Original Publication

OPEN ACCESS

Pediatric Emergency Medicine Simulation Curriculum: Hyponatremic Seizures

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Citation: Chua W, Burns R, Stone K, Reid J. Pediatric Emergency Medicine Simulation Curriculum: hyponatremic seizures. *MedEdPORTAL*. 2016;12:10498.

https://doi.org/10.15766/mep_2374-8265.10498

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Abstract

Introduction: Seizures are a common complaint in the pediatric emergency department. Effective care of this potentially life-threatening medical emergency requires the ability to stabilize the patient while simultaneously identifying and treating the underlying cause. This simulation-based curriculum involves the identification and management of a generalized seizure in a 4-month-old infant secondary to hyponatremia. The target audience is pediatric and emergency medicine residents, fellows, faculty, and nurses. **Methods:** There is no prerequisite preparation for the trainees prior to the case. The simulation scenario, simulation environment preparation, teamwork and communication glossary, and PowerPoint presentation are provided for the instructor in preparation for the simulation case. The setting is the emergency department (ED) resuscitation room. The simulation can be conducted in the ED resuscitation room or in the simulation lab. We used a high-fidelity infant mannequin. The debriefing tools have been tailored specifically for this scenario with advice on how the instructor can edit them for different learners. **Results:** We have used this curriculum with a group of six pediatric emergency medicine fellows at various stages of their training at our institution. The curriculum received overwhelmingly positive feedback through the evaluation form. **Discussion:** This resource will help support standardization of the teaching process, assisting simulation instructors to maximize their impact. In our experience, we have found that instructors who teach intermittently can successfully foster simulation-based education using similar resources. The inclusion of a learner feedback form supports the instructor's ongoing growth while helping faculty to document their teaching efforts.

Keywords

Simulation, Seizures, Hyponatremia, Pediatrics, Pediatric Emergency Medicine, Electrolyte Abnormality

Appendices

- A. Simulation Case.pdf
- B. Simulation Environment Preparation.pdf
- C. CXR EKG.pdf
- D. Teamwork and Communication Glossary .pdf
- E. Debriefing Materials.pdf
- F. Simulation Session Evaluation Form.pdf
- G. PowerPoint Presentation .pptx

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

Educational Objectives

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

1. Perform a primary survey of a pediatric patient in extremis.
2. Recognize and manage a generalized tonic-clonic seizure.
3. Demonstrate effective teamwork and communication skills.
4. Identify and manage hyponatremia-induced seizures.

Introduction

Seizures can present a significant challenge to health care providers. Effective care of this potentially life-threatening medical emergency requires the ability to stabilize the patient while simultaneously identifying and treating the underlying cause. Maintaining a wide differential is imperative as various etiologies can present with seizures.

Seizures can be the presenting symptom for medical conditions that include infectious, neurologic, metabolic, and traumatic causes. In general, there is an estimated 6% lifetime risk of having an acute symptomatic seizure.¹ This simulation scenario provides an opportunity for the learner to develop a systematic approach to work up and manage hyponatremia as a specific cause of seizures in pediatric patients. In general, hyponatremia is caused by a disturbance to the body's ability to regulate water. The

effective plasma osmolarity or tonicity is tightly regulated, as maintaining the appropriate concentration of solutes is vital to cellular function. Thirst and the regulation of antidiuretic hormone (ADH) maintain normal plasma sodium levels between 135 and 145 mEq/L. The incidence of hyponatremia in hospitalized children ranges from 17% to 45%.^{2,3}

Hyponatremia can be caused by intrinsic and extrinsic factors. Surgical interventions, respiratory infections, and head injuries are associated with inappropriate release of ADH, which can lead to electrolyte abnormalities. Hyponatremia may also be caused by feeding hypotonic fluids to infants, leading to aberrations of plasma tonicity. Risk factors include poverty, misleading advertising, and specific cultural practices. Young infants with acute gastroenteritis are especially prone to developing hyponatremia, but any child being fed excess free water has the potential of developing symptomatic hyponatremia.⁴

The initial step in resuscitating and stabilizing a child who presents with seizures starts with a thorough primary survey. Patients should be assessed to determine whether they are capable of protecting their airway and maintaining breathing and circulation. Patients may need to be repositioned with neck rolls or jaw thrusts to open the airway. Adjuncts such as nasopharyngeal or oral airways may be used to optimize the airway as well. Children who are not adequately oxygenating should be given supplemental oxygen. Bag-mask ventilation may be used to augment breathing if respiratory effort is insufficient. Ultimately, children unable to protect their airway against aspiration or requiring prolonged bag-mask ventilation should be intubated for stabilization.

Children with seizures that last less than 5 minutes should be managed with benzodiazepines and other antiepileptics, but if laboratory evaluation demonstrates hyponatremia, emergent reversal of the hyponatremia (e.g., administration of hypertonic saline) will often be required to stop seizure activity.

This simulation-based curriculum enables learners to perform a systematic primary survey, discuss a broad differential for managing seizures, and demonstrate the treatment of refractory seizures secondary to hyponatremia. This curriculum provides structured education in developing a broad differential and treating status epilepticus caused by hyponatremia. It may be used in series with other simulation-based curricula from the Pediatric Emergency Medicine Simulation Curriculum⁵⁻¹⁶ but may also be used independently, depending on learners needs.

Methods

This simulation case was designed to help learners create a systematic approach to diagnosing, managing, and treating status epilepticus. Given the wide differential diagnoses for patients who present in status epilepticus, it is critical to have an organized approach to identify the underlying etiology and to implement the appropriate interventions. There is no prerequisite preparation for the trainees prior to the case. The simulation scenario (Appendix A), simulation environment preparation (Appendix B), teamwork and communication (TeamSTEPPS¹⁷) glossary (Appendix D), and PowerPoint presentation (Appendix G) are provided for the instructor in preparation for the simulation case. Additional learning material may be provided to learners before participation depending on background and needs.^{18,19}

The setting is the emergency department (ED) resuscitation room. The simulation can be conducted in the ED resuscitation room or in the simulation lab. We used a high-fidelity infant mannequin. An internal response to the resuscitation room is announced in the ED, and the patient is brought the resuscitation room with generalized tonic-clonic movements by the triage nurse. Gentle shaking of the mannequin can be employed to demonstrate seizure activity. The bedside nurse attaches the mannequin to monitors with vital signs as described in the simulation scenario. Printouts of the chest X-ray and electrocardiogram (Appendix C) are made available to hand out to the trainees. Clinical changes and laboratory findings are verbally provided throughout the simulation case. Vital sign changes can be demonstrated on the monitor.

This simulation scenario can be adjusted to accommodate five to 10 trainees per session. The target audience is pediatric and emergency medicine residents, fellows, faculty, and nurses. This scenario is most realistic and achieves maximal learning if all participants are functioning in their normal roles, with the same number of participants as would typically be expected in their health care team (i.e., nurses

perform nursing roles, physicians perform physician roles). If a more experienced physician would normally function as the team leader, he or she should play that role in the simulation. If a response team at an institution normally consists of seven respondents, this should be the target number of trainees. If necessary, trainees or confederates can act any unfilled roles, or those roles can be left unfilled. However, the instructor should be aware that this might compromise realism and make learning objectives harder to achieve.

If using a low-fidelity mannequin, vital signs may be provided verbally or via a simulator application for a phone or tablet. Physical exam findings can be described concurrently with the learner's examination of the mannequin. Shaking related to the seizure may be described or simulated using a vibrating device such as a massage pad placed under the mannequin.

After the completion of the simulation scenario, the trainees and facilitators meet in the debriefing room to discuss the case. The most valuable component of simulation education is the debriefing session. The debriefing overview and debriefing guide are used to facilitate the discussion while the medical management evaluation/debriefing form and the teamwork and communication evaluation/debriefing form are used to help provide written formative feedback to learners (Appendix E). The simulation session evaluation form (Appendix F) is used to obtain feedback and evaluation on the simulation session. The PowerPoint slides (Appendix G) are used to help deliver content knowledge regarding seizures in infants and the diagnosis and management of hyponatremic seizures.

Results

We have used this curriculum with a group of six pediatric emergency medicine fellows at various stages of their training at our institution. The curriculum received overwhelmingly positive feedback through the evaluation form. Participants strongly agreed with the statements "The simulation case provided is relevant to my work," "The simulation case was realistic," "This simulation case was effective in teaching basic resuscitation skills," "This simulation case was effective in teaching hyponatremic seizure management skills," "The debrief created a safe environment," and "The debrief promoted reflection and team discussion." Participants reported that their clinical practice has changed due to the knowledge and skills obtained through this curriculum. Specifically, participants reported that they improved their ability to identify and manage hyponatremic seizures in both infant and adult patients as a direct outcome of participation. They remarked in particular that they considered checking electrolytes in the setting of new-onset afebrile seizures and could recall dosing for hypertonic saline.

A limitation noted during implementation is maintaining the realism of a seizing infant to convey urgency in the situation. The facilitator often has to reemphasize when the patient is actively seizing if this is not obvious within the constraints of the equipment.

Discussion

This resource is designed to help support instructors from start to finish in teaching the recognition and management of hyponatremic seizure to a wide variety of learner groups. This case represents a low-frequency, high-risk scenario that physicians and nurses caring for children must be familiar with in order to provide timely and appropriate care.

Road-testing this scenario was critical to refining details of the introductory material, the scenario itself, and the feedback materials. In the future, we would like to include nursing staff. Given restraints in schedules at our institution, facilitators often have to role-play, acting as nurses. For increased realism, having actual nurses fill these roles would be beneficial.

An additional limitation we have found while implementing this curriculum is the challenge of seizure activity using the infant simulator. Using a model that has a seizure feature or adding an adjunct to the scenario that could be used to demonstrate seizure activity would increase realism and may prompt learners to more quickly identify and manage a generalized tonic-clonic seizure.

We have tried to consolidate the information that the instructor would need into as few sources as

possible. The scenario itself includes cues to help the instructor respond to the learners' questions and interventions in real time. The debriefing guide and debriefing forms have been designed to help address issues that could arise, based on our experiences, while allowing instructors the flexibility to tailor their educational objectives to their learners. Although it is difficult to address more than three of these issues per session, we chose to include more potential issues, permitting instructors to focus on those most relevant to their groups of learners.

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Disclosures

None to report.

Funding/Support

None to report.

Ethical Approval

Reported as not applicable.

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Received: June 16, 2016 | **Accepted:** October 31, 2016 | **Published:** November 10, 2016