The Assessment and Management of Mild Traumatic Pediatric Brain Injury – Is it “Just” a Concussion?

Thomas L. Hurt, MD, MEd, FAAP
Mary Bridge Children’s Hospital
Tacoma, WA
Objectives:

1) Define mild traumatic brain injury (MTBI) and concussion
2) Identify pediatric patients who are at low risk for moderate to severe TBI
3) Identify patients in which CT scanning of the head is recommended
4) Recognize the potential complications of MTBI such as post-concussive syndrome and neurologic deficits as well as second impact syndrome
5) Identify our local and regional experts in management of pediatric patients with more complicated post-concussive symptoms
Incidence of Concussion

- U.K. Rates per 1000
- Overall risk of concussion 0.23
  1) Rugby 4.18
  2) Hockey 1.20
  3) American football 0.53
  4) Cheerleading 0.07
  5) Baseball 0.06
  6) Volleyball 0.03

U.S. sports with highest rates of concussion (per 10,000 athlete exposures)

1) Football (6.4)
2) Boy’s hockey (5.4)
3) Boy’s lacrosse (4.0)
4) Girl’s lacrosse (3.5)
5) Girl’s soccer (3.4)
6) Boy’s wrestling (2.2)
7) Girl’s field hockey (2.2)
8) Girl’s basketball (2.1)

• North America:
  – Injury is the leading cause of death and neurological disability among children
  – Head trauma > 650,000 ED visits yearly
  – Fortunately, 80-90% are mild in severity
  – That means 10-20% are more severe
Sick or not sick?
• Sick or not sick?
Sick or not sick?
• Sick or not sick?

• How do we recognize really serious head injuries in patients that don’t look too bad?
Mild Traumatic Brain Injury: traumatically induced physiological disruption of brain function, as manifested by at least one of the following:

- any period of loss of consciousness
- any loss of memory for events immediately before or after the accident
- any alteration in mental state at the time of the accident (e.g., feeling dazed, disoriented, or confused)

Cont’d
• **Mild Traumatic Brain Injury**: traumatically induced physiological disruption of brain function, as manifested by at least one of the following:
  
  – Cont’d
  
  – focal neurological deficit(s) that may or may not be transient; but where the severity of the injury does not exceed the following:
  
  • Loss of consciousness of approximately 30 minutes or less;
  • After 30 minutes, an initial Glasgow Coma Score of 13–15;
  • Posttraumatic amnesia not greater than 24 hours

Developed by the Mild Traumatic Brain Injury Committee of the Head Injury Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine
• Many physicians feel uncomfortable using the term MTBI and prefer the term concussion

• **Concussion:** “....a complex pathophysiological process affecting the brain, induced by biomechanical factors resulting from either direct force to the head or a blow to the body causing transmission of force to the head.”
  – No structural damage
  – No changes with neuroimaging (MRI or CT scan)
  – Changes at a chemical level (affect brain function)
  – Typically reversible

Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November, 2012.
• What’s the difference? Is it important?
• Considerable overlap and almost interchangeable, but connotations have different meanings to:
  – Families
    • Concussions less severe?
  – Sports coaches
    • Back to play sooner?
  – Healthcare providers
    • CT scans?
    • What type of follow-up?

DeMatteo CA, et al. My child doesn’t have a brain injury, he only has a concussion. *Pediatrics.* 2010; 125(2):327-34.
Case:

- 16 yo female, star forward on soccer team.
- Full speed collision with another player.
- “Out” for 1 minute, now dazed.
- Keeps repeating, “What happened?”
- C/O headache.
- Escort to sideline.
• Athletic Trainer administers **SCAT3**
Athletic Trainer administers **SCAT3**
- Sport Concussion Assessment Tool – 3rd Edition
- Pre-season baseline testing helpful
- Athletes ages ≥ 13 yrs
- Child SCAT3 (ages ≤ 12 yrs)
- SCAT (2005)
- SCAT2 (2009)
- POCKET Concussion Recognition Tool

bjsm.bmj.com/content/47/5/259.full.pdf+html
• If you’re not medically qualified, use the Sport Concussion Recognition Tool

• How accurate are athletic trainers? (Sports Advanced Practitioners)

• Interrater agreement and concordance with athletic trainers and physicians
  Concussions 98.5% (66/67)

Case (cont’d)

- Remains confused, amnesia
- Headache
- Vomits
- Trainer concludes it’s at least a concussion, maybe she needs a CT scan?
- Backboard, C-collar.
- Paramedics bring her to ED.
Signs and symptoms of concussion

- Headache
- Fatigue
- Amnesia
- Vomiting
- Mood changes
- Sensitivity to light
- Decreased reaction time
- Knocked out
- Lack of concentration
- Sensitivity to noise
- Inappropriate emotions
- Feeling of sadness
- Seeing stars
- Slurred speech
- Lack of orientation
- Blurred vision
- Difficulty sleeping
- Nausea
- Lack of energy
- Loss of consciousness
- Irritability
- Dizziness
- Reduced coordination
- Getting your “bell rung”
- Easily distracted

Concussion
• Signs and symptoms of concussion

• **Physical**
  • Headache
  • Dazed
  • Stunned
  • Nausea
  • Vomiting
  • Balance problems
  • Visual Problems
  • Sensitivity to light and noise
  • +/- scalp hematoma or facial injury
• Signs and symptoms of concussion

• Cognitive
  • Feeling mentally “foggy”
  • Feeling slowed down
  • Difficulty concentrating
  • Difficulty remembering
  • Forgetful of recent information
  • Confused about recent events
  • Answers questions slowly
  • Repeats questions
• Signs and symptoms of concussion

• **Sleep**
  • Difficulty falling asleep
  • Drowsiness
  • Sleeping more than usual
  • Sleeping less than usual

• **Emotional**
  • Irritability
  • Sadness
  • More emotional
  • Nervousness
Case (cont’d)

• On arrival repetitive questioning
• c/o headache. No scalp hematoma.
• No neck pain
• No numbness, tingling, is able to MAE
• GCS 14:
  – Opens eyes spontaneously (best eye response 4/4)
  – Confused (best verbal response 4/5)
  – Obeys commands (best motor response 6/6)
• Vomits again
• STAT CT?
• How do we distinguish mild TBI from more severe head injury?
• Why not just CT everyone?
• Ionizing radiation from CT scans can cause lethal malignancies.
  – Estimated rate of lethal malignancies from CT is between 1 in 1000 to 1 in 5000
  – Risk increases as age decreases
• **ALARA** (as low as reasonably achievable)

---

• **CDR’s: Clinical Decision Rules**
  – Decision-making tools derived from original research which incorporate 3 or more variables from history, physical exam, or simple tests
  – Help clinicians cope with the uncertainty of medical decision making and improve their efficiency
  – Compare, describe, and contrast 3 CDR’s (CHALICE, CATCH, and PECARN) for pediatric head injury
• **CHALICE**: (2006) *Children’s Head Injury Algorithm for the Prediction of Important Clinical Events* (UK)

• **CATCH**: (2010) *Canadian Assessment of Tomography for Childhood Head Injury*

• **CHALICE**: 22,772 patients


• All children under age 16 presenting to 10 ED’s in Northwest England with *any severity* of head injury included
• **CHALICE**: CT required if any of the following:
  – History:
    • Witnessed LOC > 5 minutes duration
    • Hx of amnesia (anterograde or retrograde) > 5 min.
    • Abnormal drowsiness (defined as in excess of that expected by the examiner)
    • ≥ 3 episodes of vomiting
    • Suspicion of NAT
    • Seizure after head injury in a patient who has no history of epilepsy
• **CHALICE**: CT required if any of the following:
  – Examination:
    • GCS < 14 or < 15 if < 1 yr old
      – 96.6% GCS 15, 1.0% GCS 14, 0.3% GCS 13, 0.9% < 13, and 1.2% unable to be determined
    • Suspicion of penetrating or depressed skull fracture or tense fontanelle
    • Sign of basal skull fracture
    • Positive focal neurology (defined as focal neurologic deficit including motor, sensory, coordination, or reflex abnormality)
    • Presence of scalp bruise, swelling or laceration > 5 cm if < 1 yr old
• **CHALICE**: CT required if any of the following:
  
  – **Mechanism:**
    
    • High speed road traffic accident either as pedestrian, cyclist or occupant (defined as accident with speed > 40 MPH)
    
    • Fall of > 3 meters in height
    
    • High speed injury from a projectile or an object

## CHALICE:

<table>
<thead>
<tr>
<th>Result</th>
<th>No clinically significant head injury</th>
<th>Had clinically significant head injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHALICE Positive</td>
<td>2933</td>
<td>277</td>
</tr>
<tr>
<td>CHALICE Negative</td>
<td>19558</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22491</strong></td>
<td><strong>281</strong></td>
</tr>
<tr>
<td>Sensitivity, % (95% CI)</td>
<td>277/281</td>
<td>98.6 %</td>
</tr>
<tr>
<td>Specificity, % (95% CI)</td>
<td>19558/22491</td>
<td>86.9%</td>
</tr>
<tr>
<td>% of patients who would undergo CT scan</td>
<td>14.1 %</td>
<td>%</td>
</tr>
</tbody>
</table>

• **CATCH**: 3866 patients

• **CATCH:**
  - **Minor head injury:**
    - GCS 13-15, injury within past 24 hrs assoc/ with either witnessed LOC, and/or definite amnesia, witnessed disorientation, persistent vomiting (> 1 episode), or persistent irritability in a child < 2 yrs.
  - **GCS:**

<table>
<thead>
<tr>
<th><strong>Best Eye Response</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) No eye opening</td>
</tr>
<tr>
<td>2) Eye opening in response to pain</td>
</tr>
<tr>
<td>3) Eye opening to speech</td>
</tr>
<tr>
<td>4) Eyes open spontaneously</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Best Verbal Response</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) No verbal response</td>
</tr>
<tr>
<td>2) Incomprehensible sounds</td>
</tr>
<tr>
<td>3) Inappropriate words</td>
</tr>
<tr>
<td>4) Confused</td>
</tr>
<tr>
<td>5) Oriented</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Best Motor Response</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) No motor response</td>
</tr>
<tr>
<td>2) Extension to pain</td>
</tr>
<tr>
<td>3) Abnormal flexion to pain</td>
</tr>
<tr>
<td>4) Flexion/withdrawal to pain</td>
</tr>
<tr>
<td>5) Localizes to pain</td>
</tr>
<tr>
<td>6) Obeyes commands</td>
</tr>
</tbody>
</table>
• **CATCH:**
  
  **Minor head injury:**
  - GCS 13-15, injury within past 24 hrs assoc/ with witnessed LOC, and/or definite amnesia, witnessed disorientation, persistent vomiting (> 1 episode), or persistent irritability in a child < 2 yrs.

  **High Risk group:**
  - GCS < 15 at 2 hrs after injury
  - Suspected open or depressed skull fracture
  - History of worsening headache
  - Irritability on examination

  **Medium risk group:**
  - Any sign of basal skull fracture
  - Large boggy scalp hematoma
  - Dangerous mechanism of injury: MVC, fall from height > 3 feet or 5 stairs, fall from bicycle with no helmet
**CATCH: Performance of all 7 risk factors**

<table>
<thead>
<tr>
<th>Result</th>
<th>Had brain injury on CT</th>
<th>Did not have brain injury on CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive (&gt; 1 risk factor)</td>
<td>156</td>
<td>1851 (Total 2007)</td>
</tr>
<tr>
<td>Negative (no risk factors)</td>
<td>3</td>
<td>1856 (Total 1859)</td>
</tr>
<tr>
<td>Total</td>
<td>159</td>
<td>3707 (Total 3866)</td>
</tr>
</tbody>
</table>

Sensitivity, % (95% CI)  
156/159  
98.1%  
(94.6 – 99.4)

Specificity, % (95% CI)  
1856/3707  
50.1%  
(48.5 – 51.7)

% of patients who would undergo CT scan  
2007/3866  
51.9%

PECARN:

PECARN is the Pediatric Emergency Care Applied Research Network, the first federally-funded multi-institutional network for research in pediatric emergency medicine in the United States.

PECARN:

- Aim was to identify children at very low risk of clinically important traumatic brain injuries (ciTBI) for whom CT scan could be omitted.
- 42,412 patients
- 2 populations: derivation and validation
- 2 age groups: < 2 yrs and 2 – 18 yrs
- GCS 14-15
PECARN:

Prediction rule for children < 2 yrs:
- Normal mental status and acting normally (according to parents)
- No scalp hematoma except frontal
- No LOC or LOC < 5 sec
- Non-severe mechanism of injury
- No palpable skull fracture
PECARN:

Prediction rule for children 2 – 18 yrs:

- Normal mental status
- No LOC
- No vomiting
- Non-severe injury mechanism
- No signs of basilar skull fracture
- No severe headache
Prediction Tree for ciTBI in Children ≤ 2 yrs of Age

1. GCS=14 or other signs of altered mental status†, or palpable skull fracture
   - Yes: CT recommended
     - 13.9% of population
     - 4.4% risk of ciTBI
   - No
     - Occipital or parietal or temporal scalp haematoma, or history of LOC ≥5 s, or severe mechanism of injury‡, or not acting normally per parent
       - Yes: Observation versus CT on the basis of other clinical factors including:
         - Physician experience
         - Multiple versus isolated§ findings
         - Worsening symptoms or signs after emergency department observation
         - Age <3 months
         - Parental preference
         - 53.5% of population
         - <0.02% risk of ciTBI
       - No: CT not recommended¶

2. Occipital or parietal or temporal scalp haematoma, or history of LOC ≥5 s, or severe mechanism of injury‡, or not acting normally per parent
   - Yes: Observation versus CT on the basis of other clinical factors including:
         - Physician experience
         - Multiple versus isolated§ findings
         - Worsening symptoms or signs after emergency department observation
         - Age <3 months
         - Parental preference
         - 32.6% of population
         - 0.9% risk of ciTBI
   - No: CT not recommended¶
PECARN: < 2 yrs of age (deriv. & valid.)

<table>
<thead>
<tr>
<th>Predictor Present</th>
<th>cITBI</th>
<th>No cITBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Predictor present</td>
<td>97 (1.93%)</td>
<td>5013</td>
</tr>
<tr>
<td>No Predictor present</td>
<td>1 (0.018%)</td>
<td>5705</td>
</tr>
<tr>
<td>Total</td>
<td>98</td>
<td>10,718</td>
</tr>
<tr>
<td>Sensitivity, %</td>
<td>99.0%</td>
<td>(97/98)</td>
</tr>
<tr>
<td>Specificity, %</td>
<td>53.7%</td>
<td>(5704/10620)</td>
</tr>
</tbody>
</table>

**PECARN:** < 2 yrs of age (deriv. & valid.)

<table>
<thead>
<tr>
<th></th>
<th>CT obtained</th>
<th>No CT obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Predictor present</td>
<td>2491 (49.7%)</td>
<td>2522 (50.3%)</td>
</tr>
<tr>
<td>No Predictor present</td>
<td>835 (14.6%)</td>
<td>4870 (85.4%)</td>
</tr>
<tr>
<td>Total</td>
<td>3326 (31%)</td>
<td>7392 (69%)</td>
</tr>
</tbody>
</table>

Neg pred value if no predictor present: 99.9%

Decreases need for CT scan by 25%

Prediction Tree for ciTBI in Children 2 – 18 Yrs Old

- GCS=14 or other signs of altered mental status†, or signs of basilar skull fracture
  - Yes: CT recommended
    - 14.0% of population
    - 4.3% risk of ciTBI
  - No: Observation versus CT on the basis of other clinical factors including:
    - Physician experience
    - Multiple versus isolated§ findings
    - Worsening symptoms or signs after emergency department observation
    - Parental preference
- History of LOC, or history of vomiting, or severe mechanism of injury†, or severe headache
  - Yes: 27.7% of population
    - 0.9% risk of ciTBI
  - No: CT not recommended
    - 58.3% of population
    - <0.05% risk of ciTBI
PECARN: 2 - 18 yrs of age (derivation)

<table>
<thead>
<tr>
<th>Predictor Status</th>
<th>ciTBI</th>
<th>No ciTBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Predictor present</td>
<td>269 (0.85%)</td>
<td>13,231</td>
</tr>
<tr>
<td>No Predictor present</td>
<td>9 (0.11%)</td>
<td>18,463</td>
</tr>
<tr>
<td>Total</td>
<td>278</td>
<td>31,694</td>
</tr>
</tbody>
</table>

Sensitivity, %: 96.7% \( \frac{269}{278} \)

Specificity, %: 58.7% \( \frac{18454}{31416} \)

PECARN: 2 - 18 yrs of age (deriv. & valid.)

<table>
<thead>
<tr>
<th>Predictor Present</th>
<th>CT obtained</th>
<th>No CT obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Predictor present</td>
<td>9420 (29.7%)</td>
<td>4080 (30.2%)</td>
</tr>
<tr>
<td>No Predictor present</td>
<td>2438 (13.2%)</td>
<td>4870 (85.4%)</td>
</tr>
<tr>
<td>Total</td>
<td>11,643 (36.7%)</td>
<td>20,051 (63.3%)</td>
</tr>
</tbody>
</table>

Neg pred value if no predictor present 99.9%

Decreases need for CT scan by 20%

Mild Traumatic Brain Injury Observation Pathway

**Observation Period**
Two hours Post Injury

- **Return to Baseline Neurological status No concerning symptoms**
  - Yes
  - Deteriorating LOC
    - GCS 13 or less
      - GCS 14-15
        - Severe/worsening headache
        - Persistent Vomiting
        - Improving Neurological Status
          - GCS = 15
          - No concerning symptoms
          - Observe 2-4 additional hours
            Or 4-6 hours post injury
          - Return to Baseline Neurological status
            - GCS = 15
            - No concerning symptoms
          - Head CT
            - (+)
            - Admission
              - Consult Trauma Surgery if
                - Other trauma injuries
                - Suspected NAT
              - Consult Neurosurgery for + CT findings
            - (-)
            - No
            - Consider admission:
              - Concern for NAT (see NAT guidelines)
              - Social concerns/Lack of follow up
              - Difficulty in assessment of mental status (pre-existing neurologic condition or late night assessment)
              - Isolated skull fracture less than 1 year with other concerns for mechanism/cause/mental status

- **Positive Head CT:**
  - Skull Fracture (depressed)
  - Subdural/Epidural Blood
  - Intracerebral hemorrhage
  - Subarachnoid hemorrhage
  - Intraventricular hemorrhage
  - Evidence of cerebral edema
  - Intraparenchymal contusion
  - Non-depressed skull fractures with no other injuries do not require neurosurgical consult or admission

---

**Observation Pathway**
- Baseline Vitals/GCS/Neurologic Exam
- Vital/GCS/Neuro Check q30' for first 2 hours
- Then q1-2 hours (ED or floor)

**Pediatric GCS Scoring**

<table>
<thead>
<tr>
<th>Eyes</th>
<th>Verbal</th>
<th>0-23 ms</th>
<th>2-5 yr</th>
<th>&gt;5 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spontaneous</td>
<td>Approp. words</td>
<td>Oriented</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To Speech</td>
<td></td>
<td></td>
<td>Approp.</td>
<td></td>
</tr>
<tr>
<td>To Pain</td>
<td></td>
<td></td>
<td>Inapprop.</td>
<td>Confused</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
<td>Cries or screams</td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td></td>
<td></td>
<td>Inapprop.</td>
<td></td>
</tr>
<tr>
<td>Spontaneous</td>
<td></td>
<td></td>
<td>Cries or screams</td>
<td></td>
</tr>
<tr>
<td>Localize to Pain</td>
<td></td>
<td></td>
<td>Inapprop.</td>
<td></td>
</tr>
<tr>
<td>Withdraw to Pain</td>
<td></td>
<td></td>
<td>Inapprop.</td>
<td></td>
</tr>
<tr>
<td>Deteriorate (Flex)</td>
<td></td>
<td></td>
<td>Inapprop.</td>
<td></td>
</tr>
<tr>
<td>Deteriorate (Ext.)</td>
<td></td>
<td></td>
<td>Inapprop.</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

This guideline is endorsed by Mary Bridge Emergency Department but it is not intended as a substitute for clinical judgment. It should be used as an adjunct to sound clinical decision making which accounts for individual patient considerations.
Case (cont’d)

- Rec’d Zofran – no more nausea or vomiting
- Observed for one hour
- Headache persists but improving
- Remembers she was in soccer game
- Gait a little slow and deliberate, but steady
- Asks if she can take a nap (will she die if she falls asleep?)
- Does she need a CT scan?
Concussion Myth: You can die if you have a concussion and you’re allowed to fall asleep.

• Current research shows that sleeping is actually a good thing for a concussed player. Getting physical and mental rest helps an athlete recover from a concussion.
Case (cont’d)

- Observed and monitored for additional 2 hours
- Napped – now awake and feeling better
- Headache almost entirely gone
- No nausea
- Balance good
- Asks if she can go home
- Parents say this is her 3rd concussion and they feel comfortable taking her home
Discharge instructions

• Return to learning – cognitive rest
  – Team communication: family, medical, school academics, school sports
  – Gradual re-introduction of cognitive activity
    • Subthreshold activity level - Limit cognitive activities to level that is tolerable to the student and does not lead to worsening or re-emergence of symptoms
  – Computers, phones, texting

Discharge instructions

• **Return to learning – cognitive rest**
  - Resumption of full cognitive workload
    - School re-entry
    - Homework at home before school work at school
    - Gradual re-integration into school
  - Educational accommodations
  - Awareness of relevant co-morbidities (ADHD, dyslexia)
  - Special cases of “high achievers”

Discharge instructions

• Return to learning – cognitive rest
  – Controversy over “Cognitive Rest”: When Is Rest Doing More Harm Than Good?
    • Depression
    • Social isolation
    • Withdrawal
    • Loss of mental health benefits of recreation

Return to Sports - Physical Rest

- Zack Lystedt law

Return to Sports - Physical Rest

- Second Impact Syndrome
- Return to play with concussive symptoms
- Swelling in brain
- 50% die
- 50% disabilities
- Under age 20 or in boxing
## Return to play

<table>
<thead>
<tr>
<th>Rehabilitation stage</th>
<th>Functional exercise at this stage</th>
<th>Objective at each stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No activity</td>
<td>Symptom limited physical and cognitive rest</td>
<td>Recovery</td>
</tr>
<tr>
<td>Light aerobic activity</td>
<td>Swimming, running, biking- 70% of max HR (no weight training)</td>
<td>Increase heart rate</td>
</tr>
<tr>
<td>Sports-specific exercise</td>
<td>Skating drills in hockey, running drills in soccer, no head contact</td>
<td>Add movement</td>
</tr>
<tr>
<td>Non-contact training drills</td>
<td>Progression to more complex training drills, eg, passing drills in football and ice hockey. May start progressive resistance training</td>
<td>Exercise, coordination and cognitive load</td>
</tr>
<tr>
<td>Full-contact practice</td>
<td>Following medical clearance participate in normal training activities</td>
<td>Restore confidence and assess functional skills by coaching staff</td>
</tr>
<tr>
<td>Return to play</td>
<td>Normal game play</td>
<td>(“cleared” by physician, PA, ARNP, or certified athletic trainer)</td>
</tr>
</tbody>
</table>
Return to Sports - Physical Rest

• Potential benefits of aerobic exercise after brain injury
  – Early forced exercise may be detrimental
  – Voluntary exercise may be helpful
  – Buffalo Concussion Treadmill Test - systematically evaluate exercise tolerance in persons with prolonged symptoms
  – Prevents deconditioning
  – Value for athletes psyche, prevents depression?

What happens when recovery doesn’t go smoothly?

- Headache
- Fatigue
- Amnesia
- Vomiting
- Mood changes
- Sensitivity to light
- Decreased reaction time
- Knocked out
- Ringing in ears
- Sensitivity to noise
- Inappropriate emotions
- Lack of concentration
- Feeling of sadness
- Confusion
- Slurred speech
- Lack of orientation
- Blurred vision
- Difficulty sleeping
- Nausea
- Lack of energy
- Loss of consciousness
- Dizziness
- Irritability
- Reduced coordination
- Getting your “bell rung”
- Easily distracted

Concussion
# Post-concussion syndrome

<table>
<thead>
<tr>
<th>THINKING/REMEMBERING</th>
<th>PHYSICAL</th>
<th>EMOTIONAL/MOOD</th>
<th>SLEEP DISTURBANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Difficulty thinking clearly*&lt;br&gt;* Feeling slowed down*&lt;br&gt;* Difficulty concentrating*&lt;br&gt;* Difficulty remembering new information*</td>
<td>* Headache*&lt;br&gt;* Nausea or vomiting (early on)<em>&lt;br&gt;</em> Balance problems*&lt;br&gt;* Dizziness*&lt;br&gt;* Fuzzy or blurry vision*&lt;br&gt;* Feeling tired, having no energy*&lt;br&gt;* Sensitivity to noise or light*</td>
<td>* Irritability*&lt;br&gt;* Sadness*&lt;br&gt;* More emotional*&lt;br&gt;* Nervousness or anxiety*</td>
<td>* Sleeping more than usual*&lt;br&gt;* Sleeping less than usual*&lt;br&gt;* Trouble falling asleep*</td>
</tr>
</tbody>
</table>
Who You Gonna Call?
• Sports Medicine Specialists:
  – Dr. Joshua Purses, DO
  – Dr. Brad Kuske, DO

• Pediatric Neurologists:
  – Dr. George Makari, MD
  – Dr. Jacqui Hrivnak, MD
  – Dr. Majeed Al-Mateen, MD
  – Dr. Steve Phillips, MD
  – Dr. Vera Korol, MD
  – Dr. Jared Mott, MD

  IEP, 504 – educational plan for accommodation
  Sleep issues, Headache, Seizure risk, Neurologic deficit
• **Neuropsychologists:**
  - Dr. Chris Ladish, PhD
  - Dr. Andrea Dorsch, PhD
  - Dr. Katrina Rayls, PhD
  - Dr. Whitney Ward, PhD

  \[\text{Pre-existing behavior issues, High achievers, Adjustment and coping issues}\]

• **Physical Therapists:**
  - Karen Perz, PT
  - Ben Grover, PT

  \[\text{brain injury and balance, dizziness}\]

• **Speech Therapy:** cognitive rehabilitation
- Mary Bridge Concussion Board

- Meets every other month
- 4th Thurs, 7AM
- Interdisciplinary case reviews
- Updates
QUESTIONS?

THANK YOU!!
• Pitfalls / Obstacles / Logistics

• What importance is timing of the event?
• Epidural hematoma and “lucent interval”.
• What significance is size and location of hematoma?
• Will your approach to care differ depending on where you are? Office vs UC vs ED?
• Depending on time of day? Late hour – end of clinic?
• Pitfalls / Obstacles / Logistics

• Need for additional “observation” time
• No CT in facility – must you refer?
• Nap time or bed time – OK to discharge home if sleepy?
• Distracting injuries – fractures and need for opiates for pain – should CT be done
• Does negative CT mean everything is OK?
References:


5) SCAT3: bjsm.bmj.com/content/47/5/259.full.pdf+html
References:


References:


• References:


Question 1: An 8 yr old boy sustained a mild traumatic brain injury 2 weeks ago after being hit on the head with a hockey puck and losing consciousness for 5 minutes. CT scan at that time was negative. He has had persisting headache and difficulty concentrating at school. What is the best diagnosis of these symptoms?

2) Concussion
3) Post concussive syndrome
4) Second impact syndrome
5) Migraine headache
Question 1: An 8 yr old boy sustained a mild traumatic brain injury 2 weeks ago after being hit on the head with a hockey puck and losing consciousness for 5 minutes. CT scan at that time was negative. He has had persisting headache and difficulty concentrating at school. What is the best diagnosis of these symptoms?

1) Concussion
2) Post concussive syndrome
3) Second impact syndrome
4) Migraine headache
Question 2: Which of the following is true regarding concussion?

1) It involves a trauma induced alteration in mental status.
2) It requires a loss of consciousness.
3) It is always associated with amnesia.
4) It only occurs in patients with a GCS of 13 or below.
Question 2: Which of the following is true regarding concussion?

1) It involves a trauma induced alteration in mental status.
2) It requires a loss of consciousness.
3) It is always associated with amnesia.
4) It only occurs in patients with a GCS of 13 or below.
Question 3: An 8 yr old boy fell from a 10 foot ladder while stringing Christmas lights 30 minutes ago. His parents think he lost consciousness for about 5 seconds. He did not vomit, there is no cephalohematoma, and he is back to his baseline mental status. He has no complaint of headache. What is the best management for this patient?

1) Immediate CT scan.
2) Monitoring for at least 2 hours.
3) Discharge home with advice to return if he seems worse.
4) Prescription for Vicodin in case he develops headache.
Question 3:  An 8 yr old boy fell from a 10 foot ladder while stringing Christmas lights 30 minutes ago. His parents think he lost consciousness for about 5 seconds. He did not vomit, there is no cephalohematoma, and he is back to his baseline mental status. He has no complaint of headache. What is the best management for this patient?

1) Immediate CT scan.
2) Monitoring for at least 2 hours.
3) Discharge home with advice to return if he seems worse.
4) Prescription for Vicodin in case he develops headache.
Question 4: A child with a sports-related concussion should be discharged with a return to play restriction until:

1) An experienced licensed health care provider clears the patient for play.
2) The headache is gone.
3) One week.
4) One month.
Question 4: A child with a sports-related concussion should be discharged with a return to play restriction until:

1) An experienced licensed health care provider clears the patient for play.
2) The headache is gone.
3) One week.
4) One month.