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Rodenticide Causing Lower Gastrointestinal Bleeding: Resident Simulation

Rohit B. Sangal, MD, Lauren W. Conlon, MD*
*Corresponding author: rohit.sangal@uphs.upenn.edu

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Appendices

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

Abstract

Introduction: Gastrointestinal (GI) bleeding is becoming more common with an aging population. Lower GI bleeding is less common than its upper GI bleed counterpart. Incidence of bleeding is increasing because more patients are on anticoagulation medication. Abnormal coagulation can lead to this life-threatening condition requiring rapid diagnosis and treatment by a skilled medical provider. Simulation can be used to practice recognition of this disease process and work through treatment algorithms. **Methods:** This simulation case used a high-fidelity simulator to teach emergency medicine providers how to manage lower GI bleeding in a patient with abnormal coagulation secondary to intentional ingestion of rodenticide. The case simulated a 58-year-old female with history of bipolar disorder presenting with brisk rectal bleeding. Residents were expected to identify the type of GI bleed, leading to recognition that the patient was in hemorrhagic shock; they then had to appropriately reverse the anticoagulation and resuscitate with blood products. Afterward, learners were given a short survey to evaluate the case and debriefing process. **Results:** The case was performed at the University of Pennsylvania Simulation Center as part of the Emergency Medicine Resident Simulation Curriculum. Twenty-eight learners took part; of these, 20 (71%) found the simulation realistic, and 24 (86%) agreed or strongly agreed that the simulation was useful. **Discussion:** Main learning points include management of lower GI bleeding and reversal of abnormal anticoagulation. This simulation case is straightforward to run, requires minimal resources, and has been well received by learners at our institution.

Keywords

Simulation, Emergency Medicine, Warfarin, Gastrointestinal Bleeding

Educational Objectives

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

1. Organize a patient-care team.
2. Recognize lower gastrointestinal bleed.
3. Recognize classes of hemorrhagic shock and administer treatment (blood transfusion).
4. Consider differential diagnosis of coagulopathy.
5. Recognize rodenticide-induced coagulopathy and administer appropriate reversal agents such as vitamin K and other coagulants.
6. Order appropriate imaging and notify appropriate consultants.

Introduction

Gastrointestinal (GI) bleeding has traditionally been subdivided into upper and lower bleeding, with lower GI bleeding defined as occurring beyond the ligament of Treitz. About a quarter of GI bleeds are lower GI; of those, most present as hematochezia. The common etiologies include diverticulosis, angiodysplasia, and colorectal cancer. The incidence of these diseases is increasing with an aging population, therefore making it important for providers to understand the management of this process.[1,2] Furthermore, patients are increasingly on anticoagulation medication, including vitamin K antagonists or novel oral anticoagulants, which can potentiate life-threatening bleeding.[3] We developed a simulation case adapted from a patient seen in our emergency department to help residents learn how to approach lower GI bleeding and emergent reversal of anticoagulation. To increase complexity for advanced learners, this case involved the ingestion of a rodenticide. These superwarfarins are 100 times more potent than warfarin and have half-lives on the order of days to weeks, as opposed to hours on warfarin.[4] Despite this, management of patients with significant bleeding who have been exposed to rodenticide is similar to that of regular warfarin, including use of vitamin K (albeit at high doses), fresh frozen plasma, or—more currently—prothrombin complex concentrate.[4]

This simulation case was generated to meet a learning need at our institution. Rote memorization, static didactic presentations, and disseminated clinical pathways were previously utilized strategies to teach management of lower GI bleeding. We discovered house staff were not uniformly aware of the institutional protocol for lower GI bleeding that was initiated over 5 years ago based on efforts of faculty within the Departments of Emergency Medicine (EM), Gastroenterology, and Surgery. The purpose of this resource was to provide real-time learning and feedback to learners on this disease process and promote teamwork between residents and nursing staff. We have not identified another lower GI bleed case available on *MedEdPORTAL*. Furthermore, this case discusses a rare presentation of acute rodenticide overdose. There are published cases of upper GI bleed and anticoagulated patients with traumatic head injury available on *MedEdPORTAL* that can complement this case.[5-7] The case's format is similar to others published at our institution, which all can be used to develop and/or enhance simulation courses for other programs.[8-13]

Methods

Development

Our simulation was targeted to EM residents; the simulation occurred during regular weekly conferences at our institution. Simulation time was 4 hours, from 8:00 a.m. to 12:00 p.m. on Wednesday mornings. Four cases were run simultaneously, with residents broken into smaller groups prior to simulation start. See the Table for a sample schedule for simulation day. No prerequisite knowledge was required for this case; however, basic understanding of resuscitations was helpful. Prior to the simulation cases, an introduction to the simulator and the schedule for the day was conducted with all participants.

Table. Sample Schedule for Simulation Day

	Groups			
Time	**Case 1**	**Case 2**	**Case 3**	**Case 4**
8:00-8:55 a.m.	A	B	C	D
8:55-9:50 a.m.	D	A	B	C
10:00-10:55 a.m.	C	D	A	B
10:55-11:50 a.m.	B	C	D	A

Equipment/Environment

This case of lower GI bleed (Appendix A) was run five times consecutively using Laerdal SimMom. It could be performed using SimMan with a wig or alternatively having the patient be a man instead. All standard items were available, including code medications, defibrillator, IV supplies, and IV fluid, among others. Learners were also able to access laboratory tests and imaging that they wanted (Appendix B). Specific moulage required to simulate hematochezia included fake blood and stool placed under the patient. In our situation, the mannequin was configured as female; however, the case can also be done with a male setup. Supply lists were available for simulation center personal to have ready (Appendix C).

Personnel

Teams were composed primarily of EM residents, with inclusion of a nurse and medical student if present. Teams had five to six participants each, for a total of about 28 learners. Teams were composed of learners at varying training levels. Each team had a resident as team leader, with other residents assigned to roles including airway, performing history and physical, and proceduralist (if needed). The nurse was a learner (not confederate) and provided IV access and hung medications ordered by the team. The medical student assisted where necessary at the discretion of the team leader. All team members were able to discuss with the team leader to make decisions. The operator of the simulator was required to have basic knowledge of operating the SimMom mannequin, including changing vital signs and communicating through the mannequin. This role can be done by anyone with a script of the case. During our simulations, a PGY 3 resident was responsible for operating the mannequin and was oriented to its operation 1 hour prior to the simulation day by simulation center staff. This resident also played the role of any consultants requested by the team. An EM faculty member familiar with the case was within the simulation room evaluating the participants and available to troubleshoot any unexpected issues. The case can be modified for smaller groups depending on the needs of the program. Larger groups are not recommended given limited roles and decision makers in this case.

Implementation

No prerequisite knowledge was required for this case, but basic understanding of resuscitations was helpful. Learners were oriented to the simulation center and high-fidelity mannequins prior to beginning the simulation. They were told to wait outside until being asked to enter the room. On entering, they met a patient who had presented to the emergency department with rectal bleeding. The resident needed to ask to get vital signs and place an IV while taking a history and performing a physical exam. If residents did not complete this task, the patient became more tachycardic and hypotensive. History was provided by the simulation operator via the mannequin speaker, and the physical exam was notable for hematochezia. Of note, the patient would not willingly reveal rodenticide ingestion unless specifically asked if she had taken anything out of the ordinary. Clues to this were within her past medical history of bipolar disorder on lithium. The patient then informed the team that she had the urge to defecate, and when she did, the nurse noted (or participants could be shown) a bloody bowel movement. If the patient was not given IV fluids through two large bore IVs and typed and crossed for blood, she would have continued worsening of her vital signs. Upon return of labs, learners had to recognize an elevated international normalized ratio (INR) and begin to reverse with vitamin K, fresh frozen plasma, or prothrombin complex concentrate. It was also allowable to recheck the INR if the learner believed this could be a laboratory error. During the simulation, learners could request CT imaging to localize the bleeding; however, if CT was requested prior to fluids or blood products being administered, the patient would undergo pulseless electrical activity arrest from hemorrhagic shock. Otherwise, the learners could perform imaging and consult gastroenterology, interventional radiology, and/or surgery. The case ended with disposition to the intensive care unit.

Assessment

Learners were evaluated based on predetermined critical actions by the faculty member in the room (Appendix D). These were determined to be lifesaving interventions. Debriefing was done with an instructor guide (Appendix E) that outlined objectives of the case as well as with any notes taken by the operator. Learners evaluated the case at the end with an evaluation form.

Debriefing

Each case was run for 10-15 minutes, with the debriefing session running 25-30 minutes. Debriefing was run by the mannequin operator (in our situation, a PGY 3 EM resident) and supplemented by the EM faculty member. The debriefing was done with advocacy-inquiry questioning and three-phase debriefing.[14] Further medical management of the case was discussed and included the questions below:

- What do you remember about the classes of hemorrhagic shock?
- How would you approach reversing vitamin K antagonists?
- What do you remember about the differences between fresh frozen plasma and prothrombin complex concentrate?
- How would you approach imaging modalities for localizing lower GI bleeds?
- Tell us about your approach to which consultants to call for further guidance and notification.

Results

This simulation was run five times consecutively, with five to six learners participating each time. There were four nurses, two medical students, 16 residents, and two participants with training level not disclosed. Case evaluations on the whole were positive regarding the realistic aspect of the case and learning a common disease process (GI bleeding) via an uncommon mechanism (rodenticide ingestion). Of 28 total participants, 24 (86%) completed the survey. Participants were informed that their responses were anonymous and that there was no obligation to participate. Twenty-four responses (86%) agreed or strongly agreed the simulation was useful. Twenty responses (71%) agreed or strongly agreed the simulation was realistic. All responses (100%) agreed or strongly agreed that interprofessional education was useful in this case. Select comments on the surveys are shown below:

- "Great example of something we don't see often as cause of bleeding"—PGY 1 resident.
- "I liked review of consult utilization and treatment for INR reversal"—PGY 2 resident.
- "Learning the importance of history questions"—unknown.
- "Good mix of acuity and not an obvious diagnosis"—PGY 4 resident.

Other positive feedback included understanding of how to activate massive transfusion and accessing hospital-specific protocols for this presentation (a sample protocol for review is included with Appendix F). Of five surveys stating what they liked the least, three (60%) found the hematochezia to be unpleasant. Faculty comments indicated that a large proportion of the discussion was directed at institution-related policies and protocols for handling lower GI bleeding. While time should be managed to discuss physiology of shock and INR reversal, discussion of institutional practice is particularly important for junior learners, who may not be aware of the resources and protocols available to them.

Discussion

We developed a novel simulation case of a lower GI bleed secondary to intentional rodenticide ingestion for added complexity. Participants found this useful, and in addition to expanding on core knowledge, residents learned hospital-specific protocols that could help their confidence and efficiency during busy shifts. Overall, this simulation case was useful to the majority of participants and could be used in other EM programs. While the case is built for emergency settings, the acuity level could be changed to make it available in an ambulatory setting as well. The case relies on standard simulation materials with minimal moulage, which could be minimized to just bright red blood from the rectum and a history of hematochezia at home. The case can also be tailored to training level. For example, the patient can rapidly decompensate into pulseless electrical activity arrest secondary to hemorrhagic shock for senior residents. Alternatively, the patient can remain stable to allow junior residents to discuss with multiple consultants. A key step is recognizing an elevated INR and further questioning to elicit rodenticide ingestion, which can be made more or less difficult based on training level. For example, the patient could act sadder in order to see if suicidal questions are asked by a senior learner, or the patient could spontaneously disclose rodenticide ingestion for a novice learner. Ultimately, the case can be adapted for institution-specific protocols on massive transfusion and lower GI bleeding.

One challenge encountered was uncovering the cause of the lower GI bleed. While senior residents were able to eventually uncover the ingestion, junior residents recognized the abnormal lab values but did not easily recognize the ingestion. Although not critical to the management of this patient, hints could be provided by having a confederate (family member, nurse, or consultant) inquire about the patient's bipolar disorder diagnosis.

This case was developed primarily for an educational purpose. Formative feedback based on specific EM milestones was provided to the learner at the conclusion of the case and later uploaded into MedHub for tracking purposes. Prior to starting the simulation case, learners were notified that a faculty member would be present in the room to provide formative feedback that would be uploaded into MedHub as a component of overall milestone scores. MedHub is an online tracking system for evaluations that can be filtered based on evaluation type (clinical performance, simulation performance, procedural data, etc.). Uploading simulation feedback to this forum provided a way to track performance, and residents were able to access evaluations at any time for self-reflection.

Maintaining psychological safety in simulation is critical. Specifically, this means creating a safe learning environment. Formative feedback on performance during a simulation is a great opportunity to summarize discoveries during debriefing and reinforce good practices while also highlighting areas for improvement. Tracking performance over time can be valuable to both the learner and program leadership, which is why we promote incorporating milestone-based scores when possible. Simulation as an assessment tool is most clearly defined in procedural tasks; however, it can also be employed for other competencies. Yet to be determined is whether simulation can be used for high-stakes assessments such as advancement in training or board certification. Additional investigation in this area would be necessary prior to initiating such a practice.

An obvious limitation to this case is the rarity of life-threatening rodenticide ingestion. Although nearly 2,700 cases of rodenticide ingestion are reported yearly (mostly unintentional ones among pediatric populations), only 2% are significant enough to result in morbidity, and less than 1% result in death.[4] Despite this limitation, lower GI bleed is a major disease process, and anticoagulation reversal is an essential topic for EM providers to understand. An additional limitation exists with the evaluation form used. While the form listed clear actions anchored on milestone subcompetencies for the evaluator to complete, the scores were perception based. Only one faculty member evaluated each resident. Using multiple reviewers to score the same learner would add to the validity of the evaluation form.

This case can be adapted in a variety of ways. For example, it could include discussion of resuscitative endovascular balloon occlusion of the aorta, or the patient could be a Jehovah's Witness to introduce ethical dilemmas and challenge the learner to understand specific resuscitative products containing blood or its derivatives. Additionally, running this case in situ as opposed to within a simulation center offers the benefit of interdisciplinary training and perhaps identification of systems-based issues in deploying massive transfusion protocols. This case represents a common disease process (lower GI bleed) from an uncommon cause (rodenticide ingestion) and contributes to the repository of cases available on *MedEdPORTAL*. On the whole, learners found the case useful and educational.

Rohit B. Sangal, MD: Emergency Medicine Resident, Perelman School of Medicine at the University of Pennsylvania

Lauren W. Conlon, MD: Assistant Professor of Emergency Medicine, Perelman School of Medicine at the University of Pennsylvania; Simulation Course Director, Perelman School of Medicine at the University of Pennsylvania

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