When the Worst Happens: Cardiac Arrest in the Pediatric PACU

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At 8 p.m., a 5-month old boy presents to your postanesthesia care unit (PACU) after undergoing an uncomplicated drainage of a large perianal abscess. The team reports that the infant had previously undergone a successful repair of tetralogy of Fallot. Shortly after the anesthesia team departs, the infant becomes apneic. Although you are stimulating and providing oxygen, the child desaturates, becomes bradycardic, and then loses all pulses.

FORTUNATELY, THIS SCENARIO is extraordinarily rare with a reported rate of less than one postanesthesia care unit (PACU) cardiac arrest in 100,000 pediatric anesthetics.[1,2] Although this rate is far lower than the reported incidence of pediatric perioperative cardiac arrests (8.6 in 10,000 anesthetics),[3] nurses in the PACU setting must, of course, remain vigilant and prepared for such a worst-case scenario. Indeed, most reported arrests that occurred in the PACU were recently deemed preventable and had resulted or progressed from a commonly occurring respiratory cause such as airway obstruction or laryngospasm.[4] Because children, in particular, are vulnerable to rapid deterioration from a state of respiratory compromise to full-blown cardiac arrest, extra vigilance is warranted. In this column, we will briefly review what is known about cardiac arrest in the pediatric PACU setting including the known risk factors. We will also provide a brief overview of pediatric advanced life support (PALS) and discuss how PACU nurse providers might improve the outcomes of children after early postoperative arrest.

Which Children Are Most at Risk for Cardiac Arrest?

Although general anesthetics in and of themselves pose a risk for respiratory depression and subsequent cardiac arrest, several conditions and factors elevate the risk for children. Most importantly, infants, young children, and those with significant medical comorbidities have been shown to be at significantly higher risk of pediatric perioperative arrest. More than two-thirds of reported PACU arrests occurred in children younger than 5 years, and one-third of *preventable* arrests occurred in infants (younger than 1 year).[4,5] Infants have a limited undeveloped reserve to respond to the stress and physiologic insults of surgery and anesthesia, placing them at particular risk. In addition, higher American Society of Anesthesiologists' (ASA) Physical Status as a gross measure of comorbidity or disease burden is highly associated with pediatric cardiac arrest across studies.[3,6,7] Significant comorbidities were recently identified as the primary contributing factor in all nonpreventable PACU arrests and as a secondary contributing factor in many preventable arrests. Of note, congenital heart disease, even long after surgical repair, places children at higher risk for arrest.[8] These children have residual scar tissue on their hearts that predisposes to arrhythmias and other complications. Children with heart disease have a much higher comorbidity burden and are also at significantly higher risk of mortality after perioperative arrest.[9] Given that infants and children with comorbid conditions are at significantly increased risk, a higher level of monitoring and support is warranted during their postoperative care. To ensure

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Conflict of interest: None to report.

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1089-9472/$36.00

http://dx.doi.org/10.1016/j.jopan.2017.04.006

appropriate attentiveness, a 1:1 nurse to patient ratio should be maintained until the stability of the child is assured.

Extrinsic factors have also been found to contribute to PACU arrest and subsequent outcomes. A small majority of PACU arrests (58%) occurred after more invasive surgery compared with noninvasive or diagnostic cases (42%),[5] and the emergent or urgent nature of the procedure (ie, ASA's E physical status) has also been found to predispose patients and children to a higher risk for perioperative arrest. Children with planned postoperative admissions and those scheduled as outpatients were similarly at risk for PACU arrest in one recent study (46% vs 54%).[4] However, children whose arrests occurred at night or on the weekend were at highest risk for mortality after the arrest.[5] These findings suggest a need for greater support around the clock.

What Do You Do?

The American Society of PeriAnesthesia Nurses' *Position Statement on the Pediatric Patient* suggests that nurses who provide care for children develop extra skills and knowledge, including PALS certification.[10] The finding that pediatric arrests that occurred in mixed adult-pediatric settings were associated with higher mortality suggests the presence of lower pediatric expertise, knowledge, or perhaps, lesser availability of pediatric resources.[5] This finding warrants attention and has been, in part, addressed in the *American College of Surgeon's Optimal Resources for Children's Surgical Care* document that requires a higher degree of expertise for the care of young children.[11]

The finding that, compared with other hospital settings, more children survive cardiac arrest in the PACU without permanent harm[4,5] may be attributed to the generally rapid appropriate response with easy access to the anesthesiologist and equipment. This response includes immediate initiation of resuscitation efforts after the PALS approach that facilitates survival and best outcomes for children.[12,13] Importantly, a hospital-wide arrest team was activated for only 17% of PACU arrests that resulted in subsequent death compared with 38% of cases resulting in the child's survival.[5] Although this difference was not statistically significant, the clinical importance of activating a code team is universally understood. Activation is particularly important during off-hours when anesthesia providers are less available. Intensive care or adult-focused code teams may not have the relevant pediatric perioperative expertise but are experts in the use of emergency equipment, medication management, communication, and other essential tasks.

While help is on the way, immediate steps should be taken to assess and form an initial impression and to initiate cardiopulmonary resuscitation (CPR). If no pulse is present, CPR using the C-A-B approach is immediately called for with chest compressions at rate of 100 to 120 per minute.[12,13] A high degree of suspicion for a respiratory cause is warranted in the PACU setting because respiratory problems account for most of the pediatric arrests.[4,5] Immediate airway management by a team member is therefore likely to yield quick and positive outcomes in most cases. Mask ventilation without the need for an invasive airway was successful in facilitating immediate recovery from the arrest in 57% of cases in one study.[5] When intubation is deemed necessary, interruptions in chest compressions should be minimized for best outcomes.

Although securing oxygenation and ventilation resolves most pediatric PACU arrest situations, cardiac monitoring and, in some cases, diagnostic testing is necessary to rule out other potential underlying causes of the arrest. PALS recommends a continuous cycle of evaluation, identification, and intervention to diagnose and ensure appropriate treatments.[12,13] For example, the patient described at the beginning of the column is at risk for arrhythmias secondary to his congenital heart disease or possibly for septic shock from his abscess. Thus, even when the cardiorespiratory status has been stabilized, other potential underlying conditions must be considered.

Checklists can quickly facilitate differential diagnoses. PALS pocket reference cards from the American Heart Association include a list of reversible causes categorized as H-causes (eg, hypovolemia, hypoxia, hypoglycemia) and T-causes (eg, tension pneumothorax, tamponade, thrombosis). Furthermore, the Society for Pediatric Anesthesia has developed pediatric perioperative crisis event

checklists, freely available in multiple languages and as a mobile app (www.pedsanesthesia.org/critical-events-checklists/).

What Will Happen After the Cardiac Arrest?

Although some children require an escalation of care including unplanned admission or transfer to an intensive care setting, most of them who experience a cardiac arrest in the PACU setting survive without permanent harm or neurologic deficit.[4,5] Despite these findings, pediatric arrest is an extremely stressful and emotional event for the providers involved.[14] When a preventable medical error is identified as the cause of the arrest, debriefing, counseling, and other support may be warranted. Nurses and physicians caring for a patient—particularly *a child*—who arrests and subsequently has poor outcomes can experience depression, burnout, and even suicide. Many institutions have formal mechanisms in place to support and counsel the affected provider and to minimize the potential for distracted care when the second victim returns to patient care.[14]

In summary, pediatric PACU cardiac arrest is a rare and catastrophic event that can generally be effectively managed with good outcomes for the patient. Following the PALS approach to resuscitation by calling for help, initiating CPR, and correcting the root cause (particularly respiratory causes) is imperative to achieving good outcomes.

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