The Evaluation and Anesthetic Management of a Child with Chronic Lung Disease and Pulmonary Hypertension for Hepatic Resection

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**Objectives:**

- Discuss the preoperative evaluation of a child with chronic lung disease and pulmonary hypertension
- Recognize potential issues with volume resuscitation and fluid management
- Develop an anesthetic plan for intraoperative management and post operative care
- Discuss the management of an intra-operative cardiac arrest, including ethical decisions regarding heroic measures in a child with multiple comorbidities

**Case Presentation:**

A 33 month old male with a history of prematurity, developmental delay, intractable epilepsy, chronic lung disease, pulmonary hypertension, tracheotomy, hypotonia, VP shunt, and ECMO in infancy presents for resection of a hepatic mass. He arrives to the operating room with a cuffed tracheostomy tube in place (mechanically ventilated on 30% FiO2), and a tunneled left internal jugular single lumen central venous catheter. The patient is scheduled to undergo a non-anatomic hepatectomy for removal of this large abdominal mass.

Questions: What are some general concerns of this child having any type of surgery? Does this patient require any special considerations for this procedure? Does he need an echocardiogram? Does he need PFTs? Is a cardiology or pulmonary evaluation required? What are the implications of anatomic vs. non-anatomic hepatic resection?

Review of the patient’s medical record is conducted and includes the following: The past medical history is as mentioned above. The patient’s medications include budenoside, albuterol, chlorothiazide, spironolactone, furosemide, amlodipine, levicetronam, valproic acid, and erythromycin. Echocardiogram performed 4 months prior to procedure shows small ASD with L-R flow, qualitatively normal RV function with estimated PAP < half systemic, and normal LV function. He has had multiple recent admissions from his chronic care facility due to seizure like activity. The mass for which the procedure is being performed is a 10 cm mass affecting both lobes of the liver.

Questions: How would you manage the child’s anesthesia? What are the goals for oxygenation, ventilation, hemodynamics, and fluid management? Should a combined regional/general technique be utilized? In addition to the CVC already in place, what access is needed? Does it matter if it is above or below the diaphragm? Is the patient’s existing airway adequate?
Induction of anesthesia proceeds smoothly. The patient is transitioned from his ICU ventilator to the anesthesia machine and adequate ventilation is achieved using the patient’s existing airway. A 22g PIV catheter and 22g right radial arterial catheter are placed without incident. Multiple attempts to obtain additional peripheral access are unsuccessful. After discussion with the surgical team about the previous ECMO cannulation and an existing left sided CVC, a single lumen 4fr catheter is placed in the right femoral vein. The procedure begins without incident and a cholecystectomy is performed prior to beginning the hepatectomy. Immediately after the surgical team begins dissecting the mass from the liver, there is an abrupt loss of EtCO2, a decrease in oxygenation, a decrease in blood pressure, and signs of right heart strain on EKG.

Questions: What are the possible causes of sudden cardiovascular collapse? What is the protocol for calling for help?

Administration of small doses of epinephrine, volume resuscitation, and decreased surgical manipulation result in an improvement in oxygenation and hemodynamics. The resection proceeds uneventfully until separation of the mass from the liver, at which time the patient experiences a profound decrease in blood pressure, decreased EtCO2, increased peak airway pressures, and hypoxia. Blood products (PRBC and FFP) are administered and vasopressors are given without effect. At this time there is no discernable blood pressure and chest compressions are started. The patient’s EKG pattern deteriorates from sinus rhythm to sinus bradycardia with ST segment depression.

Questions: What type of an arrest would this be classified as? What are the possible causes? What are the possible implications of volume overload and hyperviscosity in this ventilator dependent patient with chronic lung disease. What measures are appropriate to take in this patient if resuscitation attempts are unsuccessful (ECMO?)? Would it be different if the child had a DNR order on the floor?

PALS protocol was followed and the patient did eventually have return of spontaneous circulation. During resuscitation, this 17 kg child received 3 units of PRBC and 3 units of FFP (post-transfusion Hgb 19). The patient is maintained on an epinephrine infusion and the surgery concludes without further incident. During surgical closure, there is an increase in PAP, a decrease in oxygenation, and difficulty in hand ventilating the patient. Upon transfer to the PICU, the patient’s ABG is as follows: 7.37/42/41/25. The hemodynamics continued to be labile for 24 hours postoperatively and the patient did eventually have improvement in his oxygenation and ventilation.

Discussion:

Hepatic resection for presumed hepatoblastoma presents several unique challenges, particularly in a patient with significant comorbidities. Hepatoblastoma is the most common primary pediatric hepatic malignancy. Therapy is often directed toward resection, either primarily, or after neoadjuvant chemotherapy has reduced the tumor to a manageable size. Anesthetic management of a patient with hepatoblastoma presenting for hepatic resection is complicated, and involves planning for intravenous access, arterial access, intra-operative fluid management, and post operative pain control. Further complicating the management of these patients is the differential risk and benefit of anatomic vs. non—anatomic hepatic resection. Anatomic resection was thought to provide better cure rates, though recent evidence does not support that supposition. Anatomic resections also usually do not involve disruption of the intra-hepatic venous sinuses, which reduces the likelihood of intra-operative embolic phenomenon.

Chronic lung disease and pulmonary hypertension are common sequelae of prematurity. Severe pulmonary hypertension leading to the need for ECMO is associated with significant chronic ventilation and oxygenation difficulty. The anesthetic management of patients with chronic lung disease often directly opposes the anesthetic goals of a patient undergoing hepatectomy. This includes the need for fluid resuscitation in hepatectomy, which may compromise pulmonary function in a patient with low pulmonary reserve, particularly if that patient is diuretic.
dependent. Some surgeon/anesthesia teams advocate low CVP anesthesia to control hepatic bleeding for liver resection, which can be very difficult if patients require high intrathoracic pressures to provide adequate positive pressure ventilation. Low CVP anesthesia also increases the chance of venous air embolism during the resection, especially when coupled with non-anatomic resection technique.

The anesthetic plan was based upon the known risks associated with hepatectomy in this patient population, as well as the specific medical history of this patient. Specifically, the decision was made to induce general anesthesia via the existing tracheostomy because it was cuffed and had adequate seal to deliver positive pressure ventilation. For intravenous access, 2 large bore peripheral IVs would likely have been sufficient, especially given the existing tunneled central venous catheter. However, when only one peripheral was able to be established, adding a single lumen central venous catheter was a reasonable alternative. Given the patient’s history of ECMO cannulation and likely abnormal right sided jugular and subclavian anatomy, the decision was made to have the surgical team place a femoral central venous catheter, rather than attempt a right sided upper extremity line (there was an existing line in the left internal jugular). Anesthesia was maintained with a continuous narcotic infusion with potent inhalational agent as tolerated to maintain adequate blood pressure. This provides a good depth of anesthesia without sacrificing mean arterial pressure.

Pulseless electrical activity (PEA) occurs in a large number of intraoperative arrests in the pediatric population due to the various etiologies of PEA to which children are susceptible. In the case of this patient, any of a number of etiologies is possible, but the most likely is embolic in nature. The combination of acute onset, decreased end tidal CO2, right heart strain on EKG, and a surgery with a high risk of venous embolism (air or tumor) make this the most likely diagnosis. PALS protocol for events of this nature emphasizes high quality BLS, epinephrine to restore vascular tone, and treatment of the cause of the arrest. In this case, all of these goals were reached and the patient did not appear to suffer any adverse sequelae. Although the child suffered from significant comorbidities with no possibility of improvement in quality of life as a result this operation, the parents desired to proceed with the operation and remove the tumor. They understood the operation posed a great risk to the child’s life, which was given a poor prognosis in general based on the other significant medical problems. It becomes an ethical dilemma for the anesthesiologist to discuss with the parents their understanding of the risks of anesthesia and whether they wish to allow resuscitation of their child, especially with a history of a DNR order. A clear discussion with accurate notes must be documented in the patient’s chart to that end. Simulation studies have shown many anesthesiologists still may not be aware or comfortable with DNR orders or patients with terminal illnesses.

Post-operative analgesia following hepatic resection can be challenging due to the extent and location of the laparotomy incision required for good surgical exposure. Both parenteral narcotics and epidural analgesia have been used effectively. There can be coagulopathies associated with hepatic resection, though in children undergoing resection for primary tumors usually have excellent reserve and normal post-operative hepatic function despite large scale resections. Most patients can be expected to be extubated following hepatic resection, provided that the duration of the procedure is reasonable and there is no significant hemodynamic instability during the procedure. In this patient, who is ventilator dependent, an option with a high rate of success with little or no associated risk of morbidity was chosen, and parenteral narcotics were administered.
References:


