care of a 62-year-old female who has just undergone cystoscopy and is extubated in the operating room (OR). The participant receives a brief handoff from the outgoing anesthesiologist while the patient awaits a postanesthesia care unit slot. The case has been uneventful, aside from intermittent hypotension responsive to IV fluids and boluses of phenylephrine. Within minutes of the handoff, the patient becomes somnolent and hypotensive. Efforts to treat hypotension eventually precipitate hypoxemia. Trainees must recognize and manage this cardiopulmonary decompensation. The scenario benefits from an OR simulation environment containing an anesthetic ventilator, anesthesia drugs and equipment, and a mannequin on an OR table. **Results:** Twelve residents completed the simulation scenario. Formal feedback was collected via email questionnaire from faculty instructors within 30 days of teaching each session. **Discussion:** Sepsis presents a diagnostic dilemma in part because no single diagnostic test rules the syndrome in or out. Multiple operational definitions of sepsis in the academic literature add to the confusion for clinicians. Our case simulation challenges perioperative providers to make a timely diagnosis and initiate appropriate treatment of sepsis.

Keywords

Simulation, Septic Shock, Sepsis, Shock, SIRS, Urosepsis, Sepsis Simulation

Educational Objectives

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

1. Demonstrate effective crisis resource management skills.
2. Develop a differential diagnosis of circulatory shock that includes sepsis.
3. Take time-sensitive steps to treat sepsis.
4. Understand the current competing definitions of sepsis and septic shock.
5. Understand the rationale behind current recommendations for sepsis management.

Introduction

Sepsis is a life-threatening clinical syndrome wherein the body's immune response to infection damages the body itself. Because there is no gold standard of diagnostic test that rules in sepsis, diagnosis relies on human judgment to recognize a constellation of findings as suspicious for this syndrome. In 1991, a task force of experts operationalized sepsis as the combination of known or suspected infection and two or more signs of systemic inflammation response syndrome (SIRS), which includes tachypnea, leukocytosis or leukopenia, hypo- or hyperthermia, and tachycardia.^{1,2}

Appendices

- A. Simulation Case.docx
- B. Debriefing Material.docx
- C. Posttest and Survey.docx
- D. Posttest With Answers.docx
- E. Critical Action Checklist .docx

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

Given the variable presentation and multiorgan involvement of sepsis, the syndrome often goes unrecognized until late in its course.^{1,3} Unfortunately, these delays in diagnosis and treatment have negative consequences for patients. With each hour that goes by without appropriate antibiotics, the odds of survival from sepsis measurably decline. Conversely, septic patients do best when appropriate antibiotics are initiated within an hour of the onset of hypotension.⁴

Recently, critical care societies in Europe and the US commissioned a task force to update the definition of sepsis based on new knowledge uncovered in the last 2 decades. The task force authors described sepsis broadly as “a dysregulated host immune response to infection.”¹ To emphasize the prognostic importance of organ dysfunction in this syndrome, they incorporated organ dysfunction signs into new operational definitions of sepsis and septic shock. They defined sepsis as known or suspected infection and organ dysfunction as demonstrated by an increase of two or more points in the Sequential Organ Failure Assessment (SOFA) score. Patients meeting these criteria have an approximately 10% in-hospital mortality (for comparison, patients postmyocardial infarction after revascularization currently have about a 5% in-hospital mortality).⁵ Because the SOFA score is rarely used outside of academic medical settings, the task force authors also proposed a simplified assessment of organ failure: the quick SOFA (qSOFA). Patients with known or suspected infection meet this simplified sepsis definition if they have at least two of the following signs of organ dysfunction: altered mental status, respiratory rate ≥ 22 breaths per minute, and systolic blood pressure of ≤ 100 mm Hg.

The task force authors broadly defined septic shock as “a subset of sepsis in which underlying circulatory and cellular/metabolic abnormalities are profound enough to substantially increase mortality.”¹ Operationally, they identified such patients as having “persistent hypotension requiring vasopressors to maintain MAP 65 mm Hg” and a “serum lactate level > 2 mmol/L despite adequate volume resuscitation.” The in-hospital mortality for such patients approaches 40%.¹

The task force authors intentionally removed several concepts from this recent definition, including SIRS (replaced with SOFA) and severe sepsis (because all sepsis was felt to be severe).

Notably, this latest definition has been criticized for adding new hurdles to an already challenging clinical diagnosis without first prospectively validating these criteria. Furthermore, the definition has been criticized for sacrificing the sensitivity of the SIRS criteria in favor of the slightly better specificity of the qSOFA score. For these reasons, the definition remains unsupported by the Center for Medicare and Medicaid Service, the Centers for Disease Control and Prevention, and some physician groups (most notably, emergency medicine physicians at the front lines of sepsis diagnosis and treatment). For now, we live in a world where multiple definitions of sepsis will coexist for the foreseeable future.^{1,3,5}

Perioperative providers frequently care for patients with sepsis. Although several authors have published sepsis simulation scenarios for residents and medical students, none incorporate the latest sepsis definitions.⁶⁻¹⁴ This simulation case challenges participants to recognize and manage a realistic presentation of postoperative sepsis, providing an opportunity to discuss current concepts of sepsis diagnosis and management during debriefing.

Methods

The simulation is fully presented in the simulation case file (Appendix A). This document contains the script of the case, including the information provided initially to learners as well as a chronological listing of the key case events and their associated triggers. Also available is a debriefing document (Appendix B), a one-page synopsis of the latest clinical definitions of sepsis and the rationale behind current recommendations for sepsis management, with references for further reading. This can be provided to learners at the conclusion of the debriefing.

The posttest and survey document (Appendix C) contains a brief five-question posttest and three-question survey that assess participants' retention of information presented in the debriefing materials. The posttest could be given to trainees at the conclusion of the debriefing or some short time later (e.g., a week after the simulation) to leverage the benefit of spaced repetition to enhance learning and retention.¹⁵

Unfortunately, we developed both the survey and posttest several months after all of the residents had passed through the simulation, so we opted to forgo posttesting this cohort. We plan to utilize the posttest and survey with the next implementation of this scenario in the late spring of 2017. Another document (Appendix D) contains the answers to the posttest questions along with explanations. This can be sent to learners after they have attempted the posttest.

The module also includes a critical action checklist (Appendix E), which contains a rubric by which facilitators can systematically assess the performance of each group of learners. The rubric specifically assesses the ability of learners to accomplish the first three educational objectives of this case. Because we believe that crisis resource management (CRM) skills are the single most important thing that learners can obtain through simulation, we have assigned a higher point value to critical actions pertaining to that domain. The results of this checklist can be shared with learners either qualitatively or quantitatively, with or without a numerical score. Because the score is so heavily weighted toward CRM skills, we believe that sharing the numerical score with learners may help reinforce the importance of this skill set to junior clinical providers.

Equipment/Environment

Monitors required:

- Noninvasive blood pressure cuff.
- Arterial line (if requested).
- Central venous pressure (if requested).
- Pulmonary artery catheter.
- Five-lead EKG.
- Temperature probe (if requested).
- Pulse oximeter.
- Capnograph (if requested).

Other equipment required:

- Anesthesia machine.
- Pumps.
- Simulation mannequin.
- Audio system (to enable communication between the control room and the simulation room).
- Endotracheal tube.
- Laryngoscope.
- Emergency manual.
- Common operating room (OR) drugs.
- Anesthesia cart.
- Norepinephrine infusion.
- Epinephrine infusion.
- Phenylephrine infusion.
- Central line kit and transducer.
- Ultrasound.
- Arterial line kit and transducer.
- Facemask non-rebreather.

Personnel

- OR circulating nurse: an actor who responds to requests from the simulation participants to obtain additional help and equipment and supplies as needed. At institutions where simulation center personnel are not available to play this role, it could potentially be performed by one of the learners.
- Vital sign operator: a faculty member or simulation technician who sits in the control room and steers the patient's vital signs in a preplanned trajectory, adjusting them in response to participant interventions. This individual can also be tasked with inviting anesthesiology trainees into the OR when appropriate.

- Simulation director: a faculty member who directs the simulation. Initially, the faculty needs to hand the case off to the first resident participant and then step out of the simulation room to direct the scenario remotely. The faculty member ideally should have some means of speaking into the simulation room as the voice of the patient (i.e., initially to answer participant questions and then to communicate only unintelligible sounds suggesting altered mental status).
- Participant 1: a participant who assumes the role of anesthesia resident and receives a verbal handoff from the faculty member. This participant is tasked with handling the initial cardiopulmonary decompensation of the patient and is expected to call for help when the situation warrants it. This role could be filled by any of the following: an anesthesia provider (attending or nurse anesthetist), an anesthesia trainee (resident or student nurse anesthetist), or a medical student.
- Participants 2, 3, and 4: participants who are called by the circulator into the room if Participant 1 asks for help. This simulation can work adequately with a total of two to four participants. These roles could be taken by any combination of the following: anesthesia providers (attendings or nurse anesthetists), anesthesia trainees (residents or student nurse anesthetists), surgical residents, or medical students.

Assessment

Participants are evaluated based on their ability to satisfy the learning objectives. The first three objectives are tested during the simulation itself via the critical actions checklist. Specifically, facilitators can use the checklist to assess whether learners demonstrate effective CRM skills, develop a broad differential of circulatory shock that includes sepsis, and take time-sensitive steps to treat sepsis. The last two objectives are tested via the written posttest, which assesses whether learners understand the current competing definitions of sepsis and septic shock and the rationale behind current recommendations for sepsis management.

At the end of the posttest, we present participants with three additional survey questions to determine whether they subjectively feel that the simulation has improved their understanding of sepsis (Likert scale) and what the most and least effective aspects of the simulation are. This enables continuous improvement of the scenario.

Because the critical actions checklist, posttest, and survey were all developed many months after all the residents had passed through this simulation, we felt it was too late to administer these items to this group. Instead, we plan to implement all of these items with the next group of residents who will pass through this simulation in the late spring of 2017.

Debriefing

Once each group of residents runs through the scenario (15-20 minutes), the remainder of the session is dedicated to debriefing (~30 minutes). Structured training in debriefing has been provided to each faculty member as part of a simulation instructor course at the Duke University School of Medicine Patient Safety Center. That course consists of a 2-day workshop followed by proctored training for 6 months in simulation development and implementation.

Facilitators are taught to debrief in a three-stage format adapted from commonly used debriefing protocols.^{16,17} The format consists of reactions, understanding, and a summary.

Reactions

The facilitator prompts learners to describe their immediate emotional reaction to the simulation (e.g., “How did that feel for you?”). The facilitator aims to acknowledge and defuse the learners’ heightened arousal and angst.

Understanding

The facilitator prompts learners to analyze the team’s actions taken during the simulation, starting with big-picture questions and then focusing on specific events. For example, the facilitator might begin by asking learners, “When you walked in, what was going on in the scenario?” Once each learner’s mental frame has

been identified, the facilitator moves on to more specific questions. The following topics are used to guide the discussion:

- Crisis management concepts, specifically designating leadership, anticipation, and planning.
 - “Who was leading the patient’s care? How did that feel?”
 - “What went well? What other leadership qualities allow for optimal patient care?”
 - “What was the team’s plan for the patient’s disposition?”
 - “What, if anything, would you do differently?”
- How sepsis causes hypotension.
 - “What are the four mechanisms of hypotension?” (Low preload, low afterload, obstructive, and cardiac pump dysfunction.)¹⁸
 - “By what mechanism(s) does sepsis cause hypotension?” (Low preload, low afterload, and relative cardiac insufficiency.)
- Updated sepsis definitions.
 - “What are the latest operational definitions of sepsis and septic shock?”
 - “How do these definitions differ from prior definitions?”
- Rationale behind current standards of sepsis management.
 - “What are the priorities of early sepsis management?”
- Indications for central venous and arterial access in sepsis.
 - “When is it appropriate to place an arterial line a septic patient? What about a central line?”

Summary

The facilitator then provides a summary of key points to learners and lastly disseminates debriefing written materials (Appendix B) to them. In the future, we will encourage facilitators to first ask each learner to identify something he or she learned from the simulation: “What learning point can each of you take to the clinical world?”

Although some simulation centers ask learners to run through the same scenario one more time after the debrief session, we have not found this helpful in our experience. We find that the second run-through feels rushed and artificial. For this reason, we have omitted a reenactment of the scenario from our implementation of this simulation.

Results

The exercise described has been implemented as part of a graduated curriculum of simulation-based education for anesthesia residents at a university-based hospital. This simulation was selected to occur at the end of the year for first-year anesthesia residents. The teaching session included four residents and occurred three times over the course of a month. A total of 12 residents completed the simulation scenario. Each teaching session was led by an anesthesiology faculty member and assisted by a simulation technician. Each session lasted 1 hour in simulation and debriefing. The activity will be repeated each year, based on positive informal and formal feedback from both learners and faculty. To ensure the secrecy of the scenario, residents signed confidentiality agreements promising not to discuss the scenario with others outside of the simulation center.

Formal feedback was collected via email questionnaire from faculty instructors within 30 days of teaching each session. Responses included the following:

- Should any additional preparation be required for the simulation besides reading the template?
 - “I read the handout . . . on sepsis to make sure I was up to date prior to teaching the session.”
- What challenges with the case were identified during the simulation?
 - “Biggest challenge was having enough actors to maintain fidelity of the case. . . . 1 person should play a confederate circulator, 1 should run the simulator, and 1 should direct.”
- What aspects of the simulation “worked” or were “good”?
 - “The scenario confronts residents with a realistic presentation of urosepsis.”

- “Teaching objectives were achieved.”
- “Handouts are great.”
- “I had a group of four residents and it worked well to ask three to play anesthesia residents and 1 to play an anesthesia technician.”
- What important issues or key points were discussed during the debriefing?
 - “With the novice learners we had, we spent a good amount of time discussing the medical and technical aspects of managing refractory hypotension and sepsis.”
 - “Debriefed on important crisis management skills, including designating leadership, distributing workloads, and anticipating and planning.”
 - “Rationale behind management of sepsis.”
- Any other comments?
 - “Very educational scenario for our first year residents.”

A total of three faculty members taught the simulation scenario, two of whom were also boarded in critical care medicine. All faculty members had completed a simulation instructor curriculum at the Duke University School of Medicine Patient Safety Center.

Discussion

Sepsis presents a diagnostic dilemma in part because no single diagnostic test rules the syndrome either in or out. Furthermore, multiple operational definitions of sepsis used in the academic literature only add to the confusion for clinicians. Such confusion may have consequences, as delays in timely diagnosis and appropriate treatment of sepsis are associated with worse outcomes for patients.

To help address this issue, we developed a case simulation that challenges perioperative providers to make a timely diagnosis and initiate appropriate treatment of sepsis. During the debriefing, the case lends itself to a discussion of the latest sepsis definitions endorsed by US critical care societies and the rationale behind these definitions. Furthermore, we developed two educational adjuncts that should help clinician educators reinforce the learning objectives of this case: a brief summary of sepsis that includes the latest definitions of the syndrome and a brief five-question posttest that assesses the trainees’ fulfillment of each of the five learning objectives.

The main challenge encountered was finding enough personnel to maintain the fidelity of the case. The simulation requires an actor to serve as the OR circulating nurse, someone trained in simulation software to manage the vital signs and monitors, and a director to supervise the flow of the scenario.

The scenario has been piloted on a total of 12 anesthesia residents. Since the initial pilot, we have developed a critical action checklist, posttest, and survey and plan to use these tools with our next group of anesthesia residents in late spring of 2017. Further revision of the scenario will be influenced by resident feedback in the survey and the results of the posttest.

In our implementations of this simulation, we coupled it with a training session for central venous catheter (CVC) placement. This included having trainees watch a brief educational video about CVC placement and then having them walk through the procedure using a CVC kit and a task trainer. We spent an hour conducting the CVC training before devoting the next hour to the sepsis simulation and debriefing. Possibly because residents were primed to think about CVC placement, they routinely placed CVCs as part of their management of the septic patient. Other training programs that wish to introduce junior trainees to the process of CVC placement may find that this sepsis simulation offers a logical context in which to do so.

Because point-of-care ultrasound has emerged as a powerful bedside tool for the evaluation of unexplained hypotension and respiratory distress, it may add realism to the scenario to include an ultrasound component in the future. Since most institutions do not possess an ultrasound mannequin simulator, an alternative method would be to offer residents an actual ultrasound machine with a phased

array and linear probe and have the learners place the probe on body areas of interest where they want to look for pathology that could explain circulatory shock and respiratory distress.

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Disclosures

None to report.

Funding/Support

None to report.

Ethical Approval

Reported as not applicable.

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Received: October 23, 2016 | **Accepted:** March 6, 2017 | **Published:** March 30, 2017