Favorable Recovery Following Prolonged Intraoperative Cardiopulmonary Resuscitation in a Pediatric Patient

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Introduction: Pediatric cardiopulmonary resuscitation (CPR) of greater than 15 minute duration has been associated with dismal outcomes,\textsuperscript{1} and neurological assessment of survivors reveals at least mild abnormalities.\textsuperscript{2} Despite the preponderance of data regarding poor survival and neurologic outcomes following prolonged cardiopulmonary resuscitation in the pediatric patient, we present an example of a patient with a good outcome following a lengthy arrest.

Case Report: A 2-year old 14.6 kg male with a history of hypoplastic right ventricle status post left sided bidirectional Glenn shunt and a poorly defined hypercoagulable syndrome with bilateral occluded femoral veins presented to our Children’s Hospital to undergo elective Fontan. Following a smooth inhalational induction, two 22 gauge peripheral venous cannulaes, an arterial line, and a 5 french, 13 centimeter double lumen central line were placed. Anesthesia was maintained with intravenous fentanyl and desflurane in 50% oxygen and air.

The patient suffered injury to the aorta during sternotomy initially controlled with manual pressure. Moderate hypotension resolved with a bolus of crystalloid. During exposure for surgical repair of the aortotomy, the aortic bleeding intensified. Despite brisk administration of blood products, the hemorrhage was significant enough to result in severe hypotension, bradycardia, and asystole. While the patient received chest compressions and was ventilated with 100% FiO2, packed red blood cells, cell saver, and whole blood were continuously administered. The patient required 11 boluses of epinephrine, totaling 1580 mcg (108 mcg/kg), multiple doses of sodium bicarbonate, totaling 70 meq (5 meq/kg), and calcium chloride. The patient was not a candidate for emergent femoral cardiopulmonary bypass due to his bilateral femoral vein thrombosis. Hypothermia was induced by cooling the operating suite and placing ice on the patient’s head. After 35-40 minutes of resuscitation, the patient demonstrated an intrinsic bradycardic rhythm and a spontaneous blood pressure. An epinephrine infusion of 0.8 mcg/kg/min, a milrinone infusion of 0.5 mcg/kg/min, and cardiac pacing stabilized the patient and allowed transport to the ICU.

Over the next 24 hours, the patient was weaned off of his epinephrine infusion, maintained hemodynamic stability, was extubated, and interacted with his family as per baseline. Transaminases, BUN, creatinine, and serum lactate were within normal limits. An echocardiogram demonstrated qualitatively good left ventricular function. The patient did not display any gross neurologic focal deficits except for 3/5 strength in his left upper extremity. A head CT showed multifocal areas of decreased attenuation consistent with areas of ischemia/infarction and diffuse cerebral edema. The patient was discharged one week after his cardiac arrest with physical therapy and occupational therapy to treat left upper extremity neglect.

Discussion: The literature indicates poor survival as well as poor neurological outcome in most pediatric cardiac resuscitation attempts. In an 18-month prospective, multicenter study on the outcomes of pediatric cardiopulmonary arrest, J. Lopez-Herce et al. suggest that a patient’s best indicator of mortality is a resuscitation duration of greater than twenty minutes.\textsuperscript{3} Likewise, de Mos et al. found that all children with cardiac arrest of > 13 minutes who were not treated with ECMO died.\textsuperscript{2} Reis et al. found that thirty-day survival was decreased by 5% with each additional minute of CPR.\textsuperscript{4} Other variables negatively associated with 30-day survival in their study included administration of 3 or more doses of epinephrine and bicarbonate administration.\textsuperscript{4} In that study, the authors showed that the only
patients who survived > 30 minutes of CPR were severely neurologically impaired.\textsuperscript{4} de Mos et al. also report neurological abnormalities in survivors of cardiac arrest, with less morbidity in patients who suffered arrest in-hospital and received post-arrest ECMO.\textsuperscript{2}

Data concerning intraoperative pediatric cardiopulmonary resuscitations remains limited, however. One could assume that Reis et al.’s disappointing results may be due to their study including all in-hospital patients in both monitored and unmonitored settings, whereas our patient’s arrest was witnessed. Nonetheless, J. Lopez-Herce et al. found that there were no mortality differences when comparing the outcomes of arrest in monitored or ventilated patients with non-monitored or ventilated ones.\textsuperscript{3}

We hypothesize that our patient’s favorable outcome can be attributed to a reversible disease process, acute hemorrhagic shock, and its immediate treatment. Our patient received the administration of prompt resuscitation by an experienced operating room team who was prepared for the potential of an adverse event, a variable that is difficult to measure in large scale studies of pediatric cardiopulmonary arrest. We conclude that given a reversible precipitating cause and the immediate availability of a skilled team, a pediatric patient suffering a witnessed cardiopulmonary arrest can have a good outcome despite a prolonged resuscitation.

References
1. Slonim, AD, et al., Critical Care Medicine, 1997
2. de Mos N, et al., Critical Care Medicine 2006