Post-Traumatic Brain Injury Care in the Child and Adolescent

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Meet the Speakers

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Disclosures

We have no financial disclosures
## Learning Objectives

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Mild Traumatic Brain Injury
Mild Traumatic Brain Injury: Defined

- Definition: results from a jolt to the head that creates chemical changes in the brain and sometimes stretching and damaging brain cells. This causes temporary mental status changes.
- Synonyms: “concussion”

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<th>Feature</th>
<th>Mild</th>
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<td>Glasgow Coma Scale</td>
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<td>Post-traumatic Amnesia</td>
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<td>Imaging: CT, MRI</td>
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<td>Focal signs</td>
<td>Changes in cognition, sensation, Emotion</td>
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Friedland, D., Hutchinson, P. 2013
Mild Traumatic Brain Injury: Symptoms

- **Headache**: most common symptom
- **Sensation**: hearing, vision, impaired perception, vestibular dysfunction
- **Emotion**: depression, anxiety, impulsivity, personality changes
- **Cognitive**: impaired memory, processing, attention and sleep
- **Motor**: imbalance, impaired coordination

* Duration of concussion symptoms cannot be determined at the time of the injury
* Patient’s report of return to baseline precedes actual neuropsychological recovery
Mild Traumatic Brain Injury: Tests

• Maybe CT Head
• Neurocognitive testing
• Vestibular Evaluation
Key Recommendations from the CDC Pediatric mTBI Guideline

• Do not routinely image patients to diagnose mTBI.
• Use validated, age-appropriate symptom scales to diagnose mTBI.
• Assess evidence-based risk factors for prolonged recovery.
• Provide patients with instructions on return to activity customized to their symptoms.
• Counsel patients to return gradually to non-sports activities after no more than 2-3 days of rest.
CDC: Imaging for concussions

• Healthcare providers should not routinely obtain a head CT for diagnostic purposes in children with mTBI

• For children diagnosed with mTBI, healthcare providers should discuss the risk of a pediatric head CT in the context of risk factors for intercranial injury (ICI) with the patient and his/her family.

• It is critical to rule out ICI while avoiding unnecessary risks related to exposure from a head CT. Strong clinical evidence indicates that use of clinical decision rules are effective in identifying children at low risk for ICI.
CDC: Indications for CT

- Age < 2 years old
- Loss of consciousness
- Severe mechanism of injury
- Vomiting
- Amnesia
- Clinical suspicion for skull fracture
- Severe or worsening headache
- Non-frontal scalp hematoma
- Glasgow Coma Score < 15
Red Flags for Emergency Care

- Headache that worsens
- Seizures
- Focal neurologic signs
- Looks very different or drowsy
- Repeated vomiting
- Slurred speech
- Unable to recognize people or places

- Increasing confusion or irritability
- Weakness or numbness in arms/legs
- Neck pain
- Unusual behavioral changes
- Change in state of consciousness
Mild Traumatic Brain Injury: Neurocognitive testing

- Brief computerized cognitive evaluation tools are a commonly utilized component of mTBI management.
- For athletes, they may complete baseline computer-based testing in order to determine how he/she is functioning prior to concussion/mTBI (most common is ImPACT).
- Tests measure reaction time, memory, and other neurocognitive functions, such as concentration, attention.
- Follow-up tests are used to monitor resolution of neurocognitive and other post-concussive symptoms.
- There are validity measures within the tests and the test results should be reviewed by someone knowledgeable of the test.
- Neurocognitive tests provide an aid to the clinical decision-making process in conjunction with a range of assessments of different clinical domains. Results should not be the sole basis of management decisions with regards to return to activities.
- Only for mTBI, not for moderate or severe TBI.
Mild Traumatic Brain Injury: Vestibular Evaluation

• BALANCE:
  • Single leg stance with eyes open:
  • Single leg stance with eyes closed:

• EYE GAZE ASSESSMENT:
  • Near point convergence midline:
  • Near point convergence superior:
  • Smooth Pursuit:
  • Horizontal saccades:
  • Vertical saccades:
  • Horizontal VOR:
  • Vertical VOR:
  • Nystagmus:
  • Symptomatic with exam?
Mild Traumatic Brain Injury: Treatment

- Medications:
  - Headache: OTC, NSAID, SNRI, TCA
- Therapies: PT, OT, Speech and Language, Vestibular
- Usually doesn’t require intensive inpatient rehabilitation in a hospital
- Neuropsychology/Psychology
Mild Traumatic Brain Injury: Return to School

• Goals
  • Avoid academic and social failure during time they are recovery
  • Slowly transition back into school
  • Offer supportive services

• Physical rest: 2-3 days, no playing, wrestling, PE, leisure activities

• Cognitive rest: 2-3 days (<1 week), minimize screens or school-work, avoid loud-busy environments

• Slow transitions: consider ½ days, “symptom driven” (encourage high function without symptoms), may need short-term accommodations (504 plan)
Mild Traumatic Brain Injury: 
Return to School

Accommodations can be written in a letter by the doctor

- Rest periods
- Modified PE
- Lunch in a quiet room with 1-2 friends
- Change classes off schedule to avoid busy halls
- Decrease screen and reading time
- Provide copy of notes to student
- Quiet rooms for testing
- Extended time for assignments and tests
- Provide written instructions
- Reduce schoolwork overall
- Assistance with organization
Prevention of Second Impact Syndrome

• Occurs when a second head injury is sustained before the initial head injury symptoms have resolved.
• Can get cerebral vascular congestion, increased ICP
  • > diffuse cerebral swelling, herniation and death
• Seen more in younger individuals (<21 yo)
• Can be caused by less force
• Usually within 14 days of initial head injury
Mild Traumatic Brain Injury: Return to Activities

• “symptom driven”
• sub-symptom exercise
  • Light activities first -> outside, walking, running by self
  • Sport-specific -> drills, non-contact sport specific drills, contact drills, full contact
• If successful at each stage for 1-2 days, then ok to continue to progress
• Back down to prior level if symptomatic
Mild Traumatic Brain Injury: Returning to Driving

- Comparing 18-22 year olds with and without concussion, on safety of driving
- Used a symptom checklist, brief neuropsychological exam, and driving simulation task
- Participated within 48 hours of becoming “asymptomatic”
- Evaluated crashes, tickets, lane excursions, and deviations in lane lateral position and speed.

- Results: Despite feeling asymptomatic, those with concussion had more lane excursions, greater deviation in lane position, more variations in speed, and overall poorer vehicle control, especially when managing curves.

- Some of these findings are similar to those found in Parkinson disease
- Driving impairments may persist beyond when individuals have returned to driving
- This is especially concerning when considering returning new drivers to the road

Schmidt, JD., et. al 2016
Moderate and Severe Traumatic Brain Injury
Moderate and Severe TBI: Defined

- Definition: blow to the head causing injury to the brain tissue, resulting in deficits and symptoms that are different from functional baseline

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<th>Severe</th>
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<td>9-12</td>
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<td>24 hours-1 week</td>
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</tr>
<tr>
<td>Neuroimaging</td>
<td>Normal</td>
<td>+findings</td>
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<tr>
<td>Focal signs</td>
<td>Cognitive deficits</td>
<td>Cognitive deficits Motor deficits</td>
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Moderate and Severe TBI: Symptoms

- **Sensation**: impaired hearing, impaired vision, impaired perception, vestibular dysfunction
- **Motor**: imbalance, extremity weakness, impaired coordination, neurogenic bowel and bladder, hypertonicity
- **Cognitive**: impaired memory, impaired reasoning, slowed processing, impaired attention and sleep disruption, aphasia
- **Emotion**: depression, anxiety, impulsivity, personality changes, dysregulation, pseudobulbar affect
Moderate and Severe TBI: Tests

- **Static Imaging: CT & MRI**
  - CT head without contrast
    - What it shows: hemorrhage, petechial hemorrhage
    - When to get it: immediate upon any ER visit, continued symptoms without improvement, red flag symptoms
  - MRI Brain without contrast
    - What it shows: more sensitive to see traumatic injuries, axonal damage
    - When to get it: within 7-10 days of injury

- **Dynamic Imaging: PET & SPECT**
  - PET – position emission tomography
  - SPECT – single-photo emission computed tomography
    - What it shows: subtle abnormalities
    - When to get it: suspect TBI, but CT negative

Umile et. Al, 2002
Moderate and Severe TBI: Tests
Neuropsychological Assessment

• Tests designed to assess the different facets of brain-based behavior
• Focus more on neuro than psychological
• Takes anywhere from 4-8 hours, typically
• Assessing for abnormal vs. typical performance
• Looking at higher order functions and central processing whereas neurological diagnostic assessments are looking at lower-level aspects of brain functioning
• CT and especially MRI allow identification of abnormalities in brain structure, but do not give us information about the specific function of that individual
• NPSY testing complements other diagnostic tools
Domains Assessed in NPSY Testing

- Intellectual Abilities--IQ
- Academic Abilities
- Memory/Learning
  - Visual
  - Verbal
  - Short term
  - Long term
- Language/Vocabulary
- Visual-Spatial/Visual-Motor/Visual-Perceptual
- Fine Motor Functioning
- Processing Speed
- Attention/Concentration
- Working Memory
- Other Executive Functions
  - Planning
  - Organization
  - Problem Solving
  - Abstract Reasoning
  - Mental Flexibility
- Adaptive Functioning
- Behavioral Functioning (Observations and Questionnaires)
- Emotional/Social Functioning
Who is NOT appropriate for NPSY testing?

Persons who:

- Have Intellectual Deficiency—extensive testing not necessary or helpful
- Are in very early stages of recovery—they change rapidly, and the results have very limited application
- Have significant distractibility
- Are unwilling/uncooperative

*Below school-age—would consider it a “Developmental Assessment” rather than NPSY Assessment*
Moderate and Severe TBI: Treatment

• Medication:
  • Cognition: neurostimulants
  • Sleep: sleep aids
  • Abnormal tone: anti-spasmodics, or anti-dystonics
  • Urinary incontinence: anti-cholinergics
  • Neurogenic bowel: softeners, stimulants, laxatives

• Inpatient Rehabilitation

• Therapies: PT, OT, SLP, music, recreational, vision

• Neuropsychology/Psychology
Moderate and Severe TBI: Return to School

• May be a slower return to school due to a prolonged hospitalization, more severe symptoms, and need for more accommodations/modifications

• May have to consider
  • Home bound school
  • Slower transition back to in person school
  • 504
  • IEP
  • Therapies
Moderate and Severe TBI: Return to School

• Accommodations:
  • **504**
    • Section 504 of the Rehabilitation Act of 1973.
    • Provides equal access to education for people with disabilities. Provides accommodations developed by a team and is time limited. Lists specific adjustment to learning environment, modifications to curriculum, requested by teachers or parents. Ex: increased time, leaving the classroom, breaks, larger printer, spoken directions, reminders to pay attention.
  • **IEP**
    • Individualized Education Program. From the Individuals with Disabilities Education Act.
    • Child must fit under at least one of 13 disability categories (TBI is one, as is OHI). More structured and specific than a 504 and requires documentation of measurable growth. Includes therapies during school.
Moderate and Severe TBI: Return to Activities

• No return to leisure-wheeled activities or higher risk activities for at least one year (biking, roller blades, skateboard, tumbling, trampoline, ATV, dirt bikes)
Special Considerations
Age Matters: Pediatric Brain Injury

• YOUNGER = WORSE OUTCOMES
  • Outcome for children <7 y.o. were worse over time than those whose TBI occurred when they were >7 y.o.
  • This is especially true when the child is less than 2 y.o.
  • The younger children were at the time of their TBI, the more likely children will grow up with severe, permanent deficits.
  • Young children are especially vulnerable to the effects of brain injury

• DEVELOPMENTAL SKILLS ARE IMPACTED
  • Previously developed skills may be preserved after brain injury, but new learning is more difficult to acquire
  • Effects of brain injury may not be apparent until more advanced skills are expected to develop
  • A child may return to the previous developmental level following TBI, but may have trouble progressing past that stage

Giza, et. Al. 2009
Non-Accidental Trauma

• Compared to accidental TBI, children who sustained abusive head traumas tend to have:
  • Lower initial GCS
  • More frequent signs of acute cardiorespiratory compromise
  • More frequent and prolonged impairments of consciousness
  • More frequent bilateral HIE or swelling
  • Significantly higher incidence of pre-existing brain abnormalities prior to TBI
  • Higher mortality rate
  • Poorer long-term outcome
On the Road Again

- Driving is one of the most QOL concerns for individuals who drive and had a TBI. Helps with engagement, re-integration, independence, and life perception.

- Almost 60-70% of mod-severe TBI adults return to driving.
  - However, the ability to drive safely is not tested in about 60-70% of cases

- Skills that are essential for driving can be impacted: maintaining lane, accurate vision, concentration, memory functioning, recall, problem solving, hand-eye coordination, motor planning, reaction time, safety, awareness, judgement

- Those with TBI and CVA have larger self-reported and Motor Vehicle Safety reported crashes compared to non-injured cohorts.

- By contrast, a 5-year post-injury study of individuals with BI, which included only those that had received driver assessment and rehabilitation, did not find a higher rate of accident involvement compared to a match control. (Schultheis, MT 2002. Driving After TBI)
Driver’s Evaluation & Training

• Evaluations: often “off-the-road” and “on-the-road”
  • Driver’s safety and control
  • Clinical testing based on diagnosis: cognitive, physical, vision, emotional stability, multitasking
  • Therapist recommendations for equipment or modifications
  • Adaptive equipment evaluation

• Training:
  • Individual sessions to focus on skills from evaluation
  • Proficiency with adaptive equipment
  • Defensive driving

• Usually out of pocket expense, but <$200-500

• Locations nearby: Ability KC (KC, MO), St. Luke’s (OP, KC, Lee’s Summit, Smithville), Mercy (Chesterfield, MO), Cox Health (Springfield, MO), Avenues (Overland Park), KU Health
Major Takeaways

• Mild, moderate and severe brain injuries are defined by GCS, imaging and deficits.

• Severity of the brain injury is important for prognosis, post-injury symptoms, treatment and overall outcomes.

• Treatment of brain injury patients is multidisciplinary, and requires numerous things – medications, therapies, referrals, additional testing, and regular follow up

• Pediatric TBIs can have worse outcomes than adult TBIs

• For pediatric TBIs, we must assist them in getting back to life – including school, activities, and driving, while being mindful of allowing the brain to heal and avoidance of second impact syndrome.
Testing Our Knowledge
True or False

• Traumatic brain injury in children is less severe than in adults, because their brains are still developing, and they can recover faster.
True or False

• All children, regardless of age or severity of their trauma, should receive a head CT to rule out any brain damage.
True or False

• Neuropsychological testing is best for those who are <5 years old and completed within 1-2 weeks of the traumatic brain injury.


- ImPACT Applications: Concussion Management and training. Impacttesting.com


Thank you

Any questions?