

Concussion

- **Chief complaint**
 - 40-year-old female presents with headache.
- **Vital signs**
 - HR: 89 BP: 134/75 RR: 18 Sat: 98% on RA T: 37.5°C
- **History**
 - **HPI:** 40-year-old female presents with a closed head injury after a slip and fall on the ice (clearly mechanical mechanism) six hours ago. She hit the back of her head but denies any other injury. She felt “dazed” immediately afterward. She currently has a moderate severity generalized headache.
 - **+** : nausea, moderate generalized headache, mild dizzy/light-headedness
 - **-** : LOC, vomiting, chest pain, neck or back pain, vision change, numbness, weakness, alcohol or substance use
 - **PMH:** Hypertension. She does not take antiplatelet or anticoagulants (learner must ask).
 - Additional history is negative/non-contributory
 - **Concerns:** “I probably need a CT or MRI to make sure my brain is OK”
- **Physical Exam** (*essential exam components are bolded*)
 - General: no acute distress
 - **HEENT:** EOMI, PERRL, no nystagmus. No facial trauma. **Moderate size occipital scalp hematoma**, no palpable skull abnormality. No open scalp wounds.
 - **Neck:** no focal cervical spine tenderness, full, non painful range of motion
 - **Chest:** nontender
 - Heart: normal
 - Lungs: normal
 - Abdomen: normal
 - **Extremities:** normal
 - **Back:** normal
 - **Neuro:** CN intact. Normal strength and sensory exam. Normal cerebellar exam. Gait is normal.
 - **Skin:** scalp hematoma, otherwise intact
- **Discussion Prompt: What is your differential diagnosis?**
 - Emergent
 - Subdural hematoma
 - Epidural hematoma
 - Traumatic subarachnoid hemorrhage
 - Intraparenchymal hematoma

- Diffuse axonal injury
 - Spinal fracture
 - Spinal cord injury
 - Cervical artery dissection
 - Urgent
 - Skull fracture
 - Maxillofacial trauma
 - Nonurgent/benign
 - Mild concussion
 - Cervical strain
 - Scalp hematoma
- **Evaluation and Management:** *(learners should discuss the need/indications for diagnostic tests or therapeutics)*
 - Order Labs
 - None indicated
 - Order Imaging
 - None indicated, may discuss need for CT scan (shared decision-making)
 - Order Meds
 - Consider symptomatic management with acetaminophen, antiemetic
- **Diagnosis**
 - Concussion (mild traumatic brain injury (TBI))
- **Patient Education**
 - **What is wrong with me?**
 - Based on the mechanism of your injury and your current symptoms it is likely that you have a concussion which is also known as a mild traumatic brain injury
 - When the brain is subjected to sudden directional changes causing it to “bounce around” inside of your skull as with your fall, it can cause microscopic injuries to the brain cells and the connections between them
 - Fortunately these injuries recover spontaneously and fully in the great majority of patients with simple concussion management
 - **What symptoms should I expect with a concussion?**
 - Headache is a common symptom
 - Other symptoms may be vague and nonspecific like nausea, dizziness, blurry vision, feeling off balance and feeling fuzzy or foggy
 - It is common to have some degree of cognitive changes as well. You may experience difficulty focusing or concentrating, changes in memory, slowed reaction times, difficulty navigating complex problems or situations, or changes in mood.
 - **How can I manage symptoms at home?**

- It is important to rest your brain for the next couple of days to begin the recovery process and then gradually return to your normal activities over the next several days to weeks
 - We can recommend medications to help with some of your symptoms at home
 - Avoid alcohol, drugs and caffeine as they could slow down recovery or make it more difficult to track the progress of your recovery. Caffeine also impacts your ability to sleep and unnecessarily stimulates an injured brain.
- **Do I need a head CT scan?**
 - Based on your history, exam and other risk factors that we reviewed, there is a very low chance that you have any bleeding or structural problems with your brain
 - Even if you had a CT or MRI of your brain, we would not expect it to have any abnormalities
 - Using well studied decision tools, we can very safely forego imaging at this time which will save you time, money and radiation exposure
- **How long will I have symptoms for?**
 - Symptoms are most noticeable in the first several days and then gradually improve over the next few weeks
 - 80% of patients with your type of injury are fully recovered at 4 weeks
- **Should I try to stay awake or have someone keep me from falling asleep if I have a concussion?**
 - Sleep and rest are important when recovering from a concussion
 - It is not necessary to avoid sleep or be woken up frequently
 - Over the next 1-2 days, It would be OK to have a family member or friend check every few hours to assure that you are breathing normally and can be woken up fairly easily. Also have them watch for any changes in your behaviors or level of alertness.
- **What if I get worse? (Return Precautions)**
 - Go to an emergency department if you develop any of the following symptoms:
 - Severe or worsening headache
 - Excessive sleepiness, confusion, or significant changes in mental status
 - Seizures
 - New neurologic changes (changes in vision or speech, weakness in the arms or legs, severe difficulty with balance or walking)
 - New onset of vomiting
 - New injuries discovered from the fall
- **Patient Disposition**
 - Discharge home with reasonable recovery expectations, home management plan, work/school note and return precautions
 - Planned primary care follow-up in the next several days and potentially at one month to ensure that symptoms are improving as expected

- Recommend followup with a concussion specialist prior to return to sports, activities requiring high cognitive functioning or special safety considerations or for patients with symptoms that persist past one month
- **Discussion Prompt: Discuss indications for transfer to a higher level of care.**
 - Markedly abnormal vital signs
 - Severe mental status changes
 - Multi-system trauma
 - Complex lacerations or other wounds
 - Exam findings of basilar skull fracture (hemotympanum, periorbital ecchymosis, postauricular ecchymosis, nasal CSF leak)
 - Significant brain injury cannot be ruled out based on validated clinical decision tools
 - Concern for cervical spine injury based on validated clinical decision tools
 - Patient is taking anticoagulation medications
- **Instructor Prompt:** Provide feedback about evaluation and management of the case.
- **Essential Teaching Points: Concussion**
 - Concussion is a clinical diagnosis and need for intracranial imaging can be reliably ruled out in many cases
 - Use validated clinical decision tools when determining the need for intracranial or cervical spine imaging; remember these are tools and not rules, make individual decisions for individual patients
 - Set realistic expectations for recovery over the next several days to weeks
 - Stress the importance of gradual return to full activities
 - Stress the importance of avoiding future head injuries
 - Discuss return precautions with a family member or friend that is aware of the patient's injury and provide detailed written discharge instructions with the patient
 - Think about the long term management of concussions, make sure the patient is aware of potential complications and empirically discuss a plan and available resources if these develop
- **Deep Learning: Disease Characteristics of a Concussion**
 - In 2018, there were over 1.3 million visits to emergency departments for head injuries, approximately 75% of these are categorized as mild
 - TBI severity can be categorized based on a Glasgow Coma Scale (GCS) score
 - Mild 13-15
 - Moderate 9-12
 - Severe 8 or less
 - A concussion is a type of mild TBI associated with transient alteration of mental status that can range from confusion to loss of consciousness, amnesia of events immediately prior to or following the injury, or other neurologic symptoms such as headache, nausea, vomiting or seizure

- In the following hours and days, the patient may have continued neurologic symptoms and experience mood and cognitive disturbances, sensitivity to light and noise, and sleep disturbances.
- Mild TBI is a clinical diagnosis based on mechanism and symptoms
- With mild TBI, symptoms are due to functional disturbance, there are no structural changes seen on CT or MRI imaging of the brain
- **Deep Learning: Diagnostic Considerations**
 - What are signs to assess for on physical exam?
 - Depressed or altered mental status (GCS or Simplified Motor Score)
 - Obvious scalp lacerations
 - Scalp/skull deformity or crepitus
 - Basilar skull fracture signs: hemotympanum, Battle sign, raccoon eyes, CSF otorrhea
 - Unequal pupils
 - Focal neurologic deficits
 - Always consider concurrent spinal injuries in patient with head injuries
 - The prevalence of concomitant cervical spinal injury in patients with a TBI is around 6.5%
 - The prevalence of other concomitant spinal injury in patient with a TBI is around 12.5%
 - Some standardized evaluations have been developed to help with concussion recognition (see links under supplemental resources for learners below):
 - The Post-Concussion Symptom Scale (PCSS) and the Sports Concussion Assessment Tool 5th Edition (SCAT-5) were both developed for use in athletes but can be extrapolated to all mild head injury patients, can be easily accessed online and may be useful in determining the presence and severity of a concussion.
 - The SCAT-5 has an “immediate or on field assessment” assessment component that could be helpful in the urgent care setting in identifying patients that are high risk for more severe injuries early on
 - Both take at least 10 minutes to perform accurately but can serve as a good baseline measurement for which to compare improving or worsening symptoms at times of patient follow up.
 - The Abbreviated Westmead Post-Traumatic Amnesia Scale (A-WPTAS) is simple to perform and takes less time to perform than the PCSS or SCAT05 and correlates with the findings of more-detailed neurophysiologic testing.
- **Deep Learning: Does my patient need a head CT scan?**
 - There are clinical decision tools available to guide decision making of whether or not a patient needs a head CT and likely require a higher level of care.
 - These decision tools take into account numerous criteria including GCS, mechanism of injury, age, presence of certain associated symptoms (e.g., vomiting, seizure), evidence of skull fracture on physical exam, etc.
 - Only use clinical decision tools in patients with mild head injury (i.e., GCS 13-15).

- CT imaging is always indicated in any patient with a traumatic head injury with GCS less than 13.
- Two common clinical decision rules: Canadian CT Head Rule (CCHR) and New Orleans Criteria (NOC) -> see MDCalc for additional details
 - Canadian CT Head Rule (CCHR)
 - 100% sensitivity in identifying patients who require “neurosurgical intervention”; 85% sensitive for neurocranial traumatic CT findings that are “clinically important”
 - Apply IF GCS 13-15 and 1 of [LOC, amnesia, disorientation]
 - Exclude age <16 years, blood thinners, seizure after injury
 - High Risk Criteria (CT if any YES, rule out if NO to all)
 - GCS <15 at 2 hours post-injury
 - Suspected open or depressed skull fracture
 - Any sign of basilar skull fracture
 - 2 or more episodes of vomiting
 - Age $\geq$ 65 years
 - Medium Risk Criteria (rules out “clinically important” brain injury)
 - Retrograde amnesia $\geq$ 30 minutes
 - “Dangerous” mechanism (Ped vs Auto, ejection, fall >3ft)
 - New Orleans Criteria (NOC)
 - 100% sensitive for “neurosurgical intervention” and 99.4% sensitive for “clinically important” TBI
 - Apply if head injury + LOC and GCS 15 with normal neuro exam
 - Exclude < 3 years
 - Criteria (CT if any YES, rule out if NO to all)
 - Headache
 - Vomiting
 - Age > 60 years
 - Alcohol or drug intoxication
 - Persistent anterograde amnesia
 - Visible trauma above the clavicle
 - Seizure
- For pediatric patients, there is the PECARN Pediatric Head Injury Rule that can be used to rule out “clinically important” TBI [criteria vary by age < or > 2, see MDCalc]
 - 100% sensitivity for children < 2 years, 96.8% sensitivity for children >2 years
 - Apply if GCS $\geq$ 14
 - Criteria (CT if any YES, rule out if NO to all)
 - GCS $\leq$ 14
 - Altered mental status (agitation, somnolence, repetitive, slow response)
 - Not acting normally per parent
 - LOC $\geq$ 5 seconds
 - Vomiting or severe headache (> 2 years)
 - Palpable skull fracture or signs of basilar skull fracture

- Occipital, parietal or temporal scalp hematoma
 - Severe mechanism (MVC ejection, death of another passenger, rollover MVC, Ped/Bike vs Auto, fall from > 3 feet, strike by high-impact object)
 - Strongly consider head CT in any patient on anticoagulation or antiplatelet agents, even in the setting of mild head trauma.
 - Even in the absence of clinical findings, liberally transfer a patient in this population to a higher level of care for further evaluation and to potentially undergo head CT.
 - For elderly patients, have a lower threshold to obtain head CT given the expected anatomical changes of age which can increase the risk of intracranial bleeding.
 - Similar validated clinical decision tools exist for determining the need for CT C-spine including Canadian C-Spine Rule and NEXUS C-Spine Rule (see MDCalc)
- **Deep Learning: Treatment considerations**
 - For patients who do not require CT imaging, you can focus on symptomatic treatment of the patient.
 - Acetaminophen or ibuprofen can be given for headache
 - Antiemetics may be considered for nausea in order to maintain adequate hydration and PO intake
 - Ondanestron is reasonable given favorable side effect profile
 - Other common antiemetics such as prochlorperazine or metoclopramide can cause drowsiness which may impact accurate neurologic assessment
 - Physical and cognitive relative rest is recommended for 24-48 hours after injury followed by graduated and progressive increase back to normal activities
 - Provide appropriate work and school excuse notes
 - In the subsequent days to weeks, stress that if any symptoms are worsened by a particular activity, the patient is not yet ready to return to that activity
 - Athletes should not return to play until all symptoms have returned to baseline at rest and are not exacerbated during activity. Utilize coaches, athletic trainers, team physicians to help with post concussion aftercare and the decision of when to return.
 - Discuss that in some patients who develop persistent neuropsychiatric symptoms during the recovery from their concussion, other treatment modalities may be pursued including physical rehabilitation, psychotherapy, and medications
 - **Deep Learning: Anticipating common patient questions and practicing helpful responses**
 - **“What do you mean by “cognitive and physical rest”? What types of things should I avoid?”**
 - In the first 24-48 hours, strict bedrest is not required, but avoid any activities that highly stimulate the brain or require a high level of brain functioning
 - As much as possible, avoid bright lights, prolonged screen viewing, loud noises, prolonged reading, exercise, sports, driving, homework, work projects, and house chores
 - It is OK to do simple activities like walking around the house, sitting outside, talking on the phone briefly, preparing food, going to the bathroom, listening to quiet and calm music.

- **“I’m glad that you think I just have a “mild” brain injury but I would really feel better if I could just get a CT of my brain.”**
 - Have a discussion regarding the risks and benefits of CT imaging
 - Present some of the basic statistics from the head imaging clinical decision tools from above
 - “The chance of you having an injury to your brain that would require a brain surgeon to perform any intervention is less than 1%”
 - Stress that we always have the capability to reconsider the option to obtain CNS imaging if there was a change in condition, invite the patient to return at any time for reassessment and discuss return precautions
 - Particularly in young patients, the risk of radiation from CT imaging is a strong factor to consider
 - The radiation from a head CT scan is roughly equivalent to 16 chest x-rays or several months of background radiation
 - <https://www.acr.org/-/media/ACR/Files/Radiology-Safety/Radiation-Safety/Dose-Reference-Card.pdf>
- **“I have a really important game this coming weekend, is it OK if I play?”**
 - Have the patient think about the big picture and their future in sports or other physical activities
 - “If you rest and recover for these first several days, you will hopefully be able to safely return sooner than if you try to push yourself too early during recovery.”
 - There is some evidence that athletes who have history of previous concussions may require longer recovery times if they sustain future concussions
 - In addition to the uncomfortable symptoms they might experience, there are other risks as well:
 - Second impact syndrome: If a second concussion occurs without fully recovering, there can be a rapid evolution of malignant cerebral edema developing in a short-time course of time.
 - The greatest risk of this is within the first 10 days after the initial injury
 - Chronic Traumatic Encephalopathy (CTE): This is usually a delayed manifestation of repetitive mild TBI. This is common in athletes and can lead to psychiatric disturbances and suicidal behavior, attention deficits, and derangements in memory and executive functions.
- **“How long can I expect to have symptoms for?”**
 - The great majority of patients with concussion recover with no long term complications
 - Symptoms and disability related to a concussion are greatest within the first 7 to 10 days
 - About 80% of patients have full resolution by one month
 - About 20% of patients have symptoms that may last up to three months
 - A very small number of patients have symptoms that last for one year or longer
 - The majority of sport-related concussions resolve in 7-10 days, this may be longer in children and adolescents
- **“Should I try to stay awake or have someone keep me from falling asleep if I have a concussion?”**

- Sleep and rest are important when recovering from a concussion. It is not necessary to avoid sleep or be woken up frequently. It would be OK to have a family member or friend check every few hours to assure that you are breathing normally and can be woken up fairly easily. Also have them watch for any changes in your behaviors or mental status.

- **Learning Objectives**

- List a differential for emergent, urgent and benign diagnoses for a closed head injury
- Discuss which history and exam findings are most helpful to establish an accurate diagnosis
- Discuss treatment options focused on symptom relief
- Discuss use of validated clinical decision tools with head trauma
- Determine which patients require transfer to a higher level of care
- Anticipate and practice structured responses for common patient questions
- Discuss a formal recovery plan after a concussion
- Discuss the expected recovery course for a concussion and set expectations
- Discuss an appropriate follow up plan after a concussion

- **Attributions**

- Authors: Rachel Walsh, PA-C, Nathaniel Shekem, PA-C
- Editors: Rachel Dahms, MD, Melissa Nelson-Perron, MD, Kristen Grabow Moore, MD, MEd

- **References:**

- National Clinical Guideline Centre (UK). Head Injury: Triage, Assessment, Investigation and Early Management of Head Injury in Children, Young People and Adults. London: National Institute for Health and Care Excellence (UK); 2014 Jan. (NICE Clinical Guidelines, No. 176.) 7, Assessment in the emergency department: imaging of th
- Coma, Simon RP, Aminoff MJ, Greenberg DA. Clinical Neurology, 10e; 2017. Available at: <https://accessmedicine.mhmedical.com/content.aspx?bookid=2274§ionid=176231696> Accessed: November 17, 2019
- Guskiewicz KM, McCrea M, Marshall SW, et al. Cumulative Effects Associated With Recurrent Concussion in Collegiate Football Players: The NCAA Concussion Study. JAMA. 2003;290(19):2549–2555.
- Schneider KJ, Iverson GL, Emery CA, et al The effects of rest and treatment following sport-related concussion: a systematic review of the literature British Journal of Sports Medicine 2013;47:304-307.
- Simel DL. Head Trauma. In: Simel DL, Rennie D. eds. The Rational Clinical Examination: Evidence-Based Clinical Diagnosis New York, NY: McGraw-Hill; 2009. <http://jamaevidence.mhmedical.com.proxy.lib.uiowa.edu/content.aspx?bookid=845§ionid=139144729>. Accessed November 17, 2019.
- Smits M, Dippel DWJ, de Haan GG, et al. External Validation of the Canadian CT Head Rule and the New Orleans Criteria for CT Scanning in Patients With Minor Head Injury. JAMA. 2005;294(12):1519–1525.

- Stiell IG, Clement CM, Rowe BH, et al. Comparison of the Canadian CT Head Rule and the New Orleans Criteria in patients with minor head injury. *JAMA*. 2005;294(12):1511–1518. Medline: 16189364
- Stiell IG, Wells GA, Vandemheen K, et al. The Canadian CT Head Rule for patients with minor head injury. *Lancet*. 2001;357(9266):1391–1396. Medline: 11356436
- Nishijima DK, O. S., & Network., C. R. (2013, Feb). Risk of traumatic intracranial hemorrhage in patients with head injury and preinjury warfarin or clopidogrel use. *Acad Emerg Med*, 20(2), 140-5.
- Cairns C, Kang K, Santo L. National Hospital Ambulatory Medical Care Survey: 2018 emergency department summary tables. Available from: https://www.cdc.gov/nchs/data/nhamcs/web_tables/2018_ed_web_tables-508.pdf.
- Scorza KA, Cole W. Current Concepts in Concussion: Initial Evaluation and Management. *Am Fam Physician*. 2019 Apr 1;99(7):426-434. PMID: 30932451.
- Legome Eric, He Chen. Traumatic Brain Injury (major and minor). In: Mattu A and Swadron S, ed. CorePendium. Burbank, CA: CorePendium, LLC. <https://www.emrap.org/corependium/chapter/recgoDVX2dyeKnFCN/Traumatic-Brain-Injury-major-and-minor>. Updated April 26, 2021. Accessed November 14, 2021.
- DynaMed. Concussion and Mild Traumatic Brain Injury. EBSCO Information Services. Accessed November 14, 2021. <https://www.dynamed.com/condition/concussion-and-mild-traumatic-brain-injury>
- Jagoda AS, Bazarian JJ, Bruns JJ Jr, Cantrill SV, Gean AD, Howard PK, Ghajar J, Riggio S, Wright DW, Wears RL, Bakshy A, Burgess P, Wald MM, Whitson RR; American College of Emergency Physicians; Centers for Disease Control and Prevention. Clinical policy: neuroimaging and decisionmaking in adult mild traumatic brain injury in the acute setting. *Ann Emerg Med*. 2008 Dec;52(6):714-48. doi: 10.1016/j.annemergmed.2008.08.021. PMID: 19027497.
- Pandrich MJ, Demetriades AK. Prevalence of concomitant traumatic cranio-spinal injury: a systematic review and meta-analysis. *Neurosurg Rev*. 2020 Feb;43(1):69-77. doi: 10.1007/s10143-018-0988-3. Epub 2018 Jun 7. PMID: 29882173; PMCID: PMC7010651.
- Georges A, M Das J. Traumatic Brain Injury. [Updated 2021 Jan 16]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK459300/>
- Harmon KG, Clugston JR, Dec K, et al/American Medical Society for Sports Medicine position statement on concussion in sport. *British Journal of Sports Medicine* 2019;**53**:213-225.

● Traditional Textbook Resources

- Wright DW, Merck LH. Chapter 257: Head Trauma. In: Judith E. Tintinalli, O. John Ma, et al, editors. *Tintinalli's Emergency Medicine: A Comprehensive Study Guide* (9th ed). New York: McGraw-Hill; 2020.
- Papa L, Goldberg SA. Chapter 34: Head Trauma. In: Ron Walls, Robert Hockberger, Marianne Gausche-Hill et al, editors. *Rosen's Emergency Medicine: Concepts and Clinical Practice* (9th ed). Philadelphia: Elsevier, Inc; 2018.

● Supplemental Resources for Learners

- FOAMed resources

- <https://litfl.com/traumatic-brain-injury-tbi-overview/>
- <http://www.emdocs.net/quality-corner-head-trauma-anticoagulation-postdural-puncture-headache/>
- <https://thesgem.com/2021/05/sgem331-should-patients-with-a-concussion-be-told-to-walk-this-way/>
- <https://www.nuemblog.com/blog/concussion>
- <https://emottawablog.com/2019/06/concussion-inside-the-head-part-1/>
- <https://emottawablog.com/2019/07/concussion-inside-the-emergency-department/>
- <https://emottawablog.com/2019/07/concussion-complications-and-public-safety-part-3/>
- Clinical decision tools
 - <https://www.mdcalc.com/canadian-ct-head-injury-trauma-rule>
 - <https://www.mdcalc.com/new-orleans-charity-head-trauma-injury-rule>
- Concussion assessment tools:
 - <https://neurotoolkit.com/pcss/>
 - <https://bjsm.bmj.com/content/bjsports/early/2017/04/26/bjsports-2017-097506SCAT5.full.pdf>
 - https://www.ourphn.org.au/wp-content/uploads/2017/03/A_WPTAS-scale-for-head-injury.pdf