PedsCases Podcast Scripts

This is a text version of a podcast from Pedscases.com on "**Pediatric Trauma.**" These podcasts are designed to give medical students an overview of key topics in pediatrics. The audio versions are accessible on iTunes or at http://www.pedcases.com/podcasts

Pediatric Trauma

Developed by Breanne Paul and Dr. Melissa Chan for PedsCases.com.
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Introduction

Hello, my name is Breanne Paul, and I am a medical student at the University of Alberta. This PedsCases podcast on pediatric trauma was created in collaboration with Dr. Melissa Chan, a pediatric emergency physician and Assistant Professor at the University of Alberta and Stollery Children's Hospital in Edmonton, Alberta, Canada.

Today, I am going to be talking about an approach to pediatric trauma. This podcast will:

- Discuss trauma and its relevance in pediatrics;
- Provide an overview of the primary survey;
- Introduce the secondary survey; and
- Review the team approach to pediatric trauma

Remember that this podcast will provide an *overview* of trauma in pediatric patients. Trauma is as varied as the patients themselves so details of each case will vary accordingly. To learn more about specific presentations and procedures, check out some of the other PedsCases podcasts on pedscases.com.

Case

To provide some clinical context, let's start with a case. You are on your Emergency Medicine rotation one blistery January evening when 10-year-old Michael comes in following a motor vehicle collision on the icy roads on the way home from his hockey game. Emergency Medical Services inform you that he was sitting in the backseat and wearing his seatbelt. His Dad was also taken to nearby hospital and no other family members are present. So, where do you start?

Trauma in Children

Before we talk about Michael, let's start first by talking about trauma in children. An estimated 1 in 4 children sustain an injury requiring medical care each year[1]. Therefore,

it is no surprise that accidents, defined as unintentional injuries, are the leading cause of death among children and youth in Canada[2]. In fact, motor vehicle related accidents are the leading cause of fatal injuries in children, while falls are the leading cause of non-fatal injuries[3]. Worldwide, injuries account for 12% of the burden of disease[3].

In an effort to describe the mortality occurring as a result of trauma, the Tri-modal Death Distribution was conceptualized[3]. In this model, the first wave of deaths following a serious injury occurs within seconds. These deaths are largely due to severe brain, spinal, or other vascular injuries. Because the effects of these types of injuries are seen so quickly, prevention is key to reducing these trauma-related deaths. Next is the second wave of deaths, occurring within minutes to hours. These deaths are largely due to blood loss. Finally, the third wave of deaths occurs days to weeks following an injury. These are usually due to complications like sepsis or multi-organ system dysfunction. This temporal model highlights the fact that different interventions will become important for different types of injuries and situations. For the purposes of this podcast, we will be focusing on the second wave as this is the time period in which rapid assessment and resuscitation will have the greatest impact on patient outcomes.

Initial Assessment

As the priorities for assessment and management of trauma are the same in pediatrics as they are for the adult population, we will follow a similar systematic approach to the initial assessment of a trauma patient -focusing on triage, the primary survey, and secondary survey, noting that assessments should be repeated frequently and regularly to identify a change in status.

Triage

First, let's talk about triage. Triage refers to sorting patients based on need and available resources[3]. This is necessary to ensure patients receive the level of care that they require and also to ensure that resources are used appropriately. One important part of triage is vital signs. While this may seem obvious, it is crucial to recognize that normal pediatric reference ranges are different from the adult reference ranges, and change with the child's age. For that reason, we will only provide general patterns of pediatric vitals, focusing on differences[4]:

- The respiratory rate of an infant is 30-50 breaths per minute and decreases with age to 15-20 breaths per minute in an older child.
- A mean systolic blood pressure, in a child over the age of 1, can be determined by adding 90 mmHg plus twice the child's age in years, with a mean diastolic blood pressure being two-thirds of the systolic.
- An infant heart-rate can be as high as 205 beats per minute, falling to a normal adult range in adolescence.

Because a normal vital sign range will change with each child, it is important to be familiar with what is normal for the patient in front of you. An example of a resource that could be used to more accurately determine the appropriate reference range is the

Pediatric Vitals Chart found on pedscases.com, on your PALS card, or the app, Pedi STAT. In addition to clinical findings, vitals can be used in triage scoring systems -for example, to calculate a Pediatric Trauma Score.

Primary Survey

Next, let's talk about the primary survey using the ubiquitous ABCDE approach. The ABCDEs of trauma help identify life-threatening conditions by performing a quick assessment in a specific sequence. To review:

- A refers to establishing *airway* patency with appropriate cervical spine precaution
- B stands for *breathing* and ventilation
- C is for *circulation* with hemorrhage control
- D refers to *disability* via neurological status
- E requires adequate *exposure* with *environmental* control

If the child is old enough, a quick assessment of ABCD can be done by addressing the patient and asking them what happened. However, it should be noted that children may not respond appropriately when they are in pain, stressed, or in an unfamiliar environment.

Airway

To perform the primary survey, the airway should first be inspected for patency. This includes inspecting for foreign bodies, then if safe, suctioning and looking for fractures that could obstruct the airway. Importantly, the cervical spine should be protected appropriately during this process. Infants and toddlers have a greater disproportion between the size of the cranium and the midface. As such, the typically neutral "sniffing position" would cause the posterior pharynx to buckle anteriorly because of the exaggerated flexion caused by the large occiput[3]. To maintain the spine in a neutral position, padding placed beneath the child's torso should be considered in those children less than 8 years of age to keep the plane of the face parallel to the spine board. In addition, the airway can be opened using a jaw-thrust maneuver combined with a bimanual in-line spinal immobilization. In a traumatic injury, an unstable cervical spine should be assumed until proven otherwise. Visualization of the vocal cords can also be more difficult in a young child because the tongue is proportionately larger than in and adult, the airway can be more anterior, and the funnel-shaped larynx allows secretions to accumulate in the retropharyngeal area. If the airway is compromised, a definitive airway should be secured. Resuscitation will be touched on later.

Breathing

Because establishing an airway does not ensure that ventilation actually takes place, breathing needs to be addressed next. In pediatric trauma, cardiac arrest is most commonly caused by hypoxia[3]. To assess for breathing, the neck and chest should be exposed to inspect the neck, trachea, and chest wall. Respiratory rate and oxygenation should be noted. Next, inspection of the chest should be completed, looking for obvious

bruising, penetrating wounds, and asymmetric chest rise. Palpation should be completed of the chest wall feeling for crepitus and of the trachea to ensure it is midline. Auscultation should also be performed to ensure air is flowing into the lungs equally and bilaterally. Throughout this assessment, you are looking for signs of potentially life threatening injury such as a pneumothorax or hemothorax.

Circulation

While hemorrhage is another common cause of death after trauma, the increased physiologic reserve in a child may hide the presence of hypovolemic shock. In fact, a 30% loss in blood volume may be required before a decreased systolic pressure is observed[3]. Obvious hemorrhage aside, surrogate markers for hypovolemia can be used such tachycardia or poor skin perfusion. More subtle markers could also be assessed like progressive weakening of peripheral pulses, pulse pressure less than 20 mmHg, skin mottling, cold extremities, or a decreased level of consciousness. Changes like decreased blood pressure or reduced urine output typically manifest later in the course of injury. Hypotension, along with bradycardia, represent a state of decompensated shock with a circulating blood volume loss of 45% or more. When assessing a patient who may be hypovolemic from blood loss it is important to determine where the bleeding is coming from. Common locations to lose large amounts of blood, causing hemodynamic instability, include the chest, abdomen, pelvis, long bones, and externally from wounds like scalp lacerations. As part of the circulatory assessment, each of these locations should be assessed for signs of bleeding and volume loss.

Disability

Disability refers to a rapid neurological evaluation that will assess the level of consciousness, pupillary reaction, lateralizing signs, and spinal cord injury. Primary brain injuries occur because of the initial injury and are caused by displacement or damage of physical structures in the brain[3]. This would include injuries such as epidural bleeds, subdural bleeds, parenchymal bleeds, and diffuse axonal injury. These may need immediate and surgical management to prevent long term morbidly or mortality. Secondary injuries to the brain are those that are caused indirectly following the original insult. To prevent secondary injury, adequate oxygenation and perfusion must be addressed because hypotension from hypovolemia and hypoxia are strong risk factors for secondary injury. When assessing a child for level of consciousness, the Pediatric Glasgow Coma Scale, which adjusts for development, should be used. A score less than eight is generally regarded as a severe decreased level of consciousness which may necessitate intubation to protect the airway. Other factors that should be assessed with a decreased level of consciousness include ventilation, hypoglycemia, and substance ingestion.

Exposure

Exposure ensures that injuries are not missed. Clothing should be removed to allow for a thorough assessment; however, the body surface area in a child is much higher than

in an adult so hypothermia may develop quickly during the exam[3]. Measures should be taken to reduce thermal loss such as re-covering the child with warmed blankets, using an external warming device, and warming intravenous fluids. The smaller body mass of a child also means that more of the energy imparted from the mechanism of injury is spread over a smaller area. As a result, there is a relatively high frequency of multi-system injuries among children and the clinician should be suspect of such. Children's bones are also quite pliable compared to an adult because of incomplete ossification and multiple growth centers. Therefore, it is more common for a child to injure an internal organ without sustaining any overlying bony fracture.

Resuscitation

In reality, when a life-threatening injury is identified on the primary survey, resuscitation and management must be initiated as soon as possible to maximize patient outcomes. Often this will occur simultaneously with the primary survey; however, to keep things organized we will briefly address resuscitation now using the same sequence as before, focusing on differences between adult and pediatric protocols.

To begin, all patients who have sustained significant trauma require monitors, two large bore IVs, oxygen, and trauma blood work, which typically includes a venous blood gas, CBC, electrolytes, glucose, blood urea nitrogen, creatinine, liver enzymes, blood type and screen, and a pregnancy test in older children.

With respect to airway, an oral airway can be used initially to maintain the airway, however should only be used in an unconscious patient to prevent inducing the gag reflex and vomiting. If endotracheal intubation is indicated, orotracheal intubation should be used. In contrast to adults, the narrowest part of the airway in children is the cricoid ring[3]. To determine the size of endotracheal tube needed, a resource like a Broselow Tape or Pedi STAT can be used. If necessary, the correct size can be approximated using the diameter of the child's external nares or the diameter of their small finger. It is important to also have one size larger and one smaller available, if needed. Because of their increased vagal tone in response to laryngeal stimulation, children may experience bradycardia during insertion of the endotracheal tube. After insertion, the position of the tube should be assessed. Because of the short length of the trachea in young children, minor head movements can displace the tube so it should be re-evaluated regularly. A pneumonic to remember the causes of deterioration in an intubated patient is DOPE:

- Dislodgement
- Obstruction
- Pneumothorax
- Equipment failure

If the previously mentioned airways are insufficient, a laryngeal mask airway or needle cricothyroidotomy may be necessary. Surgical cricothyroidotomy is usually only preformed in larger children when the cricoid membrane is palpable in late childhood.

If a hemodynamic issue has been identified, intervention can take place. If fluid resuscitation is indicated, it will be necessary to estimate the child's weight. The simplest way to do this is to ask a parent or family member. If this is not possible, an estimation tool like Broselow Tape or Pedi STAT can be used. If necessary, weight can also be approximated in kilograms by doubling the child's age and adding 10 -although the accuracy of this approach will be variable. Fundamental to this process is venous access, preferably established via a peripheral intravenous line. If necessary, an intraosseous infusion or femoral venous line can be used. Once access is established, fluid resuscitation can begin with an isotonic solution. If there is significant volume loss or blood loss, use packed red blood cells. This is because hemodynamic instability in a trauma patient is usually due to blood loss. The success of fluid resuscitation and adequate perfusion is reflected in an improvement of hemodynamic abnormalities and urine output. If improvement is not achieved or sustained with this initial management, surgical assessment is required quickly to determine whether this child needs to be taken to the operating room to definitively manage bleeding.

Following the above interventions, radiological studies should be performed. Typically, chest x-ray, cervical spine views, and pelvic x-rays are completed in the resuscitation room, with other imaging ordered as required based on the mechanism of injury.

Secondary Survey

Once the primary survey has been completed and resuscitation is successfully underway, the secondary survey can begin. Essentially, the secondary survey is a head-to-toe evaluation of the patient, including a history and physical exam. If possible, the history should be gathered from the patient; but if this is not possible, family or prehospital personnel may be able to provide some insight. Commonly, the history follows the pneumonic AMPLE:

- Allergies
- Medications
- Past medical history
- Last meal
- Events/Environment leading up to the injury

Events leading up to the injury are important because the mechanism of injury may provide clues about injuries that may have been sustained. Following the history, a comprehensive head-to-toe exam should occur, including a log roll of the patient to look for posterior injuries. Because the findings of a secondary exam will be as varied as the injuries themselves, I will not go into more detail about the physical exam.

Coordination

To wrap up this discussion, we will finish by talking about some logistical details that should be considered by a team performing an initial assessment on a trauma patient. First of all, one member of the team should be designated the team leader. This is important to ensure a coordinated and systematic approach to the assessment. The

team leader also assigns roles to other members of the team as needed. Upon receiving the patient, the acronym MIST can be used to make sure that important details are not missed during the hand-over[3]. MIST refers to:

- Mechanism of injury
- Injuries found and suspected
- Signs and Symptoms
- Treatments initiated

As the team progresses, it is important for members to vocalize their actions and findings so that other members are aware and on the same page. Because trauma cases involve many things happening very quickly, studies have also suggested that teams use checklists to ensure steps are not missed[5]. Checklists have been shown to increase adherence to the assessment protocol.

Back to the Case

Finally, let's return to our case. Upon handover, EMS gives you some additional details about the collision. Another vehicle was involved but the two did not hit head-on. Following the collision, Michael's vehicle collided with a walled barrier lining the road, likely travelling about 70km/h. One side of the vehicle took most of the damage. At the scene, Michael was awake and oriented but was not sure about all of the details leading up to the crash. They suspected he might have a head injury and placed a cervical collar on him. He was a little anxious but his vitals were fairly normal. They didn't get any lines going during the short ride to the hospital.

Approaching Michael, you introduce yourself and ask him what happened. He thinks he was in a car accident and is wondering where his parents are. He responds to your commands but appears a little groggy. He also tells you that his head stings a little and his stomach hurts, but nothing else. You note that he has multiple lacerations on the side of his head and shoulder.

The fact that Michael can communicate tells you some important things: he has a patent airway and is ventilating and perfusing enough to converse. While you are talking with him, the nurse re-takes his vitals. His heart and respiratory rate are both a little high. His blood pressure and temperature are normal but he reports being a little cold - understandable of course, since it's so cold out. But just in case, you ask for some warm blankets. You also ask the nurse to place him on oxygen, establish IV access, and draw trauma bloodwork, which includes venous blood gas, CBC, electrolytes, glucose, blood urea nitrogen, creatinine, liver enzymes, and blood type and screen. You then continue on to the primary survey.

His airway is clear and there is no evidence of foreign bodies, facial fractures, or oral trauma. There is no obvious cyanosis and he has good air entry to both lungs. His peripheral pulses are present; however, he is bleeding slightly from his head. Upon further inspection, the lacerations appear superficial and are tainted with glass. One of them will need to be closed but the bleeding is presently under control. You place a

pressure dressing on the larger wound. He has a GCS of 15 and a normal pupillary reaction. Exposing his abdomen, you note an area of tenderness and bruising.

Right now, you are most concerned about his abdominal pain. You suspect that he may have blunt trauma caused by the seat belt. His heart rate is high but he has a normal blood pressure. This might be normal given the stress of the situation, but his body also might be compensating for some unknown injury. Just to be safe, you start him on a 10cc/kg normal saline bolus and plan to reassess his fluid status following this. You know that vitals in pediatric patients can be misleading so you need to perform further investigations of his abdomen and discuss the case with your surgical team. To assess for an abdominal injury, you would like to order a CT scan. You are conscious about his exposure to unnecessary radiation, but if an injury is found on CT it would greatly inform your management. Some of your labs have come back and his hemoglobin is normal but his liver enzymes are elevated. In discussion with the general surgery team, the decision is made to CT Michael for a possible abdominal injury because of the elevated liver enzymes, abdominal bruising, and mild tachycardia. While you are waiting, Michael's Mom arrives so you gather a little more history from her, explain what has happened, and your plan. Once Michael goes for CT and the results are back, it is noted that there is a small liver laceration which does not currently need surgical intervention. His heart rate has normalized and he appears to be otherwise stable. After completing the secondary survey and not finding any further injures, the general surgery team decides to admit Michael and monitor him to ensure he remains stable.

Review

Now that we've addressed the case, let's review the important points:

- Accidents are the leading cause of death among young people in Canada
- The primary survey is performed rapidly and systematically to look for immediately life-threatening injuries
- The priorities of the initial assessment in children are the same as in adults but with some key differences to account for development and anatomy
- The secondary survey is performed following the primary survey to gather more information about the injuries
- Trauma is often managed in a team environment that requires coordination and communication

That brings us to the end of this PedsCases podcast on pediatric trauma. Thanks for listening, and stay tuned for more PedsCases!

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