

Pediatric Toxidrome Simulation Curriculum: Bupropion Overdose

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Abstract

Introduction: Bupropion is a commonly used antidepressant, and overdose can lead to both neurologic and cardiovascular toxicity, including agitation, seizure, tachycardia, QT and QRS prolongation, and rhythm disturbances. **Methods:** We developed this simulation case for attendings, fellows, nurse practitioners, and nurses in the pediatric emergency department (ED). The scenario involved a 13-year-old male presenting to the ED with altered mental status and a generalized tonic-clonic seizure shortly after arrival. The team needed to quickly perform primary and secondary surveys, manage his airway and breathing, and initiate treatment for seizure. The team had to obtain an abbreviated history and include ingestion in the differential. The patient then developed pulseless ventricular tachycardia, and the team needed to respond with high-quality CPR, defibrillation, and advanced airway management. Preparatory materials, a debriefing guide, and scenario evaluation forms assisted with facilitation. **Results:** Twenty-eight physicians, 56 nurses, 10 nurse practitioners, four pharmacists, two students, and one respiratory therapist completed this simulation in 13 sessions. On a 5-point Likert scale, participants agreed with the stated objective of ability to manage a patient with a bupropion overdose ($M = 4.09$; range, 2-5). The scenario was rated as highly relevant ($M = 4.93$) and the debriefing as very effective ($M = 4.85$). **Discussion:** This scenario is a complete educational resource for setting up, implementing, and debriefing in an interprofessional setting. It was well received by learners from diverse professional backgrounds working together in actual care teams in the pediatric ED.

Keywords

Bupropion Overdose, Seizure, Ventricular Tachycardia, Toxidrome, Simulation, Emergency Medicine, Medical Toxicology

Educational Objectives

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

1. Perform a primary survey of a critically ill pediatric patient.
2. Describe the presentation of a pediatric patient with a bupropion overdose.
3. Diagnose and treat widened QRS in the setting of toxic ingestion.
4. Manage a generalized tonic-clonic seizure in a pediatric patient.
5. Identify and treat pulseless ventricular tachycardia using appropriate Pediatric Advanced Life Support interventions.
6. Demonstrate teamwork and communication skills.

Introduction

Ingestion is an important consideration for the pediatric patient presenting to the emergency department (ED) with altered mental status and seizures. In adolescents older than 16 years with new onset of generalized tonic-clonic seizure, 6% can be attributed to ingestion. In a recent report from the Toxicology Investigators Consortium Case Registry,¹ antidepressants were the most common class of medications to be associated with seizures, and of these, bupropion accounted for nearly half of the cases.

Bupropion is an aminoketone class of antidepressant approved for use in depression and smoking cessation. It is available in standard or extended-release formulations. There is a well-established dose-dependent relationship between bupropion and seizures that has resulted in a maximum daily dose for adults of 450 mg. The therapeutic window is narrow given that observational studies show seizure risk starting at 600 mg daily.² It is a leading etiologic agent described in association with seizures related to both intentional and unintentional ingestion.³

Seizures after bupropion overdose have been reported in 6%-21% of cases; the majority of these were in adults with an

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intentional ingestion. In a retrospective review of unintentional bupropion ingestions in children younger than 6 years, seizures occurred rarely in only 0.7%; more common symptoms included tachycardia (12.3%), nausea (7.9%), hyperactivity (4.4%), and hallucinations (1.2%).⁴ However, multiple seizures have also been reported in younger children who present after an unintentional ingestion.⁵ Adverse effects, including seizures, are more common with the extended-release formulation in both children and adults and can occur in the absence of preceding neurologic symptoms up to 24 hours after ingestion.⁶ Therefore, the current recommendation is for any child ingesting more than 10 mg/kg or an adult ingesting more than the prescribed daily dose to seek care in a medical facility.³

Cardiovascular effects reported in association with bupropion ingestion include tachycardia, QRS prolongation, and QT prolongation. In a report of the National Poison Data System for unintentional ingestions in children younger than 6 years, tachycardia occurred in 3.9%.⁷ Other cardiovascular effects reported include conduction disturbances, hypertension, hypotension, cardiac arrest, and death.⁸ ED providers should be aware of the potential neurologic and cardiovascular effects of bupropion ingestion, as well as the pharmacokinetics of the extended-release formulation.

This simulation-based curriculum requires learners to perform a systematic primary survey, discuss a broad differential for a pediatric patient presenting with agitation and seizures, and demonstrate treatment of both seizure and the cardiovascular sequelae of bupropion ingestion. Simulation is an ideal instructional method because this situation is a rare occurrence that requires immediate recognition and action by the care team. The case covers a novel topic for simulation in the literature and has been developed as part of a collection of pediatric simulations. It may be used in series with other simulation-based curricula from the Pediatric Toxidrome Simulation Curriculum or independently.⁹⁻¹³

Methods

A group of pediatric emergency medicine (PEM) physicians and nurses skilled in curriculum development and simulation developed this scenario as part of an annual interprofessional education curriculum. All PEM attending physicians, fellows, nurses, and advanced nurse practitioners participated in the scenario over the course of a year during one of six offered sessions. We designed this simulation case to assist learners with practicing a systematic approach to emergent patient care; developing a broad differential for the pediatric

patient with altered mental status; managing a life-threatening manifestation of bupropion ingestion; and practicing critical PEM resuscitation skills, including defibrillation and endotracheal intubation. Through participation in this scenario, participants had to demonstrate rapid patient assessment, develop a broad differential, initiate appropriate evaluation based on the differential, manage a tonic-clonic seizure in a pediatric patient, identify abnormal cardiac rhythm due to ingestion, and appropriately treat the potentially fatal cardiac rhythm applying knowledge of Pediatric Advanced Life Support (PALS) algorithms.¹⁴

This curriculum is most appropriate for providers who may encounter a pediatric patient after unintentional or intentional overdose. There were no prerequisite requirements for learners prior to participation in the case other than working in a pediatric ED. Familiarity with PALS, however, was a key to success. The simulation scenario (Appendix A), simulation environment preparation (Appendix B), electrocardiograms (ECGs) necessary for the case (Appendix C), teamwork and communication glossary (Appendix D), debriefing guide (Appendix E), and participant evaluation form (Appendix F) were created for the instructors in preparation for the simulation case. Additional learning materials or background reading could be provided to learners depending on their needs.

Equipment/Environment

We conducted the session in an ED examination room with a high-technology, adult-size manikin. The case could also be run in a simulation laboratory and/or use a low-technology manikin. We began the scenario with the patient on a hospital stretcher after reportedly being brought in by Emergency Medical Services (EMS) personnel. Participants were told that the patient was agitated and muttering incoherently. There was no IV access. Equipment and medications commonly encountered in the ED environment were available (a recommended list is provided in Appendix B). ECG printouts were available to learners at their request (Appendix C). Additional ECGs that could be used to facilitate the case and demonstrate widening of the QRS can be found at the Life in the Fastlane website¹⁵ and on Dr. Smith's ECG Blog.¹⁶

If using a low-technology simulator, vital signs could be reported verbally or written on a board. Simulation applications for phones or tablets could be utilized. Physical examination findings were described as the participants performed their examinations, and tonic-clonic movements were described or simulated as well.

Personnel

This simulation scenario was developed to accommodate approximately eight to 13 learners during each session. We conducted the simulation session with interdisciplinary teams comprising three to five PEM attendings, fellows, or nurse practitioners and four to six PEM nurses, as well as one to two respiratory therapists, one to two nurse technicians, and one to two pharmacists, as available. The session could also be run in a noninterdisciplinary setting or with fewer participants based on the availability of participants functioning in their typical roles. Facilitators included PEM attendings and nurses with expertise in simulation and debriefing. Participants had prior experience with both simulation and medical resuscitations. Participants were oriented to the simulator prior to the case. We found that having participants perform in their usual roles within the health care team maximized realism.

Implementation

The scenario (as provided in detail in Appendix A) began with EMS bringing in an adolescent male with altered mental status from home. Due to the patient's ill appearance, the ED team was called to the bedside. The triage nurse announced that the patient was agitated and altered as the team assembled. A confederate or the facilitator played the role of the parent, who provided a brief history that the patient was found at home talking quickly and acting strange after being home alone for a few hours. Additional history was available at participants' request. After a team member attached monitors, the vital signs listed in the simulation scenario were provided to the care team via a simulated monitor. The manikin was then made to shake to simulate seizure. At participants' request, ECGs (Appendix C) were available demonstrating a widened QRS. The rhythm on the simulated monitor progressed to wide complex ventricular tachycardia. Participants were required to perform CPR and defibrillation per PALS recommendations to stabilize the patient.¹⁴ After resolution of wide complex ventricular tachycardia, the patient remained unresponsive and hypotensive and required intubation (if not already done) for airway support. Laboratory values for requested diagnostic testing were provided by facilitators during the scenario.

Prior to sessions, facilitators were provided with a glossary of teamwork and communication tools (Appendix D). This helped establish a shared understanding and language around teamwork and communication skills. The glossary could also be provided to participants as a learning resource before or after

participation in the scenario. Appendix E was used by facilitators during the session to provide formative feedback during the debrief.

Assessment

We described critical actions for the team to complete at each step of the simulation scenario according to the ideal care of the patient and in accordance with PALS guidelines.¹⁴ Prompts were provided for facilitators to help guide the team if it missed an important step as the scenario unfolded. Participants then had the opportunity to evaluate the simulation case after completion to assess alignment of their experience with our educational goals. Participants completed electronic surveys on tablets immediately after the sessions. Using a 5-point Likert scale (1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, 5 = *strongly agree*), they were asked to rate their agreement with statements related to the fidelity and quality of the simulation and quality of the debrief. After the first session, questions were added to the evaluation regarding participants' perceived confidence in knowledge, skills, and behaviors related to the learning objectives to provide more detailed feedback to facilitators.

Debriefing

After completion of the simulation scenario, the learners and facilitators met to debrief and discuss the case. Participants were first asked to share their reactions to the case. Facilitators then opened the discussion for observations, concerns, and comments by participants. When necessary, we used Appendix E to help engage participants in discussions around specific learning objectives, medical management, and teamwork/communication skills.¹⁷ Facilitators could use the debriefing overview and debriefing guide to help guide the discussion; a medical management evaluation and an evaluation of teamwork and communication that could be used to provide written feedback to learners were also available.

Results

This simulation scenario was utilized for our interprofessional simulation training program for ED staff throughout 2018. We conducted 13 sessions with a total of 125 participants from the interdisciplinary ED team, 101 (80.8%) of whom completed an evaluation immediately after the session. [Table 1](#) describes the roles of the respondents. Two to three facilitators were present for each session from a core group of five PEM attendings and four ED nurse leaders. Immediately following the scenario and debrief, participants were given a survey to complete regarding the effectiveness of the simulation for their learning. After our first

Table 1. Clinical Role of Simulation Participants (n = 101)

Professional Training	No. (%)
Medical doctor	28 (27.8)
Registered nurse	56 (55.4)
Student	2 (2.0)
Nurse practitioner	10 (9.9)
Respiratory therapist	1 (1.0)
Pharmacist	4 (4.0)

session, we added additional questions to the survey to gather feedback regarding the effectiveness of the scenario to meet our learning objectives. The results are summarized for participant experience (Table 2) and clinical confidence after completing the scenario (Table 3).

Overall, the participants rated their experience highly on the Likert scale, with the highest mean scores for the relevance and appropriateness of the scenario and facilitation quality. There was more variation in responses related to the clinical learning objectives, but they remained high overall. Participants rated their confidence highest for managing a generalized tonic-clonic seizure (4.53) and airway, breathing, and circulation (4.44) and lowest for being able to manage a bupropion overdose (4.09).

Discussion

This simulation-based curriculum allows participants to manage life-threatening complications of overdose of a common medication. Currently, there are no published materials related to bupropion overdose in either adult or pediatric patients in MedEdPORTAL. This curriculum was developed as part of an interprofessional educational program within a pediatric ED. Sessions were held over the course of a year so that all attendings, fellows, nurses, and advanced practice nurses

Table 2. Participant Agreement With Statements Related to Experience After Simulation Scenario

Survey Statement	Mean Score ^a (n = 101)	Range
The simulation was relevant to my work.	4.93	4-5
I was sufficiently oriented to the manikin and equipment before the simulation.	4.54	1-5
The facilitator created a safe learning environment.	4.88	3-5
The simulation required critical thinking appropriate to my level of experience.	4.89	4-5
The facilitator was effective in teaching skills appropriate to my level of experience.	4.87	3-5
The facilitator was effective in teaching teamwork and communication skills.	4.83	2-5
The debriefing was effective in identifying areas of improvement.	4.85	2-5

^aRated on a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

Table 3. Participant Agreement With Statements Related to Confidence After Simulation Scenario

Survey Statement	Mean Score ^a (n = 60)	Range
Demonstrate ability to assess and emergently manage airway, breathing, and circulation.	4.44	3-5
Formulate a list of possible diagnoses and prioritize elements of evaluation.	4.27	3-5
Manage a generalized seizure in an acutely ill patient.	4.53	3-5
Operate a defibrillator and deliver the appropriate therapy.	4.27	2-5
Manage a patient with a bupropion overdose.	4.09	2-5

^aRated on a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

working in a single pediatric ED participated once. Respiratory therapists and pharmacists practicing in the ED environment also attended, as able. Because of the large number of participants, we were able to have providers act in the roles in which they typically would work in clinical practice. Having staff function in their typical roles added to the realism of the scenario and allowed for rich discussion during the debrief.

One challenge with implementation was the coordination of personnel to attend sessions throughout the year. Commitment from nursing, physician, and advanced practice nurse leadership was required to prioritize attendance for all employees. We found that it was important to have staff sign up for specific dates at the beginning of the year to ensure groups of relatively similar size with a balanced complement of clinical roles to maximize participant experience and engagement.

As a technical challenge, our simulation software did not allow for a tachycardic rhythm with progressive QRS prolongation. Facilitators provided ECGs demonstrating a prolonged QRS to participants on request and offered clarification if participants inquired regarding the discrepancy between the simulated monitor rhythm and the ECG.

Our facilitation team found that the scenario sometimes ran longer than the allotted educational time. To mitigate this, if participants are proceeding more slowly throughout the scenario, facilitators can shorten the duration of the patient's seizure or allow the patient's ventricular tachycardia to resolve with fewer interventions (doses of epinephrine, number of defibrillations) to ensure sufficient time to debrief team performance, medical management, and communication.

Our learners generally had experience with high-fidelity, interprofessional simulation. Because of this, they were often primed to expect clinical deterioration of the patient during the

case and may have been prepared to initiate advanced therapy and PALS resuscitation algorithms earlier than they would have in a clinical patient encounter. We tried to enhance scenario realism by placing the simulator in a small patient room typically used for the care of patients presenting with agitation rather than the resuscitation bay, where resources and space were more readily available. Although participants frequently identified physical space as a challenge during the debriefing, they acknowledged that it added to scenario realism and provided an opportunity for the facilitation team to discuss strategies for optimizing the placement of equipment and team members during a resuscitation to maximize team performance.

We adapted the evaluation process after our first session to add more questions specifically related to the learning objectives. These additional questions provided feedback on participant confidence in performing the pediatric resuscitation skills included in this scenario. Review of participant self-confidence by the facilitation team will inform which areas to continue to target in future interprofessional education sessions.

In addition to the implementation challenges listed previously, our limitations include the evaluation process because it was based on participant perception and could also be biased by participants knowing and working with the facilitators.

Appendices

- A. Bupropion Simulation Case.docx
- B. Bupropion Environment Preparation.docx
- C. Bupropion ECG Images.pdf
- D. Bupropion Simulation TeamSTEPPS Glossary.docx
- E. Bupropion Debriefing Materials.docx
- F. Bupropion Simulation Evaluation Form.docx

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

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Reported as not applicable.

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