

Original Publication

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Pediatric Pulseless Ventricular Tachycardia: A Simulation Scenario for Fellows, Residents, Medical Students, and Advanced Practitioners

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Abstract

Introduction: Pulseless ventricular tachycardia is an uncommon presentation to the pediatric emergency department (ED) or the pediatric ICU (PICU); however, if unrecognized or inappropriately treated, it can lead to significant morbidity and mortality. This resource was created to simulate a high-acuity and low-frequency event targeting PICU fellows, pediatric emergency medicine fellows, pediatric residents, ED residents, medical students, and advanced nursing providers. **Methods:** This scenario details the case of a 12-year-old boy with a history of heart transplant who presents with the chief complaint of dizziness. He initially has multiple premature ventricular contractions and then progresses to pulseless ventricular tachycardia due to acute rejection. This simulation may be performed in a simulation lab or in situ in the ICU or ED. Necessary personnel include a simulation technician, instructors, and a nurse. A code cart and defibrillator with hands-free pads appropriate for the mannequin are needed supplies. Critical actions include cardiopulmonary resuscitation, defibrillation with three shocks, and administration of anti-arrhythmic. At the end of the scenario, a formal debriefing and learner assessment with structured feedback are performed. **Results:** Approximately 110 learners have completed this module during 18 separate sessions. Written evaluation from participants ($n = 94$) using a Likert scale (1 = not at all, 4 = to a great extent) shows that the objectives of the simulation are met to a great extent, with an average score of 3.8. **Discussion:** In conclusion, this resource advances learner knowledge and comfort when managing a pediatric patient with pulseless ventricular tachycardia, reviews appropriate management, and helps identify knowledge deficits in the management of these patients.

Keywords

Arrhythmias, Cardiac, Emergency Medicine, Arrhythmia, Critical Care, Heart Transplantation, Pediatric, Pulseless Ventricular Tachycardia

Appendices

- A. Simulation.pdf
- B. Chest X-ray.pdf
- C. Triage Sheet.pdf
- D. Lab Values - Metabolic Panel.pdf
- E. Lab Values - CBG.pdf
- F. Lab Values - CBC With Differential.pdf
- G. Critical Action List.pdf
- H. Debriefing Questions.pdf
- I. Learner Assessment Tool .pdf
- J. PowerPoint Presentation .pptx

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. Identify/diagnose a patient with ventricular tachycardia.
2. Understand and implement the correct management for a patient with pulseless ventricular tachycardia (the American Heart Association's Pediatric Advanced Life Support cardiac arrest algorithm—ventricular fibrillation/ventricular tachycardia).
3. Develop a focused differential diagnosis for a child with a history of heart transplantation presenting with ventricular tachycardia.
4. Comfortably use the defibrillator.

Introduction

Pulseless ventricular tachycardia is an uncommon presentation to the pediatric emergency department (ED) or the pediatric ICU (PICU); however, if unrecognized or inappropriately treated, it can lead to significant morbidity and mortality. Arrhythmias are more common in certain subsets of pediatric patients,

including children with complex congenital heart disease, orthotopic heart transplantation (OHT) recipients, and children with cardiomyopathy.¹⁻⁵ With improved medical care, survival in these patient populations continues to increase, and providers must be prepared to manage arrhythmias in these patients.^{6,7} This resource was created to simulate a high-acuity and low-frequency event. The target learners are PICU fellows, pediatric emergency medicine fellows, pediatric residents, ED residents, medical students, and advanced nursing providers. A prerequisite knowledge of Pediatric Advanced Life Support (PALS) is the only requirement. This simulation may be performed in a simulation lab or in situ.

The overarching goal of this simulation case is to enable health care professionals to recognize the signs and symptoms of pulseless ventricular tachycardia in a child with a history of heart transplantation presenting with syncopal episode. In addition, learners will review stabilization using PALS algorithms and medical management of a patient with ventricular tachycardia. Furthermore, learners will review a focused differential diagnosis for ventricular tachycardia in a patient with a history of heart transplantation.

This case allows learners to recognize a patient with pulseless ventricular tachycardia, to initiate appropriate and timely management, and to develop a focused differential diagnosis for ventricular tachycardia in a patient status following heart transplantation. In addition, this simulation scenario allows for review of the differential diagnosis of ventricular tachycardia in a child after OHT and identification of knowledge deficits, as well as leading to increased provider comfort with implementation of the PALS algorithm for pulseless ventricular tachycardia.

There are few MedEdPORTAL publications focusing on ventricular tachycardia. Related adult scenarios focus on wide complex tachycardia and advanced cardiac life support adult management, which is different than pediatric management.^{8,9} Related pediatric MedEdPORTAL publications focus on ventricular fibrillation and ventricular tachycardia with a pulse.^{10,11}

Our case involves a child with OHT and ventricular tachycardia and is the only publication in MedEdPORTAL to our knowledge involving a pediatric heart transplant patient. During prior educational sessions and via feedback from other simulation sessions, both nursing personnel and trainees reported feeling most uncomfortable utilizing the defibrillator during an acute scenario. Therefore, this resource was developed to address this knowledge gap.

Methods

This simulation case was designed so that learners could use active learning to identify the arrhythmia, differential diagnosis, and hands-on management. We focused on critical thinking involved in identifying a patient in ventricular tachycardia, utilization of the PALS algorithm, and deliberate practice with the defibrillator.

No prerequisite preparation is required for use of this case. It is recommended that the instructor become familiar with the case scenario (Appendix A) and the PowerPoint presentation (Appendix J) and have familiarity with pediatric heart transplant. In addition, familiarity with PALS and a defibrillator is advised to facilitate the simulation.

The setting may be a PICU room or ED room or trauma bay. This simulation may be performed in a simulation lab or in situ with an area for debriefing. We use a high-fidelity Laerdal SimJunior mannequin. He is initially sitting up in bed, and the facilitator responds to questions at an age-appropriate level. Initial vital signs are detailed in the simulation template. We have the nurse connect the patient to the monitor then call the trainee into the room to evaluate the patient due to abnormal heart rhythm on the monitor (multiple premature ventricular contractions.) The patient has a right antecubital intravenous line on arrival. Other necessary equipment includes defibrillator with Laerdal SimJunior hands-free pads and code cart; we use a kidney basin connected to the end of the IV tubing for wasting medications, and we print out the chest X-ray (Appendix B), triage sheet (Appendix C), and laboratory values (Appendices D-F) to hand to the participants.

When the participants arrive, they are divided into groups of four to six. We usually invite a junior nurse to participate as a learner and the initial responder. Simulation personnel include the simulation technician to set up and program the mannequin. Two to three faculty moderators observe the actions for debriefing and pretend to be the consultant available on the telephone and the patient's mother who also is available via telephone. A PICU fellow may play the role of consultant or mother when using this simulation for residents, medical students, and ED residents/fellows. To place a consult, the participant may call on the phone in the room or say out loud who he/she wants to consult. The participant pretends to call from the room and speaks to a consultant who is one of the case instructors. Typically, the consulted team is not available to come to the bedside, forcing the learners to perform the necessary procedures (in this case, defibrillation).

The module takes approximately 45 minutes to complete. Each group completes the simulation module (approximately 25 minutes). Once all of the groups have completed the module, the case is discussed using the debriefing questions (Appendix H), and then the PowerPoint presentation (Appendix J) is reviewed. At the end of the discussion of the case, each learner is evaluated via the evaluation sheet (Appendix I) provided. The critical actions checklist (Appendix G) was devised by referencing the 2015 PALS algorithm and a consensus of PICU faculty moderators. The simulation evaluation was modified from the format previously used during simulation scenarios, with actions identified by the critical actions checklist. Learners are evaluated by faculty, then meet with faculty to discuss their performance and receive direct feedback regarding their performance.

The trainees meet in a debriefing room after each group has completed the scenario. The debriefing will be facilitated using, first, self-reflection from the participants and directed with the questions provided. Learning objectives are reviewed, and after assessment, participants and faculty moderators return to the simulation room and practice procedures with the defibrillator or other issues that were identified during the debriefing.

Results

This module has been used with pediatric residents, emergency medicine residents, pediatric emergency medicine fellows, and pediatric intensive care fellows. Approximately 110 learners have completed this module during 18 separate sessions. Approximately 10 different faculty members have used our resource. These faculty were all pediatric critical care medicine attending physicians or pediatric emergency medicine attendings with subspecialty training.

Learner satisfaction data universally reflect that this simulation adds to trainee knowledge and comfort when managing patients with ventricular tachycardia. The majority of verbal and written feedback has reported that trainees feel better about identifying ventricular tachycardia and more comfortable with the defibrillator and their understanding of the PALS algorithm. Written evaluation from participants ($n = 94$) using a Likert scale (1 = not at all, 4 = to a great extent) shows that the objectives of the simulation are met to a great extent, with an average score of 3.8. Using the same Likert scale, learners report professional growth (learned from simulation, feel more comfortable caring for a patient with ventricular tachycardia) at 3.3. On average, participants report that they learned something from the experience to a moderate to great extent, with an average response of 3.7. Nurse participants during a post hoc focus group have all reported learner satisfaction, improved understanding of this scenario, and need for additional participation in simulation scenarios involving pediatric cardiac patients.

Discussion

This case was designed based on an actual patient and developed with feedback from multiple PICU providers and ongoing evaluation and feedback from participants. Dissemination to the ED and trainees via the simulation faculty is ongoing. This simulation addresses a high-acuity and low-prevalence event.

More encounters and practice with the defibrillator have increased reported comfort in this scenario by trainees. This resource is useful in multiple settings for pediatric providers.

We have observed a few patterns between groups of learners. The groups did recognize ventricular tachycardia and verbalized the need for defibrillation, but many did not start CPR while they were connecting the defibrillator. Many groups did not resume compressions immediately after defibrillation but checked for a pulse or attempted to analyze the rhythm. Many groups did not know how to infuse amiodarone despite instructions on actual medication. Many groups did not discuss reversible causes for ventricular tachycardic arrest. These patterns were recognized in earlier sessions, and the debriefing was modified to focus on these knowledge and practice gaps.

One challenge that applies to all simulation education is that even a high-fidelity mannequin is not a human. Therefore, it is always a challenge to create the most realistic scenario one can and have the trainees treat the mannequin and scenario as they would a real patient. The overwhelming learner feedback has been positive, and requests for simulation have occurred most. We plan to repeat this scenario with fellows at the end of the year using team training with PICU personnel to see whether they retain the knowledge and skills learned in the previous session.

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Ethical Approval

Reported as not applicable.

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