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Isoniazid Poisoning: A Pediatric Simulation Case for Emergency Medicine Residents

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Abstract

Introduction: Seizures in the setting of isoniazid (abbreviated INH, from isonocotinyldiazide) toxicity can be intractable and persistent despite treatment with the usual status epilepticus (SE) medications. If not recognized in a timely fashion, SE can lead to significant morbidity and mortality. This simulation scenario instructs emergency medicine and pediatric residents and fellows in any year of training on the principles and management strategies of approaching a pediatric patient with SE due to INH toxicity. **Methods:** This scenario presents a 5-year-old pediatric patient brought into the emergency department after a witnessed seizure at home, another en route to the emergency department, and a third event in front of the medical provider. This scenario was designed to include one 15- to 20-minute group simulation session, followed by a 10- to 15-minute debriefing of the case. The simulation can be run with a minimum of two participants—one to play the role of physician and the other to play the case director or simulation operator. Also included are visual stimuli consisting of relevant lab results, imaging, and other diagnostic studies. Finally, an educational handout created for all simulation participants reviews important teaching points related to the case. **Results:** To date, 30 residents have participated in this simulation during one of the weekly conference days. In the postactivity survey reviews, residents have reaffirmed their appreciation for their simulation time and have requested more exposure. **Discussion:** Simulation scenarios are an ideal teaching tool for rare and life-threatening diseases, as medical trainees will have little to no prior applied experience with such conditions.

Keywords

Overdose, Seizures, Status Epilepticus, Isoniazid, Toxicology, Pediatrics

Appendices

- A. Simulation Case.docx
- B. Visual Stimuli.pptx
- C. Critical Actions Checklist.docx
- D. Debriefing Materials.docx

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

Educational Objectives

By the end of this module, the learner will be able to:

1. Develop a differential diagnosis for status epilepticus (SE) in a pediatric patient, including toxicological causes.
2. Demonstrate an appropriate initial approach to a pediatric patient with seizure activity.
3. Demonstrate appropriate management of SE and isoniazid toxicity.
4. Identify treatment failure of standard therapies such as benzodiazepines and anticonvulsants.
5. Recognize the need for airway protection in a patient with refractory SE.

Introduction

Unfortunately, status epilepticus (SE) is not often recognized, especially if only signs of subtle SE are present.¹⁻³ Hospital complications from delayed recognition of drug-induced seizures have been studied and include a prolonged hospital course, endotracheal intubation, anoxic brain injury, and death.⁴ This resource was created to assist medical trainees in the general principles of the recognition and management of SE in a child with a focus on SE that is due to isoniazid (abbreviated INH, from isonocotinyldiazide) toxicity. The target audience for this simulation scenario is emergency medicine and pediatric residents or fellows at any level of training. Pediatric advanced life support (PALS) training would be ideal but is not necessary.

This simulation scenario references pharmaceutical guidelines for SE in a pediatric child from Micromedex Solutions and also related simulation scenarios available on MedEdPORTAL. Related toxicological simulation scenarios available on MedEdPORTAL include “A Simulated Patient Encounter of Status Epilepticus,”⁵ in which an adult patient is in SE due to INH toxicity; “Altered Mental Status in an Adolescent Patient,”⁶ in which a 16-year-old develops apnea due to clonidine ingestion; “Lethargic Infant,”⁷ in which a 10-month-old infant develops a generalized seizure, shock, and cardiac arrest; and “Pediatric Simulation: A Seizing Infant in the PACU - Differential Diagnosis and Treatment,”⁸ in which a 6-month-old infant develops seizures due to local anesthetic toxicity.

Methods

The case is fully presented for facilitators in the simulation case file (Appendix A). Visual stimuli materials (Appendix B), including laboratory values, a chest X-ray, a CAT scan, and an EKG, are available for the learner during the simulation. A separate critical actions checklist (Appendix C) is also included for learners to reference while running the simulation. A debriefing handout (Appendix D) is included to facilitate the postassessment session.

Equipment/Environment

The participants find a pediatric manikin reclined on an emergency department stretcher wearing street clothes. The manikin has neither cardiac monitor leads nor an IV line placed until requested by the physician. Available for use is a cardiac monitor with leads, pulse oximeter, blood pressure cuff, and EKG machine. Supplemental oxygen by either nasal cannula or 15-liter face mask is at the bedside. There is also a fully stocked pediatric code cart, including a Broselow tape, PALS medications, vasoactive agents, antiepileptic medications, and medicines necessary for sedation, rapid sequence intubation, and analgesia. Direct laryngoscopes, intubation supplies, a respiratory ventilator, and a manual external defibrillator are available at the bedside.

Due to our institution’s large emergency medicine residency class size and to time limitations, we separated the entire emergency medicine residency into groups based on residency year. At our institution, we have three simulation rooms available, so three scenarios were run simultaneously, and the groups rotated between each station. We recommend no more than five participants per group. Ideally, the scenarios should be repeated for each group, with participants rotating roles.

Personnel

The target audience is emergency medicine and pediatric residents or fellows with basic knowledge about SE and resuscitation. Although PALS training is recommended, it is not necessary for participation in the scenario. The simulation can be run with a minimum of two participants—one to play the role of physician and the other to play the case director or simulation operator. Additional roles may consist of emergency medical services personnel, nurses, attending physician, residents, consultants (pharmacy, neurology, toxicology, ICU), and the patient’s babysitter and family members. An ideal group size would be about five participants. The roles may be played by medical students, resident physicians, fellow physicians, attending physicians, and nurses.

Assessment

A critical actions checklist was created as a guide to assess resident performance. The simulation faculty member should check off in real time the critical actions performed. If residents do not perform a critical action, this should be addressed during the debriefing session. A key component of the critical actions checklist is the administration of medications using appropriate age- and weight-based doses, which can be obtained using a Broselow tape if requested. The dosing of medications provided in the case was obtained by using Micromedex guidelines as a reference.

Debriefing

Our debriefing session is modeled after an integrated conceptual framework for a blended approach to debriefing called PEARLS (promoting excellence and reflective learning in simulation).⁹ The PEARLS framework integrates three common educational strategies used during debriefing, namely, learner self-

assessment, facilitating focused discussion, and providing information in the form of directive feedback and teaching. We begin the debriefing with open-ended questions from the facilitator about how he or she felt the scenario went. The facilitator then fosters participant-led discussion while highlighting the major issues in the case. All secondary participants and observers are included and encouraged to participate in the discussion. The facilitator places emphasis on the learning and thinking process of the learner by attempting to solicit the learner's frame of reference. The facilitator should begin the informal discussion by discussing aspects of the case management that were performed well, followed by discussing areas of the case management where there was need for improvement. The team's decisions in the case should be evaluated in a nonjudgmental manner. Facilitators should place an emphasis on the learning and thinking process from the simulation rather than focusing solely on correct or incorrect answers. They should also help participants and observers identify pearls and pitfalls for critical decision points in the management of patients such as this one.

Examples of questions to use for facilitating the debriefing include the following:

- What are the disease processes that may result in seizures and SE?
- What are possible toxicological etiologies of seizures and SE?
- What etiologies for SE may be resistant to standard anticonvulsant therapy?
- What are appropriate initial steps to take in treating seizures?
- What is the appropriate sequence of medications used to treat SE?
- What are the optimal medications for rapid sequence induction and sedation in this patient?
- In cases with possible trauma, what precautions ought to be taken initially?
- What about during intubation (e.g., pretreatment with lidocaine and fentanyl while using video laryngoscopy)?
- What are indications for consulting neurology or neurosurgery?

A debriefing handout was created to make sure key learning points are discussed during the debriefing session. The handout also has proper weight-based dosing of SE drugs that should be reviewed. The debriefing session should take approximately 15 minutes to complete.

Results

The development of this resource is related to other simulation studies that have been done by the Emergency Medicine Department at Emory University. At our institution, we have been incorporating simulation sessions into our didactic curriculum for nearly 9 years. Our 3-year residency program has 18 residents in each class. All of the residents in our program go through a simulation session every month. The Emory School of Medicine's Center for Experiential Learning has been an active research laboratory since its inception. Significant work has been performed around the role of OSCEs in undergraduate medical education,¹⁰ interprofessional education,¹¹ and palliative medicine.^{12,13} Current work is ongoing around the use of milestone-based simulation assessments in graduate medical education. This work has reinforced the importance of teaching via active, relevant, problem-focused methods for the adult learners we serve.

Once per week, the emergency medicine residents at our institution have a conference day when they are excused from clinical responsibilities. Approximately 30 residents participated in this particular simulation session. All of the residents who participated in the simulation session also participated in the debriefing session and postsession assessment. Currently, residents engage in simulation at least once a month in the simulation center, sporadically during in situ simulations in the clinical setting, and semiannually for individual formal assessments. The latter are rigorous, milestone-based assessments incorporating standardized patients and nurses, with trained faculty raters using standardized assessment tools. During the formative sessions nested in the didactic curriculum, residents participate in small groups and are debriefed in real time by emergency medicine faculty. We primarily use learner satisfaction data from survey instruments given immediately after the simulation experience to assess the quality of the simulation session. In each of the annual and postactivity survey reviews we have sent, residents have reaffirmed their appreciation for their simulation time and have requested more exposure. The high level

of learner satisfaction that was reported prompted us to initiate in situ simulations over the past year focusing on team training and both interprofessional and interdisciplinary communication skills.

This simulation session was taught during a toxicology-themed conference day. In the morning, didactics in general toxicology were given to prime the residents and provide them with background before participating in the simulation session. Previous research in medical education has shown that medical students prefer lecture durations less than 45 minutes, simulation sessions, and the use of multimedia and active participation.^{9,14,15} We prefer to break apart the simulation sessions with debriefing and make each simulation short to maintain the participants' attention. The use of a debriefing session immediately following a simulation session has also been found to be preferred by medical trainees.¹⁶ Debriefing at the end of the session not only provides immediate feedback on performance but also gives students an opportunity to discuss their own personal performance with the instructor in order to develop the habit of lifelong, self-directed adult learning.¹⁶

Discussion

This simulation case could be used with emergency medicine and pediatric residents and fellows from multiple different levels of training. Simulation scenarios are an ideal teaching tool for rare and life-threatening diseases, as medical trainees will have little to no prior applied experience with such conditions. The greatest challenge is the time, space, and faculty members needed to run such an activity. Because time was a constraint, we designed this simulation session to be brief. The simulation session can be run alone or simultaneously with other simulation sessions if done as part of a larger simulation residency conference day. We highly recommend a debriefing be done immediately after the simulation session to not only provide immediate feedback but also give participants the opportunity to reflect on their own personal performance, which is essential to the lifelong adult learner. We chose to incorporate this simulation scenario as a part of a larger simulation conference because of scheduling restraints.

The main challenge that we encountered was having sufficient faculty members and simulation rooms available to run multiple simultaneous sessions. If we had more faculty members and simulation rooms available, then every participant could practice being the group leader, and everyone would be an active participant instead of rotating between being a participant and an observer. We had only three simulation rooms available during the simulation conference day but had the entire class of emergency medicine residents as participants. During the debriefing sessions, we were told that many of the observers felt as if they were bystanders and that they would have had learned more if they had been active participants.

One limitation of this simulation scenario is that it is only a 1-day session for residents to practice management of a difficult pediatric case. Each participant has variable background and experience with managing a pediatric patient in extremis, and it is possible that many have had no experience with managing a pediatric patient with SE. While some participants may find this case relatively straightforward, other participants may grapple with obtaining the diagnosis and making appropriate management decisions. The simulation group leaders need to be flexible and to tailor their teaching points during the debriefing depending on the participants' level of background.

In the future, we will use smaller groups for each simulation session so that every resident will be an active participant and have more opportunities to be the simulation group leader. Also, a limitation of our evaluation tool is that we used only learner satisfaction data to assess the quality of the simulation session. A future goal of ours is to use more objective measures such as learner pre- and posttest data and analyses of post hoc focus group data to better assess the quality of our simulation designs depending on the participants' training levels.

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Ethical Approval

Reported as not applicable.

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