Diabetic Ketoacidosis in the Obstetric Population: A Simulation Scenario for Anesthesia Providers

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Abstract

Introduction: This simulation on diabetic ketoacidosis (DKA) in the obstetric population presents learners with one of the more commonly encountered etiologies of critical illness in the pregnant patient. It was developed for anesthesiology resident physicians with some background knowledge and experience caring for critically ill patients. Firsthand experience with obstetric anesthesia is not necessary, but background knowledge of the physiologic changes of pregnancy is helpful. Methods: This simulation is designed to be delivered in a single 1-hour session. Educational objectives are designed to reinforce the educational milestones for anesthesiology set forth by the Accreditation Council for Graduate Medical Education and the American Board of Anesthesiology. Materials contained within this simulation include a case template designed to provide facilitators with a general overview of the simulation and a checklist of critical actions that each learner should perform during the scenario. Also included are a brief summary designed to reinforce knowledge gained through this simulation and an evaluation form used to assess the learner’s view of the educational value of this activity. Results: Several eligible learners from the University of Iowa Department of Anesthesiology experienced this simulation content. Comments were generally positive, including “high quality learning and information given” and “It was a good [simulation] focusing on things we don't necessarily talk about.” All learners who returned surveys regarding the simulation answered the question “This simulation enhanced my understanding of how to manage critically ill patients in the perioperative period” with either agree or strongly agree (4 or 5 out of 5). Discussion: This module could be used to improve training on diagnosis and treatment of DKA independent of the focus on obstetrics; by modifying the scenario slightly (emergency general surgery or no surgical issue instead of term pregnancy, for example), the simulation can be tailored to a broader, more diverse target group of learners.

Keywords

Anesthesia, Cesarean Section, Hypoglycemia, Diabetic Ketoacidosis, Obstetric Population, Perioperative Period, Breech, Apgar, Meconium

Educational Objectives

By the end of this simulation, the learner will be able to:
1. Discuss the diagnosis and management of diabetic ketoacidosis in the obstetric population.
2. Discuss rationale for delaying nonemergent surgery in a patient not medically optimized for surgery.
3. Discuss preparation for emergent surgery in the critically ill obstetric patient.
4. Discuss and demonstrate management of a neonate with a poor response to initial resuscitation.
5. Discuss areas of strength and areas for improvement discovered during the simulation.

Introduction

Diabetic ketoacidosis (DKA) is a relatively infrequent but life-threatening pathology that is sometimes seen in the obstetric population. Because of the physiologic changes of pregnancy, including changes in hormone regulation, diabetic pregnant women are predisposed to developing DKA, particularly in the
second and third trimesters of pregnancy. As perioperative consultants, anesthesia providers are increasingly being asked to assist in the management of parturients with major comorbidities, including DKA. As a result, this simulation was created to assist learners in developing the skills and confidence to assist with management of DKA in the obstetric population.

In creating a simulation for anesthesiology trainees, we used our personal experience to assist in the development of the proposed scenario. Treatment guidelines for DKA and neonatal resuscitation were identified in the literature, and these guidelines were utilized as a framework for construction of the simulation, including details of pathophysiology and proposed methods of treatment.

This simulation was instituted at the University of Iowa for resident physicians within the Department of Anesthesiology. Learners from the residency program are required to complete an intern year of training prior to the beginning of anesthesiology specialty training; this intern year includes 1 month of internal medicine and 2 months of intensive care. As a result, resident physicians currently in anesthesiology training are expected to have a baseline level of knowledge of the pathophysiology, diagnosis, and treatment of DKA. In addition, most anesthesiology resident physicians at the University of Iowa have some experience with obstetric anesthesia by the end of their first year of anesthesia training; however, this is not a requirement to experience the simulation.

The format of this simulation is designed to be a single 1-hour session using the adult SimMan (Laerdal Medical) medical simulator connected to standard monitors. The simulation can be proctored by a single instructor with the help of a technician for the high-fidelity medical simulator; having an additional instructor to play the role of the obstetrician on call is beneficial but not necessary. Vital signs are provided throughout the simulation via the monitors connected to the simulator; laboratory results are provided to the learner by the instructor. In addition, a pediatric manikin suitable for practicing resuscitation is necessary for the final phase of the simulation. By using the SimMan medical simulator to provide real-time vital signs and procedural guidance, learners are immersed in this experiential learning opportunity rather than simply participating in a question-and-answer session to learn about the topic at hand, which in turn improves the overall learning experience.

**Methods**

**Educational Approach**

For most learners, experiencing the stress of a high-acuity situation such as DKA firsthand in a high-fidelity simulation is a much more valuable learning experience than simply reading treatment algorithms in a textbook or being lectured to about the importance of insulin and electrolyte management. This simulation (Appendix A) was designed to provide a valuable, memorable educational experience regarding DKA in an otherwise low-risk simulation environment.

Prior to administering the simulation, the primary instructor meets with the simulation technician and secondary instructor (if available to play the role of the on-call obstetrician) to discuss preparation for the scenario. The necessary simulation equipment is obtained and reviewed (see checklist below). Expected directions that the simulation can take are discussed. On beginning the scenario, the history of present illness is given to the student. As the case unfolds, additional information such as laboratory studies and physical exam findings is provided when requested by the learner. Depending on what course the simulation takes, the instructor may provide visual aids (Appendix B) to the learner. During the case, the instructor uses the critical actions checklist (Appendix C) to evaluate the diagnostic and management decisions made by the trainee. The checklist also contains an overall evaluation tool of the learner created from the primary learning objectives. Following the case, the trainee is debriefed using the debriefing summary (Appendix D). Finally, he or she is subsequently given the survey found in the evaluation form (Appendix E) to evaluate both the instructor and the case itself.
Simulation Equipment

- **High-fidelity simulator.**
- **Simulated real-time monitors:**
  - Noninvasive (cuff) blood pressure.
  - Invasive (arterial line) blood pressure.
  - Capnograph.
  - Pulse oximeter.
  - EKG.
  - Temperature.
- **Airway supplies:**
  - Laryngoscope.
  - Supraglottic airways (various sizes).
  - Adult endotracheal tubes (various sizes).
  - Pediatric endotracheal tubes (various sizes).
- **Pre-prepared simulation syringes:**
  - Propofol.
  - Etomidate.
  - Succinylcholine.
  - Rocuronium.
  - Fentanyl.
  - Lidocaine.
  - Ketamine.
  - Midazolam.
  - Ephedrine.
  - Phenylephrine.

Because this simulation is designed to be performed on a high-fidelity simulator for improved efficiency and realism, access to a SimMan or other similar medical simulator is beneficial. The environment is set up to mimic that of an operating theatre with all associated supplies, again to lend a degree of realism to the simulation.

In addition to the instructor facilitating the simulation, it is beneficial to have a technician for the medical simulator to provide changes in patient status and vital signs in real time. It is recommended to have the facilitator and technician discuss the case in its entirety before the simulation is performed to improve communication and coordination between team members. If additional personnel are available, it is also beneficial to have a separate instructor act as the obstetrician on call to provide more realism to the conflict-resolution theme of this simulation.

Learners during the simulation are to be assessed on items that are critical to quality care; these items include both critical actions that need to be taken in diagnosis and treatment (e.g., potassium replacement) and avoidance of critical pitfalls that can occur (e.g., going to surgery before resuscitation). The critical action checklist was created during evaluation of the step-by-step process of the simulation with the goal of providing a list of the most essential steps in caring for the simulated patient; however, as clinical judgment is more important than any single checklist, this list is meant to be modified based on institutional protocols at the discretion of the instructor.

Following the completion of this potentially difficult case, it is recommended that the learner first be given the opportunity for self-reflection with questions such as “Overall, how did you think the case went?,” “What do you think you did well?,” and “What do you think is an area where you could improve?” The instructor then discusses the critical action checklist with the learner, stopping periodically to ask questions about pathophysiology, which will encourage discussion and further learning.
Discussion is complete, the pathophysiology and perioperative management of DKA are summarized in the debriefing summary, which can also be presented to the learner as a handout.

Results
During the 2015-2016 academic year, several eligible anesthesiology resident physicians were able to experience the content of this simulation. The simulation was presented by or with the assistance of the core simulation faculty within the Department of Anesthesiology.

Learners who experienced the content felt it was worthwhile, with all trainees who responded to surveys about the simulation (N = 8) agreeing or strongly agreeing (4 or 5 on a 5-point Likert scale) with the statement “This simulation enhanced my understanding of how to manage critically ill patients in the perioperative period.” Comments were generally positive, including “high quality learning and information given” and “It was a good [simulation] focusing on things we don’t necessarily talk about,” again indicating that anesthesiology resident physicians felt that the simulation was a positive learning experience.

The learning objectives for this scenario were carefully crafted to mirror the critical actions to be performed by the learner during the simulation. By providing positive reinforcement regarding critical actions taken and constructive feedback regarding critical actions missed, each of the learning objectives can quickly and effectively be covered during and after the simulated case.

Discussion
This simulation was created to provide learners the opportunity to manage a critically ill parturient in a realistic, low-risk environment. The opportunity to create this learning experience arose out of a recognized gap in simulation training on this particular issue. Additionally, this module could be used to improve training on diagnosis and treatment of DKA independent of the focus on obstetrics; by modifying the scenario slightly (emergency general surgery or no surgical issue instead of term pregnancy, for example), the simulation can be tailored to a broader, more diverse target group of learners.

The index case was selected based on our personal experience; it was thought, after having been asked by the local obstetrics team to assist in managing DKA in a pregnant patient, that this experience would be valuable for other trainees within the Department of Anesthesiology as well. As a result, the scenario detailed above was created for dissemination to add to the breadth of learning opportunities available to trainees at the University of Iowa.

In the future, this simulation could be expanded to address other forms of critical illness in the pregnant patient, such as peripartum cardiomyopathy, pulmonary embolism, trauma, or other pathology. In addition, this simulation could be expanded in scope to involve learners from the Department of Obstetrics and Gynecology, thereby focusing on improving communication and teamwork as well.

Feedback received from learners who have experienced this content has been largely positive. Based on learner feedback, the simulation was improved in a number of ways, one example of which is by providing laboratory data more readily during the stem of the case in order to focus on management and clinical decision-making rather than diagnosis. Overall, this simulation has been demonstrated to be an effective, valuable learning experience for trainees of all levels within the Department of Anesthesiology at the University of Iowa.

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References

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