Head Injuries: To Scan or Not to Scan (That is the question...)

Nicole Coyne, MBS, MMS, PA-C

Learning Objectives

• Review epidemiology and pathophysiology of acute head injury.
• Describe common mechanisms for acute head injury.
• Discuss signs and symptoms of acute head injury. Be able to differentiate between mild, moderate and severe head injuries.
• Identify current indications for head CT in children and adults with head injury.
• Discuss safety concerns related to head CT in children.
• Review home care recommendations and patient/parent education.

Today’s Goals

• Provide up to date practice guidelines for the evaluation of children and adults with acute head injury.
• These injuries commonly present to outpatient clinics, including pediatric offices, family practice and urgent care.
• Adequate understanding of head injury mechanisms, presentation, and clinical course is important to aid in determination of whether a patient requires a higher level of care and/or CT scan.
Head Injury Epidemiology

- Nearly 2 million people annually
  - 75 percent “mild”
- Children four years and younger, young persons 15 to 19 years of age, older adults are most susceptible
  - Falls being the most common etiology among patients older than 75 years.
- Men more likely at every age to experience acute traumatic brain injury
- Women are more likely to have subacute to chronic sequelae.
- Most improve over the first few hours to days
  - 5 to 20 percent may have postconcussive symptoms for an extended period
  - Women, older adults, less educated persons, and those with a previous mental health diagnosis are prone to persistent symptoms.

Pathophysiology

- Caused by rotational and angular forces to the brain,
  - direct impact to the head is not required.
- Shear forces disrupt neural membranes
  - potassium efflux into extracellular space.
  - increases of calcium and excitatory amino acids are followed by further potassium efflux
  - suppression of neuron activity
- Sodium-potassium pumps restore balance
  - increased energy requirement
  - decrease in cerebral blood flow.
- Disruptions of autonomic regulation can persist for several weeks, and brain may be vulnerable to additional injury.

Axon Stretching and Ionic Disequilibrium

Increased Extracellular K+ and glutamate release

Activates N-methyl-D-aspartate receptors

Increased intracellular Ca++

Mitochondrial respiration dysfunction, protease activation, apoptosis

Acute energy crisis
Common Mechanisms

- Toddler trips and hits head on coffee table
- Adolescent hit in head with soccer ball
- Adult male hit in head with wrench
- Infant falls off counter onto tile floor
- Weekend warrior takes baseball to face
- GLF while intoxicated
- Elderly slip getting out of tub
- MVA
- Sibling head to head contact

Signs and Symptoms

- Symptoms typically present immediately after injury, but may be delayed several hours.
- Symptoms usually last less than 72 hours
- Most resolve spontaneously within seven to 10 days.
- Recovery may be prolonged in children, adolescents and those with previous closed head injuries.

Initial Physical Symptoms

- Most common: headache.
- May also complain of nausea, blurred vision, fatigue, and sleep disturbances.
- Typically improvement within 24 hours of the injury; likely resolved within seven days of the injury
Behavioral Symptoms

- Irritability, mood and sleep disturbances, and fatigue
- Persons with preexisting depression, anxiety, posttraumatic stress disorder, or substance abuse disorders at higher risk
- Other factors: lower functional and socioeconomic status

Cognitive Symptoms

- Attention difficulties, memory problems, and executive dysfunction (a decreased ability to organize activities and thoughts, and to plan and reason effectively).
- Symptoms typically mild; difficult to detect on routine testing.
- Patients often describe slowing of thought processes.
- Typically improve in first two to four weeks following injury
  - small percentage of patients may have prolonged symptoms

Physical Exam

- Neurologic examination:
  - mental status
  - the cranial nerves
  - deep tendon reflexes
  - Strength
  - gross cutaneous sensation
  - postural stability
- Visual acuity, visual fields, and eye movements
- Focused musculoskeletal examination of the head, neck, and jaw
- Any abnormal findings should be documented and compared with baseline if possible.
Findings Suggesting Severe Injury

<table>
<thead>
<tr>
<th>Type of Assessment</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balance</td>
<td>Romberg sign, postural instability, unsteadiness</td>
</tr>
<tr>
<td>Cranial Nerves</td>
<td>Vision problems; unequal or fixed, dilated pupils; abnormal extracranial movements; or other abnor-</td>
</tr>
<tr>
<td></td>
<td>mal cranial nerve findings may be suggestive of brainstem injury</td>
</tr>
<tr>
<td>Deep Tendon Reflexes</td>
<td>Hyperreflexia or Babinski reflex suggests upper motor neuron lesion</td>
</tr>
<tr>
<td>Drug-to-use test</td>
<td>Abnormal findings suggest coordination deficit</td>
</tr>
<tr>
<td>Gait</td>
<td>Atomic gait may suggest cerebellar dysfunction</td>
</tr>
<tr>
<td>Mental Status</td>
<td>Prolonged loss of consciousness (more than 30 seconds); somnolence or confusion; disorienta-</td>
</tr>
<tr>
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<td>tion; deficit in language, speech, or long-term memory</td>
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<tr>
<td>Muscular Strength</td>
<td>Weakness or unequal strength, decreased tone; akinesia movements may indi-</td>
</tr>
<tr>
<td></td>
<td>cates basal ganglia or cerebellar injury</td>
</tr>
<tr>
<td>Sensory Assessment</td>
<td>Numbness or abnormal sensation can be traced to spinal nerve root</td>
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</tbody>
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Classification

<table>
<thead>
<tr>
<th>Classification of Traumatic Brain Injury (TBIs)</th>
<th>( GCS &lt; 13 )</th>
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<tbody>
<tr>
<td>Criteria</td>
<td>Mild</td>
</tr>
<tr>
<td>Duration of Loss of Consciousness</td>
<td>6-20 min</td>
</tr>
<tr>
<td>Duration of Loss of Consciousness (assumed start)</td>
<td>5-10 min, &gt;12 hr</td>
</tr>
<tr>
<td>Loss of Consciousness (assumed start)</td>
<td>5-12 min, &gt;12 hr</td>
</tr>
<tr>
<td>Loss of Consciousness (assumed start)</td>
<td>15-19 min</td>
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<tr>
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GCS review

<table>
<thead>
<tr>
<th>Glasgow Coma Score</th>
<th></th>
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<tbody>
<tr>
<td>Eye Opening (E)</td>
<td></td>
</tr>
<tr>
<td>4=Spontaneous</td>
<td></td>
</tr>
<tr>
<td>3=To voice</td>
<td></td>
</tr>
<tr>
<td>2=To pain</td>
<td></td>
</tr>
<tr>
<td>1=None</td>
<td></td>
</tr>
<tr>
<td>Verbal Response (V)</td>
<td>5=Normal conversation</td>
</tr>
<tr>
<td></td>
<td>4=Decreased conversation</td>
</tr>
<tr>
<td></td>
<td>3=Words, but not coherent</td>
</tr>
<tr>
<td></td>
<td>2=No words ...... only sounds</td>
</tr>
<tr>
<td></td>
<td>1=None</td>
</tr>
<tr>
<td>Motor Response (M)</td>
<td>6=Normal</td>
</tr>
<tr>
<td></td>
<td>5=Locates to pain</td>
</tr>
<tr>
<td></td>
<td>4=Withholds to pain</td>
</tr>
<tr>
<td></td>
<td>3=Decorticate posture</td>
</tr>
<tr>
<td></td>
<td>2=Decorticate</td>
</tr>
<tr>
<td></td>
<td>1=None</td>
</tr>
<tr>
<td>Total = E+V+M</td>
<td></td>
</tr>
</tbody>
</table>
### Indications for CT

**American College of Emergency Physicians Guidelines:**
- Imaging indicated in patients with LOC or amnesia if at least one of the following is present:
  - Headache (diffuse)
  - Vomiting
  - Older than 60 years
  - Intoxication
  - Short term memory deficits
  - Evidence of trauma above the clavicle, seizures, GCS less than 15, focal neurological deficits, coagulopathy
- Imaging indicated in patients without LOC or amnesia if at least one of the following is present:
  - Focal neurological deficit, vomiting, severe headache
  - Age older than 65 years
  - Signs of basilar skull fracture
  - GCS less than 15
  - Coagulopathy
  - Significant mechanism of injury

**American Academy of Pediatrics/American Academy of Family Physicians Guidelines:**
- Perform imaging in patients with LOC greater than 60 seconds, evidence of skull fracture, or focal neurological findings
- Consider imaging or observation if patient has brief LOC
- Note that nonspecific signs (i.e. immediate seizures, headache, vomiting, lethargy) increase likelihood of intracranial injury, but have limited predictive value.

### Canadian CT Head Rule (age <15)

- Head CT not required if NONE are present:
  - Age >64 years
  - Vomiting >2 times
  - Suspected open or depressed skull fracture
  - Signs of basilar skull fracture
  - Hemotympanum
  - Racoon eyes
  - CSF otorrea or rhinorrhea
  - Battle Sign
  - GCS <15 2 hours post injury
  - Retrograde amnesia >30 min
  - Dangerous mechanism
    - Pedestrian vs. vehicle
    - Ejection from vehicle
    - Fall from >3 feet or 5 stairs

99% Sensitivity, 47% Specificity
New Orleans Rule (Age >18)

- Head Ct not require if NONE are present:
  - Headache
  - Vomiting
  - Age >60 years
  - Drug or Alcohol Intoxication
  - Persistent retrograde amnesia
  - Visible trauma above the clavicles
  - Seizures

99% sensitivity, 47% specificity

CT Safety

**Pediatric Computed Tomography and Associated Radiation Exposure and Estimated Cancer Risk**

- In 2011, 85 million CTs performed in the US, with 5-11% on children.
- CT has greatly improved diagnostic capabilities; use comes with risks.
- Ionizing radiation doses delivered by CT are 100-500 times higher than conventional radiography and in ranges linked to increased cancer risk.
- Concerning for children, who are more sensitive to radiation-induced carcinogenesis and have many remaining years of life for cancer to develop

Pediatric Cancer Risks

- For head CTs, 7% of scans in children <5, 8% of scans in children 5-9, and 14% of scans in children 10-14 gave a brain dose of 50 mGy or higher
- Projected lifetime attributable risk of solid cancer decreased with advancing age for head and spine CT
- Projected lifetime attributable risk of leukemia was highest for head CTs among children <10 and decreased with age from 1.9/10,000 scans in children <5 to 0.5/10,000 scans in children 10-14.
Provider Resources

CDC HEADS UP Resources for Health Care Providers

- Updated Mild Traumatic Brain Injury Guidelines for Adults (http://www.cdc.gov/concussion/headsup/clinicians_guide.html)
- CDC Workgroup to Improve Clinical Care of Youth with Mild TBI (http://www.cdc.gov/traumaticbraininjury/MTB鄄clinician.html)
- Acute Concussion Evaluation (ACE) Form (http://www.cdc.gov/traumaticbraininjury/MTB鄄clinician.html) (HEADS UP to Health Care Providers)
- Concussion in Society Palm Card (http://www.cdc.gov/headsup/providers/tools.html) (HEADS UP to Health Care Providers)
- Concussion in Society Palm Card (http://www.cdc.gov/headsup/providers/tools.html) (HEADS UP to Health Care Providers)
- Managing Return to Activities (http://www.cdc.gov/headsup/providers/return_to_activities.html) (HEADS UP to Health Care Providers)
- Online Concussion Training (http://www.cdc.gov/headsup/providers/training/index.html) (HEADS UP to Health Care Providers)

Post Concussive Periods

Period 1: Acute Metabolic Cascade
- Neurotransmitter release
- Ionic disequilibrium
- Metabolic crisis and cytoskeletal damage

Period 2: Subacute altered neural activation

Period 3: Chronic accumulation of insults

1: Acute Metabolic Cascade

- Neurotransmitter release
- Ionic disequilibrium
- Metabolic crisis and cytoskeletal damage

Creates state of vulnerability to repeated injury
2: Subacute Altered Neural Activation

- Impaired neuroplasticity
- Brain vulnerable to premature forced activation
- Exacerbates dysfunctional and neural damages

3: Chronic Accumulation of Insults

- Leads to abnormal protein deposition
- Delayed cell death
- Cognitive and behavioral decline

Head Injury Management

- Cognitive rest
  - Avoid text messaging or video games
  - Limit television and computer use
  - Decrease schoolwork
  - Avoid activities that require attention or concentration
Head Injury Management

- Physical rest
  - Avoid any physical activity that exacerbates symptoms (e.g., aerobic exercise, lifting weights, household chores, sexual activity)
  - Severe or worsening headache, persistent vomiting, or seizures may suggest a need for neuroimaging

- Medications/interventions
  - Wear sunglasses for photophobia
  - Wear earplugs or noise canceling headphones for phonophobia
  - Take medications to alleviate specific symptoms (e.g., nonsteroidal anti-inflammatory drugs, acetaminophen, or amitriptyline for persistent headaches; sleep aids, anxiolytics, selective serotonin reuptake inhibitors for depressive symptoms)
  - Be aware that some medications may mask postconcussive symptoms
  - Avoid acute use of nonsteroidal anti-inflammatory drugs if there is potential for intracranial bleeding

Transition Back to School

- Alert school personnel to injury, and initiate slow reintegration
- Consider the following:
  - forgiveness of missed assignments and more time to complete tests and schoolwork
  - standard breaks and rest periods as needed
  - decreased schoolwork
  - distraction-free work areas
  - note taker
- Avoid standardized testing during recovery
- Monitor carefully for two to three months after concussion for scholastic difficulties
Return to Sports

- After rest and resolution of symptoms, athletes may progress through a return-to-play protocol; each of the following steps should take 24 hours:
  - Nonimpact aerobic exercise
  - Sport-specific exercise (nonimpact drills)
  - Noncontact training drills
  - Full contact practice
- Patient must be symptom-free and medication-free before starting return-to-play protocol
- If any symptoms develop, activity should be stopped immediately; 24 hours after symptoms resolve, protocol may resume at the last step for which the athlete was asymptomatic

Patient Education

- Provide list of expected symptoms
- Home care
- Red Flags for ED evaluation

Expected Symptoms

- Thinking/Remembering
  - Difficulty thinking clearly, concentrating, remembering
  - Feeling slowed down
- Emotional/Mood
  - Irritability
  - Sadness
  - Nervous/anxious
- Sleep
  - Sleeping more or less than usual
  - Trouble falling asleep
- Physical
  - Headache
  - Vision changes
  - Nausea/Vomiting
  - Dizzy
  - Sensitivity to noise or light
  - Balance problems
  - Fatigue
# Home Care

**What to do to feel better:**
- Get plenty of rest
- Avoid physically demanding activities
- Avoid activities that require a lot of thinking or concentration
- Avoid alcohol
- Do not drive or operate machinery until cleared by a healthcare professional

## Activities:
- Inform your employer if injury occurred on the job or if job is physically or mentally demanding
- No sports until cleared by a healthcare professional

# Red Flag Symptoms

- Go immediately to the Emergency Department if you have:
  - Repeated vomiting
  - Headache that gets worse and does not go away
  - Loss of consciousness
  - Inability to stay awake when you would normally be awake
  - Get more confused or agitated
  - Seizures
  - Problems walking
  - Weakness or Numbness
  - Vision problems

# Take Home Points

- When evaluating a patient with a complaint of head injury, the patient’s history should be examined for elements indicating a higher risk injury or symptoms.
- All patients should have a COMPLETE neurologic exam.
- Appropriately identifying patients who are low risk for TBI can help reduce unnecessary radiation exposure and Emergency Department visits, especially in the pediatric population.
- Thorough patient education important to help assure patient and family fears about head injury as well as catch more severe injuries with delayed presentation
References


Thank you for your attention!

• Questions?
• Contact information
  Nicole Coyne, PA-C
  Clinical Support Liaison, Arizona West
  NextCare Urgent Care
  nicolecoyne@nextcare.com