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Pediatric Emergency Medicine Simulation Curriculum: Marijuana Ingestion

Carson Burns, MD*, Rebekah Burns, MD, Elizabeth Sanseau, MD, MS, Suzan Mazor, MD, Jennifer Reid, MD, Kimberly Stone, MD, Anita Thomas, MD, MPH

*Corresponding author: carson.burns@seattlechildrens.org

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Abstract

Introduction: Altered mental status can be a challenging presenting symptom in children due to the wide differential diagnosis, which ranges from the relatively benign to the life threatening. Marijuana ingestion and unintentional intoxication are becoming an increasingly common cause of altered mental status in children as marijuana use and availability of enticing marijuana edibles increase in the United States. Because children present with altered mental status rather than the typical marijuana toxidrome, appropriately managing these patients in emergency settings can be particularly challenging. **Methods:** This simulation-based curriculum involved the evaluation and management of a 6-year-old boy who presented with altered mental status from acute marijuana intoxication unbeknownst to his parents. Participants systematically evaluated a pediatric patient with a broad differential diagnosis of altered mental status and managed the patient with acute marijuana intoxication. This scenario may be modified based on trainee level (medical student vs. resident vs. fellow). **Results:** A total of 20 trainees comprising six emergency medicine fellows and 14 pediatric residents and medical students participated in this simulation curriculum over three iterations. Trainees consistently rated it as an overall positive learning experience for pediatric altered mental status and toxidrome education. **Discussion:** Low-frequency, high-risk illnesses such as altered mental status due to marijuana intoxication require providers to be familiar with their evaluation and management. This curriculum provides instructors with the materials to successfully implement and improve the simulation over time.

Keywords

Simulation, Altered Mental Status, Toxicology, Ingestion, Pediatrics, Pediatric Emergency Medicine, Lethargy, Marijuana

Educational Objectives

After the end of the session, participants will be able to:

1. Formulate a systematic approach to the evaluation and management of altered mental status.
2. Describe the signs and symptoms of marijuana intoxication in a pediatric patient.
3. Demonstrate teamwork using the principles of crisis resource management.

Introduction

Altered mental status (AMS) can be a challenging presenting symptom in pediatric patients because the potential causes range from the relatively minor to the life threatening. Appropriate care requires the provider to stabilize the patient while simultaneously determining the underlying etiology. Furthermore, the differential diagnosis is broad and can be divided into primary central nervous system (CNS) versus systemic processes. Primary CNS causes include trauma, tumor, infection, stroke, and seizure; systemic causes may include hypoxemia, abnormal body temperature, hypoglycemia, diabetic ketoacidosis, electrolyte disorders, uremia, endocrinopathies, inborn errors of metabolism, intussusception, exogenous toxins, and systemic infections.[1] This simulation scenario allows the learner to develop and apply a systematic approach to work up and manage a child with AMS caused by marijuana ingestion.

Appendices

A. Marijuana Ingestion Simulation Case.docx
B. Simulation Environment Preparation.docx
C. TeamSTEPPS Glossary .docx
D. Imaging, EKG, and Cookie .pdf
E. Debriefing Materials.docx
F. Evaluation Form.docx
G. PowerPoint Presentation .pptx

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

Initial management of a pediatric patient with AMS should begin with a primary survey to assess the patient's ability to protect his or her airway, followed by evaluation of breathing, circulation, and neurologic deficits, including vital signs and immediate intervention as needed. A secondary survey should follow while intravenous access is obtained, including evaluation for the characteristic toxidrome signs and symptoms. Laboratory evaluation should begin with a point-of-care glucose and may also include venous blood gas, serum electrolytes, liver function tests, blood urea nitrogen, creatinine, complete blood count, ammonia, lipase, lactate, salicylate level, acetaminophen level, blood alcohol level, and a rapid urine toxicology screen. A focused history should review the events leading up to the onset of AMS, recent trauma or symptoms of infection, potential medication or toxin exposures, allergies, and the patient's past medical history.

Marijuana use has increased significantly in the United States over the last decade, and legalization at the state level is increasingly more common.[2] In 2015, over 13% of adults reported having used marijuana within the past year.[3] In 2017, more than 50% of US adults supported legalization.[4] As of 2017, 29 states and Washington, DC, have decriminalized or legalized marijuana for either medical or recreational use.[5] Unintentional marijuana ingestions among children have historically been very rare. However, with decriminalization and legalization, marijuana is now commercially available in baked goods, soft drinks, and candies, which may be enticing to young children. Furthermore, not all states require child-resistant packaging.[6,7] A marked increase in unintentional marijuana exposures among children aged less than 12 years occurred following decriminalization of marijuana in Colorado.[8] Most of those exposures were from ingestion of marijuana in a food product, suggesting inadequacy or lack of child-resistant containers and the enticing nature of marijuana edibles to children.[8] After legalization in Washington state, Washington poison control had a 55% increase in marijuana-related calls, and 19% of these calls in 2014 were regarding children ages 12 or younger.[9] Given the risk of potential intentional or unintentional exposure, pediatric providers, especially those in states with decriminalized or legalized marijuana, need to be able to recognize and appropriately manage children with marijuana intoxication.

The primary active ingredient in marijuana is Δ-9-tetrahydrocannabinol (THC), which binds to cannabinoid receptors in the regions of the brain involved in cognition, memory, reward, pain perception, and motor coordination.[10,11] In general, acute adverse effects in a naive user may include symptoms of disorientation, impaired memory, panic, and anxiety.[10,11] Physical examination findings may include tachycardia, dilated and sluggish pupils, injected conjunctiva, ataxia, disorientation, stupor, or coma.[11] Younger pediatric patients may present with signs of CNS depression, such as lethargy or somnolence, with the most serious effect being respiratory insufficiency and coma.[8,12-17]

Acute marijuana toxicity requires only supportive care. Depending on the effective dose, the child may recover after several hours of observation or require admission to the hospital wards or intensive care unit for persistent AMS and/or respiratory insufficiency.[12] Cases of unintentional marijuana ingestion should be reported to the local poison control center for epidemiologic tracking. Depending on the social and family situations, providers may need to engage additional social support or child protective services.

MedEdPORTAL has published simulation-based curricula for synthetic cannabinoid toxicity in an adult patient and AMS in a toddler with cerebral sinovenous thrombosis, as well as one educational module on pediatric AMS.[18-20] Our simulation-based curriculum adds to the literature by providing an opportunity to assess and stabilize a 6-year-old pediatric patient presenting with AMS caused by marijuana intoxication. The target audience of the simulation is trainees in pediatrics and/or emergency medicine, including medical students, residents, fellows, faculty, and nurses. The simulation requires learners to perform a primary and secondary survey while gathering relevant historical data. Learners must systematically evaluate for potential causes of AMS and demonstrate supportive care for a child with marijuana intoxication. Prerequisite knowledge includes the evaluation and management of an unstable child. This

resource may be used independently or in series with other simulations from the Pediatric Emergency Medicine Simulation Curriculum[21-34] or the Pediatric Toxidrome Simulation Curriculum[35-38] available in *MedEdPORTAL*.

Methods

Development

We designed this simulation to help learners develop a systematic approach to diagnose, manage, and treat children with AMS caused by marijuana intoxication. The case does not inherently require prerequisite preparation; however, facilitators may distribute additional learning material before the case depending on learners' prior knowledge. The curriculum provides the instructor with all materials needed for implementation, including the simulation case template (Appendix A); simulation environment preparation guide (Appendix B); teamwork and communication glossary[39] (Appendix C); chest X-ray, abdominal X-ray, electrocardiogram (EKG), focused assessment with sonography in trauma (FAST) images, and photo of a marijuana cookie (Appendix D); debriefing materials (Appendix E); evaluation form (Appendix F); and PowerPoint presentation (Appendix G).

Equipment/Environment

We conducted the simulation in the emergency department resuscitation room during the first iteration and in a hospital inpatient room during the second two iterations due to room availability. However, the simulation can be conducted in any hospital patient room or simulation lab. Similarly, we used a high-fidelity child mannequin, although a low-fidelity mannequin may be used with adjustments. Prior to the participants' arrival, we prepared the room with the mannequin; bedside equipment such as monitors, stethoscopes, and intravenous supplies; and respiratory supplies such as nasal cannulas, oxygen hook-up, oral and nasal airways, bag-mask system, suction devices, endotracheal tubes, laryngoscope, and end-tidal carbon dioxide colorimeter. Additionally, we prepared printouts of a normal chest X-ray, EKG, FAST images, abdominal X-ray, and computerized tomography (CT) head images. If a low-fidelity mannequin were to be used, the instructor could provide the vital signs verbally or via a simulator application on a smartphone or tablet. The instructor could also describe physical exam findings while the learner examines the mannequin.

Personnel

The target audience was five to 10 trainees in pediatric and/or emergency medicine, including medical students, residents, fellows, faculty, and nurses, ideally with each member performing his or her usual role during the simulation (e.g., nurses performing nursing roles, resident physicians performing primary and secondary surveys, experienced physicians such as fellows or faculty performing team leader roles). We also aimed to have the team be the same number of health care providers as would be expected to respond within the hospital. However, due to scheduling limitations, we conducted the simulation with only medical students, pediatric residents, and pediatric emergency medicine fellows. The facilitator answered questions in the role of the parent. Additional personnel included the simulation technician. Due to these limitations, the instructor allowed the residents to act in the nursing and team leader roles, which compromised realism to some extent. If necessary, the instructor could also allow confederates to act in any unfilled roles or leave roles unfilled; however, this might similarly compromise realism or the ability to achieve the learning objectives.

Implementation

To begin the scenario, the facilitator announced an internal response to the resuscitation room, where the learners found the mannequin with AMS. The participant performing the role of bedside nurse attached the mannequin to monitors with vital signs as described in the simulation scenario. The simulation technician displayed vital signs on the monitor. As the learners assessed and managed the patient, the facilitator made printouts of imaging and diagnostic test results (Appendix D) available when requested by

the learners, as well as announcing clinical changes and laboratory results throughout the simulation. Using Appendix A as a guide, the facilitator also answered history questions in the role of the parent, and the technician intermittently responded to participants' questions via the mannequin in the role of the child with statements such as "I'm confused."

Assessment and Debriefing

When the scenario was completed, the instructor and learners debriefed using the debriefing materials and glossary to facilitate discussion (Appendices C & E). The debriefing session was often the most valuable component of the simulation. The facilitator provided formative assessments verbally during the debriefing session. Learners were evaluated on their ability to perform primary and secondary surveys, use effective teamwork and communication skills, identify and develop a differential diagnosis for AMS, judiciously use diagnostic tests, and manage AMS caused by marijuana ingestion. The PowerPoint slides (Appendix G) helped deliver content knowledge regarding AMS and unintentional drug exposure in children. Finally, learners were asked to complete the evaluation form (Appendix F) to provide feedback on the simulation. We used feedback from the learners to modify the scenario as described in the Results and Discussion sections.

Results

This simulation case was in use at our institution as part of the simulation curriculum for pediatric emergency medicine fellows, pediatric residents, and medical students at various stages of training. We used this curriculum over three iterations, with six pediatric emergency medicine fellows and 14 pediatric residents and medical students in total. The curriculum received strongly positive feedback via the evaluation forms. Learners agreed with these 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," "The debrief created a safe environment," and "The debrief promoted reflection and team discussion" (Table 1). In particular, learners remarked that this scenario was useful in developing a differential diagnosis and managing a pediatric patient with AMS in the emergency department. Furthermore, they reported that they would consider marijuana and other ingestions more quickly in their differential diagnoses of AMS in pediatric patients, ask parents specifically about possible marijuana exposure, and order toxicology screens sooner in their management.

Table 1. Initial Participant Feedback on Simulation as Part of Pediatric Emergency Medicine Fellow and Pediatric Resident Simulation Curricula

Statement	*Mdn* Likert Score[a] (*N* = 12)	Range of Likert Scores (*N* = 12)
This case presented during the simulation is relevant to my work.	5	4-5
The simulation case was realistic.	5	3.5-5
This simulation case was effective in teaching basic resuscitation skills.[b]	5	3-5
I was able to practice assessing and emergently managing airway, breathing, and circulation.[b]	4	3-5
I can formulate a systematic approach (i.e., differential diagnosis) to the evaluation and management of pediatric altered mental status.	5	4-5
I feel comfortable describing the signs and symptoms of THC exposure in a pediatric patient.	5	4-5
The simulation allowed me to practice teamwork using principles of crisis resource management.[b]	5	4-5
I feel confident in constructing a disposition plan for a patient with THC exposure after stabilization in the emergency department.	4.5	1-5
The debrief promoted reflection and team discussion.	5	3-5
The facilitators created a safe environment for discussion and exploration.	5	5-5

[a]1 = *strongly disagree,* 2 = *disagree,* 3 = *neutral,* 4 = *agree,* 5 = *strongly agree.*
[b]*N* = 11.

After the first iteration, we incorporated a normal two-view abdominal X-ray, FAST images, and normal complete blood count with differential based on feedback. After the second iteration, we revised the participant feedback form to assess learner confidence with objectives, particularly to assess learners' ability to recognize AMS versus ingestion, and to prioritize elements of evaluation of AMS (Table 2).

Table 2. Revised Participant Feedback on Simulation as Part of Pediatric Emergency Medicine Fellow and Pediatric Resident Simulation Curricula

Statement	*Mdn* Likert Score[a] (*N* = 8)	Range of Likert Scores (*N* = 8)
This case presented during the simulation is relevant to my work.	5	4-5
The simulation case was realistic.	5	3.5-5
This simulation case was effective in teaching basic resuscitation skills.	5	3-5
The debrief promoted reflection and team discussion.	5	3-5
The group discussion helped me develop and prioritize evaluation and management options for a child with altered mental status from THC exposure.	5	4-5
The facilitators created a safe environment for discussion and exploration.	5	5-5
After participating in this session how confident are you in your ability to:		
Demonstrate ability to assess and emergently manage airway, breathing, and circulation.	4	3-5
Recognize the signs and symptoms of altered mental status.	4.5	4-5
Formulate a differential diagnosis for altered mental status and prioritize elements of evaluation.	5	4-5
Recognize potential ingestions (alcohol/drugs).	5	4-5
Construct a disposition plan after stabilization in the emergency department.	4.5	1-5

[a]1 = *strongly disagree,* 2 = *disagree,* 3 = *neutral,* 4 = *agree,* 5 = *strongly agree.*

Discussion

Because of increasing rates of children unintentionally ingesting marijuana products, health care providers who care for pediatric patients in emergency settings need to be able to recognize and manage pediatric patients who present with AMS due to marijuana intoxication. To care for patients presenting with low-frequency, high-risk illnesses, providers need to be familiar with the clinical presentation, evaluation, and management while working as a team. This simulation-based curriculum provides instructors with the resources to teach medical trainees how to systematically approach a child with AMS and manage a child with marijuana intoxication.

After the first iteration, we added FAST images based on learner feedback, which helped subsequent learners consider trauma or other intraabdominal processes as less likely among their differential diagnoses. During the third iteration, we used an updated feedback form to capture the learners' confidence with the objectives, specifically, to recognize AMS and ingestion and to prioritize elements of the evaluation (Table 2). Learners remarked that the simulation emphasized integral aspects of caring for patients with AMS who, in the absence of trauma, do not ultimately require intubation, seizure rescue, or advanced imaging such as a head CT. Correspondingly, learners reported that this simulation in particular provided less of an opportunity to demonstrate their ability to emergently manage airway, breathing, and circulation (Tables 1-2). If facilitators would like their learners to practice securing an airway, they can consider adapting the simulation so that the child has mental status changes requiring intubation. That said, several learners reflected that performing observation and repeat examinations of a lethargic child as the emergency provider while waiting for the toxicology screen results was more challenging than performing expensive or invasive procedures such as a head CT, intubation, or lumbar puncture. Similarly, learners rated the simulation particularly strong in developing confidence in their ability to formulate a differential diagnosis for AMS and prioritize elements of evaluation (Table 2). In most cases, pediatric patients with AMS from marijuana intoxication require only observation and supportive care.

One challenge, as with many simulation cases, was the inability to involve nurses due to scheduling limitations. Medical students, residents, and fellows filled in these roles, which limited the realism of the simulation. Another challenge occurred when the learners requested a urine toxicology screen very early during the third iteration. Rather than providing the positive THC result immediately, we delayed it until 10 minutes into the simulation to allow the learners to develop and work through a differential diagnosis of AMS. We learned during feedback that this was both well received and felt to be more reflective of a real-life scenario. In reality, the rapid urine drug abuse screen returns results in 1 hour at our institution. We recommend that users of this curriculum adapt the relative diagnostic result times during the simulation to be proportional to the times required for diagnostic studies at their respective institutions. One limitation was the inability to stratify results by trainee level of experience because we did not ask the learners to

identify as medical student, resident, or fellow on the feedback forms in order to protect anonymity. Additionally, we did not perform pre- and postsimulation tests on management of AMS and marijuana intoxication, so our results are limited to learners' perceptions of their relative abilities rather than actual knowledge or skill.

The scenario and materials in the Appendices include more detail on the patient's clinical presentation, expected course of the case, and cues and timing for instructors to provide information to learners, as well as a debriefing guide, slide set, and evaluation forms. This curriculum provides instructors with the tools needed to implement the simulation and to elicit feedback to improve it over time.

Carson Burns, MD: Resident, Department of Pediatrics, Seattle Children's Hospital; Resident, Department of Pediatrics, University of Washington School of Medicine

Rebekah Burns, MD: Assistant Professor, Department of Pediatrics, University of Washington School of Medicine

Elizabeth Sanseau, MD, MS: Pediatrician, Yukon-Kuskokwim Health Corporation

Suzan Mazor, MD: Associate Professor, Department of Pediatrics, University of Washington School of Medicine

Jennifer Reid, MD: Associate Professor, Department of Pediatrics, University of Washington School of Medicine

Kimberly Stone, MD: Associate Professor, Department of Pediatrics, University of Washington School of Medicine

Anita Thomas, MD, MPH: Assistant Professor, Department of Pediatrics, University of Washington School of Medicine

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