Mild Traumatic Brain Injury in the Developing Brain

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Objectives

- Summarize how mild traumatic brain injury in children is unique to the developing brain
- Provide a guideline based on a previous review of literature
- Diagnostic options
- Therapeutic options
- Prognosis, counseling and realistic expectations
Many studies have tried to standardize or predict what diagnostic tools should be utilized immediately after TBI to help determine long term impairment.

Giza and Hovad published a translational review of clinical symptoms as they correlated with neurometabolic cellular changes and subsequent long term neurocognitive development.

This is especially pertinent to the developing brain.
Clinical Symptoms

Neurometabolic Cascade

Mechanism of Injury

Clinical Symptoms
Mechanism of Injury

Falls
Accidental
Sport
MVA/Assault
Blast
Recreational

→

neurometabolic cascade

→

clinical symptoms
Neurometabolic Cascade

- Ionic Flux
- Glutamate Release
- Energy Crisis
- Axonal Injury
- Impaired Transmission
- Protease activation
- Altered cytoskeletal proteins
- Cell death

Clinical symptoms
Clinical Symptoms

Ionic Flux
Glutamate Release
Energy Crisis
Axonal Injury
Impaired Transmission
Protease activation
Altered cytoskeletal proteins
Cell death

Migraine
Secondary Injury
Cognition
Processing
Reaction Time
Persistent Impairments
## Clinical Manifestations

<table>
<thead>
<tr>
<th>Physical</th>
<th>Cognitive</th>
<th>Emotional</th>
<th>Sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Mental fog</td>
<td>Moody</td>
<td>Falling</td>
</tr>
<tr>
<td>Motor</td>
<td>Memory</td>
<td>Irritable</td>
<td>Staying</td>
</tr>
<tr>
<td>Sensory</td>
<td>Focusing</td>
<td>Sad/Blue</td>
<td>Duration</td>
</tr>
<tr>
<td>LOC</td>
<td></td>
<td>Clingy</td>
<td></td>
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<tr>
<td>AMS</td>
<td></td>
<td>Activity</td>
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<tr>
<td>Vestibular</td>
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<td></td>
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<tr>
<td>Seizure</td>
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<tr>
<td>Vision</td>
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</table>
Terminology

- Mild traumatic brain injury
- Closed head injury
- Minor head trauma
- Concussion

“Frequently used interchangeably and have different connotations for families, researchers, and health care professionals, allowing for misinterpretation.”

In an attempt to standardize this terminology, CDC established the pediatric mTBI workgroup who utilized methods from the American Academy of Neurology to help develop guidelines.
Pediatric Mild TBI
Guideline Work Group

- Goal was to bridge the variability between subjective clinical symptoms and determine what are the best practices for diagnostic and treatment options
- Impeded by a lack of standard nomenclature, no real definition (mild, minor, moderate)
- GCS: > 13 mild, 9-12 moderate, <8 severe
- Subjective: initial “mild” symptoms of foggy, memory, HA can evolve to “severe” ICH
“Mild traumatic brain injury”

JAMA Pediatrics November 2018 - evidence based clinical guidelines in the United States


Children 18 years or younger

“an acute brain injury resulting from mechanical energy to the head from external forces including:

1. confusion, LOC <30mins, amnesia <24 hrs, TFND

2. GCS 13-15 after 30mins
### Diagnostic Recommendations

<table>
<thead>
<tr>
<th></th>
<th>LOC 1 (high)</th>
<th>2 (mod)</th>
<th>3 (low)</th>
<th>4 (vl)</th>
<th>SOR - A (always)</th>
<th>B (usually)</th>
<th>C (some)</th>
<th>D (insuf)</th>
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<tbody>
<tr>
<td>CT</td>
<td>✗</td>
<td>✗</td>
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<tr>
<td>SPECT</td>
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<td></td>
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<td></td>
<td>✗</td>
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*Note: The table indicates the level of evidence and recommendation for each diagnostic method.*
Treatment
Recommendations

Ionic Flux
Glutamate Release
→ Energy Crisis
→ Axonal Injury
→ Impaired Transmission
→ Protease activation
→ Altered cytoskeletal proteins
→ Cell death
→ Migraine
→ Chronic HA
→ Secondary Injury
→ Cognition Processing
→ Reaction Time
→ Impairments

Nonopioid Analgesics (M/B)
Multifactorial Evaluation (H/B)
Cognitive & Physical Rest (M/B)
Gradually Resume ADL'S (M/B)
Non Contact Aerobic (H/B)
Return to School (M/B)
Vestibular Therapy (M/C)
Neuropsych Eval (H/C)
Emotional Lability (M/C)
Sleep Hygiene (M/C)
Prognostic Recommendations

- 70-80% with mTBI have symptom resolution by 1-3 months
- Realistic expectations of recovery based on premorbid risk factors
- Medical & social risk factors
- No single assessment tool is strongly predictive
- Multifaceted approach
Thank You