Pediatric Trauma PBLD

David A. Young, MD and Stuart R. Hall, MD

Oops!! Did you really do that? Management of the pediatric trauma patient with cardiac arrest and disclosure of a medical error.

Learning Objectives:

1. Develop an anesthetic management plan for the pediatric trauma patient.
2. Develop a treatment strategy for the pediatric patient with intraoperative cardiac arrest.
3. Develop a strategy for the disclosure of a medical error.

CASE AND QUESTIONS:

You have been asked to go the Emergency Department to assist with the management of several trauma patients that are enroute to your facility. As you arrive, the pre-hospital report is being transmitted about the patient you will manage:

The patient is a 5-year-old boy involved in a house fire. He was initially on the second floor and was dropped to the ground by his mother. On initial evaluation by the paramedics, he has an open right tibial fracture and possible right forearm fracture. The patient is crying, appears in pain, and uncooperative. No other obvious injuries are present. Intravenous access is unable to be obtained.

Vital signs: Resp: 38, HR: 154; SpO_2: 94% (room air); and BP 132/66.

He is being transported with a cervical collar, backboard, arm and leg splints, and supplemental oxygen. Estimated time for arrival is 4 minutes.

Questions:

1. What are the priorities in the initial evaluation and management upon the patient's arrival to the Emergency Department? What should be completed during the primary and secondary surveys?

2. What injuries are more common and unique in pediatric patients compared to adults?

3. Should you determine if inhalational injury is present? If present, how will you manage this? How reliable is pulse oximetry in this setting?

The patient has been evaluated and resuscitated. He has remained overall in stable condition over the last hour. The patient is scheduled for central line placement due to an anticipated prolonged antibiotic administration. This will be followed by closed vs. open reduction of the right forearm and placement of an external fixator to the right lower extremity.

Vital signs are:

Temperature 96.8 F, Heart rate 148 (sinus tachycardia), Respiratory rate 24, Blood pressure 110/54, Oxygen saturation 97% (FiO_2 40%). Airway: Cervical collar in place

In the Emergency Department, a peripheral intravenous line was placed followed by a fluid bolus of 300 cc Lactated Ringers. Laboratory and radiological studies were completed. Medications given by the emergency physician included morphine 1 mg IV and ranitidine 15 mg IV.

The patient is "cleared" for surgery by the trauma surgeon and pediatrician on-call.
The parents were not present at the hospital but telephone consent from the father was obtained.
The only significant past medical history was "a very severe reaction" after receiving a cephalosporin antibiotic for otitis media one year ago.

Questions:

4. What preoperative information including laboratory and radiological studies would you request? How will you determine if the patient is optimized to go to the operating room?

5. The cervical spine film (cross table lateral) shows C_2-C_3 subluxation. What is the clinical significance of this? How will this change your management? What is SCIWORA?

6. Describe your plan for induction of anesthesia.

Induction of anesthesia is uneventful. The airway is secured in a rapid and atraumatic fashion. Vital signs are stable immediately after induction. The peripheral intravenous line is functioning well. Two units of crossmatched packed red blood cells are available. A 5F (French) Double lumen central line was just placed by the surgeon in the right subclavian vein without apparent complications. The orthopedic surgeon verifies that cefazolin was administered. Three minutes later, the pulse oximetry monitor is reading "no signal." Incision was about to occur when the blood pressure monitor was reading "error." You assume it's just artifact but decide to feel for a carotid pulse when NONE was palpable!! You suddenly look at the anesthesia record and see **"Allergies: Cephalosporins".**

Questions:

7.What are your initial steps in management? Suppose all intravenous access has been lost, what options do you have for emergency drug delivery?

8. If the rhythm is ventricular fibrillation, what pharmacological and/or electrical therapy would you choose and in what sequence?

9. Suppose the rhythm is unstable bradycardia, what would be your management?

10. Suppose the rhythm is unstable tachycardia, what would be your management?

The patient survives the resuscitation and the case is aborted. The patient receives hydrocortisone, diphenhydramine and ranitidine in addition to other emergency drugs. The patient is hemodynamically unstable and in critical condition. Therefore, the patient is brought to the intensive care unit intubated, sedated, chemically paralyzed, and on an epinephrine infusion.

11. What is(are) the etiology(ies) of the intraoperative cardiac arrest?

12. While you are transporting the patient to the intensive care unit, the surgeon is about to go speak with the parents. What would you like to discuss with the surgeon prior to him speaking with the parents?

13. After patient care is concluded, what do you tell the parents?

14. Should you call your attorney and/or risk management department prior to talking to the parents? What should you do after speaking with the parents?

15. What should you write on the anesthesia record?

DISCUSSION:

I. Introduction:

Traumatic injuries in children are the most common cause of death in the United States for children above one year of age. This will account for over 20,000 deaths this year alone. Most traumatic injuries in children are a result of one of the following: motor vehicle accidents, child abuse, drowning, thermal injury, or falls. Anesthesiologists should be familiar with the initial evaluation and management of pediatric traumatic injuries in order to continue this care in the perioperative setting. Most anesthesiologists are familiar and current with adult cardiac resuscitation such as Advanced Cardiac Life Support (ACLS). However, the etiologies and treatment for cardiac resuscitation are different for pediatric patients than adults. Pediatric Advanced Life Support (PALS) was created by the American Heart Association for cardiac resuscitation of the pediatric patient. Unfortunately, the occurrence of medical errors with significant morbidity or mortality is not rare. Most anesthesiologists have little experience with the disclosure of medical errors to patients or parents.

II. Pediatric Trauma (Questions 1-6)

Based on the Advanced Trauma Life Support (ATLS) course developed by the American College of Surgeons, the initial evaluation of the pediatric trauma patient composes the primary survey. The sequence of evaluation includes: **A** (Airway), **B** (Breathing), **C** (Circulation), **D** (Disability), and **E** (Exposure). The **A** (airway) should be evaluated for patency and opened using a jaw thrust technique if obstructed. Immobilization of the cervical spine should be maintained. The patient's **B** (Breathing) and ventilation should be evaluated and immediate intervention should take place if not adequate. **C** (Circulation) is evaluated by blood pressure, sensorium, and skin turgor. Control of hemorrhage also occurs by the application of direct pressure. **D** (Disability) should be evaluated for potential neurological injuries. Several scales including the Pediatric Trauma Score (PTS) and Glasgow Coma Scale (GCS) have been used to evaluate severity of injury. A GCS score of 8 or less implies significant neurological injury and immediate intubation is recommended. **E** (Exposure) of the entire patient for evaluation. A heated treatment area should be prepared in advance to maintain normothermia. The establishment of an adequate and secure airway cannot be overemphasized. All trauma patients should initially receive 100% supplemental oxygen. Patients should be monitored with frequent blood pressure measurements along with continuous electrocardiography and pulse oximetry. Two large bore (appropriate for age) intravenous lines should be started. For hypotension, an initial fluid bolus of 20 cc/kg of

isotonic crystalloid is given.

The secondary survey is a complete assessment of all organ systems. It is not begun until the primary survey is complete and the patient is in overall stable condition. If the patient is not in stable condition, then resuscitation continues with possible emergent transfer to the operating room. A complete history and head-to-toe evaluation occurs as well as frequent reassessment of vital signs. If deteriation should occur, regression to the primary survey and resuscitation should take place. A complete neurological exam and special procedures such as peritoneal lavage, CT scan, and FAST exam (Focused Abdominal Sonography for Trauma) are completed during the secondary survey. Laboratory studies are also done during the secondary survey.

Pediatric trauma patients develop unique injuries when compared with adults. Head injuries are the most common isolated injuries and the leading cause of death. Thoracic injuries are the second leading cause of death. Due to increased ribcage pliability, severe injury can occur without external signs such as rib fractures. Blunt abdominal trauma can frequently be treated with close observation and lack of invasive treatment. However, penetrating abdominal trauma usually requires surgical exploration.

The priority in management of a potential thermal injury is to evaluate the airway for inhalational injury. Inhalational injury should be evaluated by history, signs of respiratory distress, and burns to the perioral area as well as the presence of carbonaceous sputum or singed nasal hairs. If any sign or symptom suggesting inhalational injury is present, one should strongly consider early endotracheal intubation to secure the airway before additional airway compromise occurs. This is followed by appropriate resuscitation measures to maintain normovolemia. Children have an increased head to body surface ratio when compared with adults. This requires different estimations of burn assessment than the "rule of 9's" used for adults. Pulse oximetry, in the presence of elevated carboxyhemoglobin, will read this as oxyhemoglobin. This will underestimate oxyhemoglobin and prevent detection of hypoxemia. An arterial blood gas with co-oximetry will detect the presence of elevated carboxyhemoglobin. Treatment for elevated carboxyhemoglobin centers on the administration of 100% oxygen.

The preoperative evaluation should include a complete patient assessment. Vital signs should be stable and appropriate for age. Sensorium, urine output, and skin turgor as well as vital signs can be used to evaluate and estimate the patient's preoperative volume status. A comprehensive airway evaluation should be done including the cervical spine. Past medical and surgical history is obtained, if available. A list of injuries and the management done prior to the operating room should be acquired. Special attention to fluid management will be important to estimate preoperative volume status and assist with intraoperative fluid administration. Laboratory studies such hemoglobin, electrolytes, coagulation studies, arterial blood gas (with co-oximetry) should be reviewed. Radiological studies including plain films of chest, pelvis, and cervical spine as well as CT Scans should be examined and the results obtained.

Cervical spine injuries in children commonly occur in different locations than adults. These injuries tend to be located at a higher level, which is usually at, or above C_3. Pseudosubluxation of the cervical spine is a common and benign finding in children. This is usually seen as the anterior displacement of C_2 onto C_3. However, in this case, one must differentiate pseudosubluxation versus a true cervical spine injury. After consultation with the surgeon, pseudosubluxation can be excluded by placing the child's head in the sniffing position and repeating the film. Pseudosubluxation will be reduced with this maneuver. If neck tenderness, decreased sensorium, or neurological deficits are present, one must assume a cervical spine injury

exists and a surgical consultation is suggested. A CT scan of the cervical spine may be helpful in the identification of lesions not visible on the plain film. However, SCIWORA (Spinal cord injury without radiographic abnormality) is a functional injury that has been estimated to occur in approximately 25-50% of patients with spinal cord injuries. This type of injury cannot be visually detected and therefore not excluded by radiographic examinations.

Induction of anesthesia should begin with pre-oxygenation followed by intravenous induction using a rapid sequence technique with cricoid pressure. If the patient is thought to be hypovolemic, a preoperative fluid bolus prior to induction should be given if the patient's condition permits. If concern exists regarding possible cervical spine injury then one should also incorporate in-line immobilization during intubation and all patient transfers. Ketamine or etomidate are appropriate induction agents if hypovolemia is suspected. Succinylcholine or rocuronium are both acceptable choices for muscle relaxants. Standard monitors are acceptable for this case. Arterial line placement should be selected on a case by case basis. Additional intravenous fluids can be connected to the central line after placement along with monitoring of central venous pressure to help guide fluid management.

III. Cardiac Arrest/Pediatric Advanced Life Support (Questions 7-10)

Initial steps during a cardiac arrest should include calling for help and the crash cart/defibrillator. Verification of a secure airway and ventilation should follow. Chest compressions should be started without delay. The FiO_2 should be 100% with the vaporizers turned off. Emergency drugs can be delivered by the endotracheal or intraosseous routes if loss of intravenous access should occur. Intraosseous lines are particularly useful for children under the age of 7 years. All drugs and fluids, including blood products, can be given by this route. The anterior-medial portion of the tibia (the non-operative one in this case) is the most commonly used location. One would advance the needle perpendicular to the long axis of the tibia with a twisting motion until a sudden loss of resistance occurs. Positive aspiration of bone marrow followed by easy flushing of the carrier fluid should follow.

The pulseless arrest algorithm of (PALS) incorporates pulseless electrical activity, asystole, ventricular fibrillation, and pulseless ventricular tachycardia. For ventricular fibrillation or pulseless ventricular tachycardia, defibrillation up to 3 times first at 2 J/kg followed by 4 J/kg thereafter. After defibrillation, epinephrine is used every 3-5 minutes. The first dose is 10 ug/kg followed by defibrillation at 4J/kg. This is followed by lidocaine 1 mg/kg (or amiodarone) and then by defibrillation at 4J/kg. One can consider increasing the epinephrine dose to 100 ug/kg for all future doses. An alternating cycle of defibrillation and drug therapy takes place. The smaller defibrillator paddles are used for infants less than 1 year old or less than 10 kg. Vasopressin has not been incorporated into the (PALS) guidelines at this time. Amiodarone 5 mg/kg IV push can also be used for pulseless arrest in place of lidocaine.

Asystole and pulseless electrical activity are both treated with chest compressions and epinephrine 10 ug/kg every 3-5 minutes. If ineffective, one can consider increasing the epinephrine dose to 100 ug/kg for all future doses. An attempt to identify and treat possible causes such as hypoxemia, hypovolemia, pneumothorax, and cardiac tamponade should also take place.

Unstable bradycardia is treated with epinephrine 10 ug/kg every 3-5 minutes. If ineffective, this is followed by atropine 0.02 mg/kg with a minimum dose of 0.1 mg and maximum dose of 1 mg. A secure airway and delivery of 100% oxygen should be verified. Chest compressions should be

performed if the heart rate is below 60 per minute. This rhythm may progress into asystole which would then follow the pulseless arrest algorithm. Transcutaneous pacing can also be used and should be considered.

Supraventricular tachycardia is a rapid, regular rhythm with nonidentifiable P waves. This may be distinguished from sinus tachycardia by a rate that is usually greater than 230. Supraventricular tachycardias (SVT), with a pulse, is initially treated with adenosine 0.1 mg/kg followed by 0.2 mg/kg if ineffective. Adenosine must be flushed in rapidly during its administration. Vagal maneuvers may also be attempted. If ineffective or if the patient becomes unstable, synchronized cardioversion is recommended with a dose of 0.5 J/kg followed by 1 J/kg for further attempts. If a wide QRS duration is present, treat as presumptive ventricular tachycardia using lidocaine 1 mg/kg. If ineffective, one may attempt synchronized cardioversion at 0.5-1.0 J/kg. Amiodarone 5 mg/kg may also be used and is administered over 20-60 minutes.

IV. Medical Errors (Questions 11-15)

The etiology of the cardiac arrest could be a result of several categories including cardiac, pulmonary, medical error, and trauma. Specifically, several etiologies such as cardiac contusion, cardiac tamponade, pulmonary embolism, pneumothorax, arrhythmia, electrolyte disorders, hypovolemia, and even latex allergy are all possible as well as an anaphylactic reaction from either cefazolin or another pharmacologic agent.

Ideally, a meeting should take place with the parents, surgeon and anesthesiologist all present. This should be in a quiet and private location. Social workers and/or clergy should also be offered to the parents to be present. A discussion with the surgeon before speaking to the parents to review the intraoperative events is recommended to prevent conflicting stories. Plan what to say to the parents in advance. Tell the parents what you know and what you don't know. An objective and compassionate discussion on an appropriate educational level for the parents should be the objective. The truth should be told even though it is uncomfortable and has possible legal implications. It is possible that by doing such you may avoid future litigation. Patients (or parents) may forgive mistakes when told upfront, in detail, with a full explanation. Saying you are sorry that the event occurred is acceptable as long as blame isn't mentioned.

The risk management department should be notified as soon as possible about this case. This may occur before or after speaking to the parents. Furthermore, it is not suggested to create an excessive delay in order to contact risk management. The risk management department is an excellent resource for advice on patient discussions, written statements, and future actions to take. The anesthesia record should be reviewed for accuracy, legibility, and completeness. A separate progress note can be used to document additional patient care details such as management in the intensive care unit and/or additional intraoperative information. Alterations to prior entries in the record should not be done. One should be cautious about writing in the medical record any details that are not objective findings such as a suspected error among other staff or attempting to assign blame to another party.

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