

This is a text version of a podcast from PedsCases.com on the “**Approach to Pediatric Head Injury.**” These podcasts are designed to give medical students an overview of key topics in pediatrics. The audio versions are accessible on iTunes or at www.pedcases.com/podcasts.

Approach to Pediatric Head Injury

Developed by Mark McKinney and Dr. Peter Gill for PedsCases.com.
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Introduction

You are listening to the PedsCases podcast series. My name is Mark McKinney, I'm currently a medical student at the University of Alberta, and in this podcast I will be discussing acute management of head injuries. This podcast was developed in collaboration with Dr. Peter Gill, who is a pediatrics resident at the Hospital for Sick Children at the University of Toronto.

As with other PedsCases presentations, information will be presented in the context of a clinical case. The objectives of this podcast are to:

- Introduce the subject of traumatic head/brain injuries in children and youth
- describe the initial stabilization and management of a patient with acute head injury
- review further investigations, with emphasis on indications for imaging using clinical prediction rules
- discuss elements of disposition planning

We recommend that you also work through the partner cases on Acute Head Injury and Abusive Head Trauma available on PedsCases.com. These cases include additional information which is not covered in this podcast.

First off - this is a high anxiety topic for most parents. Whenever we talk about head injury, we have to worry about brain injury, and the worst worry for the parent is that their child will have permanent deficits. We need to remember to be compassionate to these worries, even when head injuries are seemingly very mild.

Minor impacts to the head are extremely common for children and adolescents, but only a small percentage of these will result in skull or intracranial injuries, and even fewer will result in clinically significant long term effects. Nevertheless, trauma is the number one cause of mortality in children over 1 year of age, with head trauma involved in the vast majority of those deaths. It is important to be able to recognize which head traumas are

minor, which can result in intracranial injury, and which might result in lasting neurological deficits or mortality.

Before moving on, let's stop for a moment to emphasize prevention. As accidental traumas are the biggest cause of death in pediatrics, the most influential intervention we can offer is to prevent the traumas in the first place: namely with helmets, seatbelts, carseats, or anything else that keeps a child's head out of harm's way. Take any minor head injury or close call as an opportunity to counsel or even nag about the importance of prevention, because it does work. You can see the PedsCases podcast on injury prevention for more information on this topic.

Case

Now let's start with the case we'll be working with for this podcast. This is a case you might see working in an emergency department or urgent care clinic. The patient is a 9 year old girl who is brought in by her parents after falling off of her bike and striking her head on the ground. You are told that she hit a pothole, the bike twisted on itself, and she was thrown off landing with her head forward. Her parents drove her to the hospital after she vomited on scene.

Initial Stabilization

As this patient is brought into an assessment room, remember that the first step in any urgent setting is ensuring she is not at risk of immediate deterioration by doing a primary survey, namely the ABCs of airway, breathing, and circulation - and don't forget D for disability and E for exposure. We won't belabour the basics of ABCs in this podcast, but rather focus on some relevant points for pediatric head injuries. The main goal of the primary survey is to keep the vitals stable to avoid secondary injury due to hypoxia, hypotension, or raised intracranial pressure. Another important goal you should have in your mind when assessing head trauma is to quickly identify those who need early neurosurgical intervention, because these are the ones for who time is a crucial factor.

Throughout the exam, do not forget about the C-Spine – remember, you clicked on the head injury podcast, so you can't forget about the C-spine. When you hear head injury, think C-spine. Some prefer to think of the ABCs as the cABCs so they don't forget the C-spine. If the patient walked in, there's a good chance their C-spine is okay, but if they came in on a stretcher, be sure they have a proper collar on!

Airway and breathing may be affected if there are associated injuries to the face or chest, but more often they may be at risk because of reduced level of consciousness, so be mindful of this upfront. In terms of circulation, it is very unlikely that a cranial bleed or intracranial bleed would cause hemodynamic instability on its own. If there is instability, look closely for extracranial sources of bleeding; especially the pelvis, abdomen, or long bones like the femur. Definitely keep this in mind if the mechanism of injury is high energy, like in an MVC.

D for disability in head injury primarily refers to neurological status, which as part of the primary survey should be a very basic neuro exam. Assess mental state and GCS, check for bulging fontanelles, pupil size and reactivity, and briefly all four limbs for symmetric movement, tone, and reflexes. One common way to classify severity of head trauma is based on GCS, where 14-15 is mild head trauma, 8-13 is moderate head trauma, and less than 8 is severe head trauma. In non-verbal children, level of consciousness can be assessed with a pediatric GCS, or pGCS, rather than an adult GCS. The major difference between the pGCS and the adult GCS is in the verbal score. A score of:

- 5/5 is cooing or babbling,
- 4/5 is irritable and spontaneous crying,
- 3/5 is crying in response to pain,
- 2/5 is moaning in response to pain,
- 1/5 is no response.

Remember that in our case we are seeing a 9 year old girl, who we would expect to be verbal, so an adult GCS should be applied.

E is for exposure. In head injuries this is important because a child may not be able to tell you about other sites of injury, either because they are too young or because their level of consciousness has deteriorated. Be sure to check the whole body for injuries which might not be obvious.

To summarize the primary survey, you'll do the ABCs, and also D and E where D is a quick neuro exam and E is ensuring you have exposed every potential site of injury. While doing the primary survey, keep a close eye out for any alarm features, such as:

- Hypotension, suggesting hemodynamic instability;
- Unilaterally fixed and dilated pupils suggesting mass effect from raised intracranial pressure;
- Bilaterally fixed and dilated pupils, suggesting substantial mass effect and possible uncal herniation;
- Any other signs of increased ICP including apneic spells, hypoventilation, and Cushing's triad of low heart rate, high blood pressure, and irregular breathing.

If any of these alarm features are present, things are very bad and they need to be seen by a neurosurgeon right away. Management of these severe cases is outside the scope of this podcast.

After the primary survey is the secondary survey, which is a more thorough assessment of the extent of injuries. Most of the important parts of the secondary survey relevant to head injury will come from a head and neurological exam. Look for head deformities such as a depressed skull fracture, which is a surgical emergency. Check for hematomas – frontal hematomas are not as worrisome as hematomas elsewhere,

unless very large or boggy. Check for signs of basilar skull fracture such as racoon eyes where there is periorbital bruising, Battle's sign where there is a hematoma behind the ear, and CSF rhinorrhea, where clear fluid leaks from the nose; or CSF otorrhea, where or clear fluid leaks from the ears. Any sign of basilar skull fracture would be a contraindication to nasal tubes.

Whereas on the primary survey you may do a rapid neuro exam, on the secondary survey you should do a complete neuro exam. Start with mental status, then a full cranial nerve exam to look for any focal deficits, which would suggest mass effect or other intracranial lesion. Bulging fontanelles and papilledema are also signs suggestive of raised ICP. Next, move on to a careful exam of all four limbs for symmetry in tone, movement, and reflexes. Finish the exam with coordination and cerebellar testing.

History

History is often gathered simultaneously with the primary and secondary survey, or immediately after identifying the patient is not in immediate risk. If the patient is unconscious and unstable, get a rapid SAMPLE history. We won't talk much about SAMPLE histories in this podcast, but for those of you who are not familiar, the mnemonic stands for Signs and Symptoms; Allergies; Medications; Past illness; Last Meal; and Events related to illness or injury. More commonly, you will encounter mild or moderate head injuries and you will have time for a full history. The key points to get from history are:

1. What happened including the mechanism of injury, how they were found, was the incident witnessed, and were they wearing a helmet, seatbelts, or other protective gear
2. Immediate and subsequent symptoms including loss of consciousness and for how long, vomiting and how many times, headache and if it is has been worsening, seizures, amnesia, or vision changes
3. Prior history of head trauma or major injury
4. Past medical history, especially for bleeding disorders, or neurological issues which could affect the exam
5. For teens, ask about alcohol or drug use and if it was involved in the injury
6. Ask the parent directly if their child appears to be acting different from their normal. This can be an accurate way of picking up less obvious mental status changes.

In all head injuries, keep an eye out for abuse or neglect, particularly if the mechanism doesn't match with the clinical picture. Listen to the PedsCases podcast on child abuse for more information on this important topic.

Case

At this point, we can add more information to the case so far. Remember we have a 9 year old girl who was thrown from her bicycle after hitting a pothole on the road. To this

history we will add that she was wearing a helmet. After the collision she was walking, but the parents think that she was “out” for several seconds and that she was not acting normal. She vomited once on the sidewalk, and is still fairly nauseated. She has a moderate 7/10 headache around the left frontal area. She has no significant past medical history, and specifically no bleeding disorders or neurological issues. On exam she is alert with a GCS of 15. She is mildly tachycardic but vitals are stable. Her neurological exam shows no focal findings, and there is no papilledema. She has a small hematoma on her left temporal area, but otherwise only scrapes and early bruising with no indication of other substantial injuries.

At this point we have determined that this young girl is stable, but there has been a head injury with some mental status changes, vomiting, and a unilateral headache associated with a temporal area hematoma. What is the best course of management from this point? The parents are wondering if she could have severe bleeding in her head. Do we need to get imaging on this patient?

Clinical Prediction Rules for Imaging

Clinical prediction rules for head imaging have been developed to help clinicians determine which children need imaging. In head injury cases, the most widely used ones are the CATCH and the PECARN rules, so these are the ones to know. The CATCH prediction rule helps predict which children with a minor head injury need a head CT, while the PECARN rule helps identify those children who are at very low risk of meaningful intracranial injury in whom CT should be avoided. In other words, CATCH for who should be imaged, and PECARN for who do not need to be imaged. It's important to keep in mind that the clinical exam is not very reliable at detecting intracranial injury, but the actual rate of positive CT findings in head traumas is very low rate. These prediction rules are designed to balance the risk of delayed or missed diagnosis with the risk of sedation and radiation exposure, which is more significant in children than adults.

First off, all depressed or open skull fractures need a CT, and probably a neurosurgery consult. Barring these, your first decision point is neurologic status and GCS. All moderate or severe head injuries should be imaged. This means if GCS is lower than 13, get an urgent CT. If GCS is 13 or higher and there are no neurological deficits, risk of brain injury is much lower. Some relative indications for CT imaging may be prolonged GCS 13 or less at any time, basilar skull fracture, deterioration of symptoms with observation over 6 hours or more, high energy traumas, large boggy cephalohematomas, or persistent irritability in children <2yo. In the absence of these indications, use the CATCH or PECARN rules to help make your decision clear.

PECARN Rule

PECARN stands for Pediatric Emergency Care Applied Research Network, which was the research group that developed it. The PECARN rule applies to patients with a GCS greater than 13, who present within 24 hours of injury. The PECARN prediction rule is

excellent at predicting children in whom a CT would NOT result in a change in management or outcomes.

The rule criteria are divided into two groups. For children older than 2, a CT is recommended if GCS is 14 or lower, or if there are signs of basilar skull fracture. Either CT or careful observation alone is recommended if there is a history of loss of consciousness, vomiting, severe headache, or a dangerous mechanism of injury. If none of these are present, careful observation without CT is enough.

For children younger than 2 years old, a CT is recommended if GCS is 14 or lower, or there is a palpable skull fracture. Either CT or careful observation alone is recommended if there is any scalp hematoma other than frontal, loss of consciousness greater than or equal to 5 seconds, a severe mechanism of injury, or the patient is not acting normal according to parent. If none of these are present, careful observation without CT is enough.

CATCH rule

CATCH stands for Canadian Assessment of Tomography for Childhood Head Injury. The CATCH rule has high sensitivity for predicting acute brain injury. In children who meet the criteria, there is high likelihood that the CT will show intracranial injury and change management. The rule criteria require presentation within the first 24 hours and GCS 13-15. Patients who meet the criteria are classified either as medium risk, meaning a CT is likely to show brain injury; or high risk, meaning urgent neurological intervention may be necessary.

Medium risk is defined as any sign of basal skull fracture, which remember means raccoon eyes, Battle's sign, or fluid from the ears or nose either blood or clear CSF; a large and boggy hematoma on the scalp; or a dangerous mechanism of injury such as an MVC, fall from greater than 3 feet, falling down 5 stairs, falling off a bicycle without a helmet.

High risk is defined as GCS less than 15 two hours after injury, suspected open or depressed skull fracture, a worsening headache, or persistent irritability on exam

So to summarize the PECARN and CATCH rules - for low-risk children in who you may already be debating a CT, the PECARN rules can help you decide NOT to do a CT. For all other children with mild injury the CATCH rules can help you decide if a CT is likely to be beneficial or not. For any child with more than a mild injury, the prediction rules don't apply and clinical judgement should be used, generally indicating need for a CT.

Case

Now let's go back to our case of a 9-year-old girl who was thrown from her bike after hitting a pothole. She is currently stable, but there has been a head injury with some

mental status changes, vomiting, and a unilateral headache associated with a temporal area hematoma. Does she need imaging?

We identified that she had a GCS of 15, though is reporting a loss consciousness. In her case, the CATCH rule would be more appropriate. Looking at the criteria, she does not have signs of a basal skull fracture, she has a hematoma but it is not large or boggy, and the mechanism would not classify as very dangerous because though she was biking she was wearing a helmet. The CATCH rule would suggest that a CT might not be necessary.

If we wanted to apply the PECARN rule as well, we would see that her GCS is not less than 15 and she does not have signs of basilar skull fracture, but she did report a loss of consciousness. The PECARN rule would suggest either a CT or watchful waiting would be reasonable approaches.

So after reviewing the CATCH and PECARN rules, you decide that watchful waiting is an appropriate choice. You reassure the parents that she is unlikely to have bleeding on CT, so you do not want to expose her to unnecessary radiation. However you also say that you will be paying close attention to their daughter, and will of course get a CT if she is not improving. How will you know when she is ready to go home?

Disposition

In mild-moderate head injury cases, the decision is either going home or admission to hospital. If it is a severe injury, the decision should be made in consultation with neurosurgery.

Patients who can go home right away are those with a GCS greater than 13, and absence of symptoms. The chance of intracranial injury is well below 1% in these patients. In symptomatic patients, such as vomiting or headache, a brief observation period of 6-8 hours is recommended. Symptoms should improve within this period. If they do not improve, they may require a brief admission for observation or symptomatic management. If any alarm features are present, such as worsening symptoms or mental status, persistent vomiting, focal neurological findings, seizure, or basilar skull fracture, then neurosurgical intervention may be needed.

For those who are discharged home with a responsible caregiver, there should be very explicit instructions given. The child should be watched for worsening symptoms, but they don't have to be kept awake. They should be encouraged to drink clear fluids if still nauseated or if vomiting. They may continue to have headaches and nausea, but they should be instructed to return if there is recurrent vomiting or otherwise worsening symptoms. They should be advised to have physical rest, but also cognitive rest, meaning avoiding activities like reading, watching TV or being on a computer for prolonged periods. For older children, they should avoid driving.

Children take longer to recover than adults, at least 1 week, probably more. Children can return to school as symptoms permit. They may need time off school, but symptoms can be lessened by allowing time for extra breaks throughout the day, such as lying down for an hour on a couch in the teacher's lounge or offices. Return to sport will need to be delayed longer. They should be entirely symptom free at rest before starting any light activity, and symptom free with light activity before attempting any sport-specific activity. Any training in the gym or cardiovascular training should be delayed until symptom free as well.

Case

After carefully watching her for about 8 hours overnight, she has no further vomiting, her headache improves, and she becomes her normal self. She is very tired from everything that has happened, but is alert and easily rousable with GCS 15/15. Her parents are comfortable taking her home and will watch her over the next day or two to ensure she keeps doing well, and will bring her back if she deteriorates in any way.

Conclusion

To summarize what we've talked about in this podcast, we've talked about head injury and the importance of prevention; initial stabilization and assessment with the primary survey, emphasizing the cABCs, and the secondary survey, emphasizing head and neuro exam; how the pediatric GCS differs from adult GCS; key history topics; PECARN and CATCH prediction rules for imaging; and when you can send a patient home and what instructions to give.

That's it for this PedsCase podcast on head injury. Again, my name is Mark McKinney and this podcast has been produced in collaboration with Dr. Peter Gill. I hope this has been a helpful look at acute management of head injuries in pediatrics. For more information, be sure to check out the case series that go along with this podcast.

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