42 What Is the Best Approach to a Pediatric Patient with an Unexplained Intraoperative Cardiac Arrest?

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Case

Still bleary-eyed from a long night on call doing a liver transplant, you stumble into the local coffee shop looking for a jolt of caffeine before the drive home. One of your new colleagues, fresh out of fellowship, bounces in the front door.

You attempt to duck out of the shop through a side door, but unfortunately she spots you and starts talking at a rapid pace, "Hi, Doctor! Boy, you look tired! I have to tell you, I did the craziest case yesterday."

You sigh and look up at her through half-closed eyelids.

"This kid suddenly lost end-tidal carbon dioxide ($EtCO_2$) and became pulseless during the middle of the surgery!" Dr. Sprightly squeaks.

Realizing that you DID go into academics to mentor residents and younger faculty, you shift into professor mode and ask her about the case.

She replies, "The patient was a healthy 4-year-old who presented for resection of a renal tumor that extended into the inferior vena cava."

"Healthy patients tend to do well," you muse. "Was there anything else in the medical history? What about the labs?"

"We checked a chemistry, complete blood count, and coagulation studies. All the lab values were within normal limits. Besides the tumor, the only abnormal finding was a tumor thrombus that was located in the inferior vena cava."

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"Interesting," you state. "I can guess how this story ends. The patient arrests secondary to a massive pulmonary embolus, correct?"

"That would be the most obvious reason, but the short answer is no."

"You have now peaked my curiosity. Can we talk over coffee and you can tell me what happened?"

"Sure!" she exclaims, excited to have a mentor hear her story.

You now wonder what you have started.

Question

What is the best approach to a pediatric patient with an unexplained intraoperative cardiac arrest?

PRO: You tell her, "I would follow the Pediatric Advanced Life Support (PALS) guidelines and consult the pulmonary embolus algorithm."

She continues, "We initiated the PALS guidelines. Chest compressions were started immediately and we called for help and the automated external defibrillator (AED). The rhythm was checked, and it was shockable ventricular fibrillation. The patient weighed 17 kg, so we gave 170 µg of epinephrine (10 µg/kg) and planned on defibrillating the patient at 40 J ($\sim$2 J/kg). Once the defibrillator was available, we attempted to place the 'fast patches' (self-adhesive defibrillation electrodes), but there wasn't enough area available on the chest due to the sterile surgical field. We lost time trying to figure out how to defibrillate the patient. Fortunately one of our team members suggested using the external paddles. More time was lost because our surgeon objected that the paddles would contaminate the sterile field because there was no way to make them sterile. We were able to convince the surgeon to accept contamination, as defibrillation could be life-saving, and we defibrillated at 40 J without success."

C.S. Scher et al. (eds.), *You're Wrong, I'm Right*, DOI 10.1007/978-3-319-43169-7_42

You reply sagely, "That doesn't surprise me. Unanticipated cardiac arrests are very rare. Adding the sterile field to a stressful situation only makes matters worse. Going to the external paddles when the fast patched aren't available or when they can't be quickly placed due to a draped surgical field is a good idea. Plus, it may be difficult to resuscitate a patient with a massive pulmonary embolus anyway. What happened next?"

CON: Your colleague looks down and sighs, "Kept following the PALS guidelines without success."

"That's unfortunate. The PALS guidelines should be successful, as long as you treat the underlying cause. Did you perform a TEE?" you ask.

"We did and no thrombus was identified."

Now alert, you say, "I am intrigued. There has to be more to this story. What events led up to the arrest?"

She goes on, "The patient had been losing blood throughout the case. It was more oozing than massive bleeding. We treated it with lactated Ringers and 5 % albumin boluses. When the patient became hypotensive and anemic, we initiated a blood transfusion. After starting the second unit of blood the patient suddenly arrested."

PRO: "So it sounds like a hypovolemic arrest—one of the most common causes of unanticipated cardiac arrests in children," you muse. "I would have continued to transfuse the blood while continuing the PALS resuscitation."

"That's exactly what we did and the patient did not respond. We continued to give epinephrine and defibrillated the patient at 80 J (∼4 J/kg) with no conversion of the ventricular fibrillation. It had been over 15 min since the arrest and I was sweating bullets. I couldn't figure out why the patient wasn't responding to treatment."

"Hmmmm. Did you check labs?" you reply.

"I tried but wasn't able to get blood from the arterial line. I felt all was lost, and then a team member suggested giving calcium. I thought that it wouldn't hurt the patient and it might help even though there wasn't a clear indication. I gave 340 mg of calcium intravenously while chest compressions were continued. At the next rhythm check (and 20 min into the arrest), the patient was still in v-fib. We defibrillated at 80 J, and this time there was conversion of the rhythm to normal sinus with a perfusing blood pressure."

CON: You now state definitively, "Sounds like while following the PALS guidelines, you concentrated on one possible underlying cause to the exclusion of other possibilities. Due to the successful resuscitation after giving calcium, I'm now changing my guess to a hyperkalemic cardiac arrest. Of course this now makes sense since the arrest happened during a blood transfusion, with the high potassium concentration in a unit of packed red blood cells. Hyperkalemia is one of the most common causes of pediatric cardiovascular arrest under anesthesia according to the Pediatric Perioperative Cardiac Arrest (POCA) Registry [1]. This registry encompassed 80 hospitals reporting all cardiac arrests in children 18 years old and younger. Over a 6-year period, ∼400 arrests were reported, half connected to an anesthesia cause."

She looks at you knowingly and says, "Your second guess is correct. We ran a full panel arterial blood gas once the line was functional. The potassium was 9.1 mEq/L."

"There are some great teaching points here," you muse.

"Such as?"

"This is a great reminder for me as well. What you think is obvious may not be so obvious. Going down the pulmonary embolus algorithm would never have gotten you to the correct answer. Also, strictly adhering to PALS guidelines wouldn't have gotten you quickly to the correct answer either. I think that it is very easy to get stuck on what seems to be the obvious pathway and become blinded to other possibilities (e.g., the use of the external paddles instead of the fast patches). Back in the day, the paddles were all we had, but now 'fast patches' are usually the best choice. But what happens when you don't have them or can't use them? Most medical professionals wouldn't even think to use the external paddles since they may not have had experience with them."

"It's amazing how obvious it becomes once the answer is staring at you," she states.

You answer, "Even though I'm more experienced than you, I would have thought it was a PE from the tumor thrombus too. I do have to say that I'm glad that you shared this experience with me. It has certainly educated me to many points that I would not have thought about."

Summary

Intraoperative cardiac arrest in children is a rare event, especially in children without cardiac disease; 34 % of children with an intraoperative cardiac arrest had cardiac disease, either acquired or congenital [2]. When intraoperative cardiac arrest occurs, the PALS guidelines are a good starting point, but the PALS algorithm itself only begins to consider the treatment of underlying causes (Hs and Ts). Fixation error, which occurred in this case, can lead to focusing on one cause of cardiac arrest and ignoring all other possibilities [3]. Frequent simulation training, as well as specific training on avoiding cognitive errors, may be a solution, but more research is needed to determine the best means of implementation.

References

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