Concussion and Executive Function: Return to Learn

Ben Katholi, MD
Lisa Leonard, MA CCC-SLP

Disclosures

• Katholi-no financial disclosures
• Leonard-no financial disclosures
Objectives

- To develop a brief understanding of the neurometabolic cascade related to concussion
- To define concussion vs. post concussion syndrome
- To understand executive function deficits related to post concussion syndrome.
- To identify appropriate means of assessing executive function deficits in children/adolescents who have post concussion syndrome
- To demonstrate knowledge of treatment strategies and appropriate interventions for children/adolescents who have post concussion syndrome.

Concussion

- Concussion/mTBI
  - A complex pathophysiological brain insult as a result of traumatic biomechanical injury resulting in physical, cognitive, and emotional symptoms
  - Transient constellation of symptoms reflecting functional vs structural symptoms
Symptoms

<table>
<thead>
<tr>
<th>Cognitive</th>
<th>Physical</th>
<th>Affective</th>
<th>Sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inattention</td>
<td>Headache</td>
<td>Emotional lability</td>
<td>Increased latency</td>
</tr>
<tr>
<td>Slowed thinking</td>
<td>N/V</td>
<td>Anxiety</td>
<td>Frequently awake</td>
</tr>
<tr>
<td>Amnesia</td>
<td>Photophobia</td>
<td>Mania</td>
<td>Increase or decreased sleep time</td>
</tr>
<tr>
<td>Confusion</td>
<td>Photophobia</td>
<td>Depression</td>
<td></td>
</tr>
<tr>
<td>Disorientation</td>
<td>Dizziness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOC</td>
<td>Slurred speech</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blurred vision</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incoordination</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Kutcher and Giza, Continuum, 2014

Neurometabolic Cascade

Giza and Hovda, 2001
Neurometabolic Cascade

• 1. Immediate release of neurotransmitters
• 2. Hypermetabolic state
• 3. Refractory Hypometabolic state

Stage 1

• Disruption of neuronal membranes
• Axonal stretching
• Wave of neuronal excitation
• Wave of neuronal suppression
• Reduced cerebral blood flow
Stage 2

• Attempted restoration of balance
• Increase cerebral lactate due to energy consumption

Stage 3

• Hypometabolic state
• Continued low glucose use and low cerebral blood flow
• Unrelated to level of consciousness
Neuroplasticity

• Despite no structural damage, there is reorganization at the cellular level
• Reorganization and repair is neuroplasticity
• In most concussion, recovery is complete at 1-2 weeks
• Prolonged recovery may occur in minority of cases

Rehab

• Prolonged rest no longer appropriate
• Tailor exercise to symptoms (if exercise worsens symptoms, then reduce intensity)
• Chronic symptoms indicate involvement with additional services
Risk factors for prolonged recovery

• Younger age
• PTA
• History of prior concussions or learning disability
• Severity of concussion
• Premorbid cognition, occupation, family/social factors, psychological functioning

Educational needs

• There is much overlap between psychological needs, concussion recovery and may impact learning needs
• Multidisciplinary support is needed from family, school, medical team to support the student
What’s next?

Initial Treatment recommendations

• Following concussion patients should be educated on cognitive strategies to help the deal with difficulties in how they are feeling following a concussion.
• Education should also occur for prevention of another concussion.
• Academic modifications to deal with short term difficulties.
Athletes of all ages, participating in sports, are at risk for concussion; 65% of concussions occur in children between 5 and 18 years of age.

These children are at a greater risk for traumatic brain injury as the young brain of a pediatric athlete is still developing and tissue is not as able to recover as quickly as an adult brain.

In some cases symptoms persist for much longer and 5-10% last a lifetime.

Children are more susceptible to neurochemical and metabolic changes, their axons are not yet well insulated or myelinated.

Children’s cervical and shoulder musculature is less developed resulting in a decreased ability to absorb mechanical energy throughout their bodies.

Children are less likely to use proper techniques to reduce risk.

Until recovered, children should receive accommodations in all settings to promote cognitive rest.
Post concussion Syndrome when symptoms persist

• **Subjective** physical complaints (i.e. Headache, dizziness), cognitive, emotional, and behavioral changes that persist beyond the average recovery times, typically 2-3 months (when diagnosed varies). Post-concussion syndrome disturbances can be chronic, permanent, or late emerging.

• For some people these symptoms last months for others it is years

• 5-10% of concussions will end up being classified as post concussion syndrome (this number varies pending which literature you are reading).

Cognitive/Executive Function Deficits

• Difficulties concentrating/attending to information (visual and auditory)
• Difficulties with sequencing/organizing/prioritizing (difficulties multi-tasking)
• Difficulties initiating and completing tasks
• Difficulties with time management
• Slowed response times
• Memory/Recall Issues (anterograde amnesia/retrograde amnesia)
• Decrease in mental flexibility, increased rigidity
• Word retrieval difficulties
• Decreased insight into limitations
• Difficulty carrying conversation/tangential speech
• Self regulation/personality changes – behavior changes affect cognition
• Occasionally changes in speech patterns (decreased prosody, slurring)
Evaluation for Cognition/Executive Function Following Concussion

• Gather medical/concussion history via patient/family interview
  • Information regarding most recent concussion
  • Information regarding previous concussions
  • What services/treatment the patient did or is currently receiving?
  • Current medications?
  • Academic performance history
  • Are there any results from previous cognitive testing/questionnaires?
    • ImpAct – are there changes from baseline
    • Sports Concussion Assessment Tool (Scat 3)
    • Acute Concussion Evaluation (ACE)
• Informal Assessments/checklists
  – mTBI checklists
  – Portions of the SCAT 3 or ACE
  – Pragmatic checklists
  – Personality/behavior checklists
  – Memory questionnaires
  – Executive skills questionnaires

Evaluation for Cognition/Executive Function Following Concussion

• Use of standardized testing
  – Not always recommended, but you may do as part of initial evaluation
  – May trigger symptoms to occur secondary to the cognitive load it places on a person
  – May help identify areas of strength and weakness
  – Informal assessment may not be sensitive enough
Evaluation for Cognition/Executive Function Following Concussion

Recommended Assessments – patient dependent on which evaluation you may choose

• Behavior Rating Inventory of Executive Function (BRIEF)
• Woodcock–Johnson Tests of Cognitive Abilities
• Scales of Traumatic Brain Injury (SCATBI) 16 & up
• Pediatric Test of Brain Injury (PTBI)
• Test of Memory and Learning 2 (TOMAL 2)
• Functional Assessment of Verbal Reasoning and Executive Strategies (Favre-S)
• The Test of Everyday Attention for Children (TEA-Ch)
• RIPA – P
• Test of Narrative Language
• Boston Naming Test

What Does Treatment Involve?

• Initiation school re-entry if it has not been started
• Treatment should aim at increasing independence and adjustment
## Treatment

### Direct Training
- Sustained Attention
- Alternating Attention
- Divided Attention
- Working Memory

According to Solberg and Ledbetter 2016

### Metacognitive Strategy Instruction
- Instruction in use of strategies to facilitate self-regulation of states of mind, academic tasks, and study skills
  - Note Taking
  - Study Agenda
  - Reading Comprehension Strategies
  - Self Monitoring of Social Behavior
  - Conversational Marking Strategies
  - Internal Memory Strategies

### Training Assistive Technology
- Instruction in use of external cognitive aids
  - Smart Phones/Apps
  - Smart pens
  - Digital Recorders
  - Calendars/Planners

According to Solberg and Ledbetter 2016

### Psycho-Social Education Supports
- Symptom Monitoring
  - Fatigue management and sleep hygiene
  - Incorporation of headache management plan
  - Incorporation of stress management plan
- Concussion Education
- Goal Setting
Persistent concussion symptoms are going to require a plan to return to learn

School Re-entry

- Questions start to arise when symptoms persist beyond average length of recovery
- School accommodations aimed to promote learning during the period of chronic symptoms
  - Response to Intervention Protocol (RTI)
  - 504 Plan
  - Individualized Education Plan (IEP)
- Requires a team to assist re-entry process
  - Administrator
  - Athletic Trainer
  - Coach
  - School Counselor
  - School Psychologist
  - School Nurse
  - Teacher
  - Medical Provider
  - School based therapies
Role of school following concussion

- Protect student from further brain injury.
- Support and coordinate with team the return to physical activity within school environment.
- Support and coordinate with team the students return to cognitive exertion.

Phases of return to school

- Weeks 1-3 is a focus on academic adjustment.
- Beyond 3 weeks is period of academic accommodations.
- Beyond few months may need academic modifications if symptoms persist.
Guidelines for Return to School Following Concussion

Table 1. Protocol for return to full academic participation.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Activity level</th>
<th>Criteria to move to next stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No return, all new</td>
<td>Stage 1: maintain low level cognitive and physical activity. No prolonged conversation. Cognitive, emotional, and physical symptoms resolve with minimal testing or self challenge test for 20–30 min.</td>
<td>To move to stage 1. Minimal cognitive symptoms and no symptoms reduce or disappear with cognitive and physical activity.</td>
</tr>
<tr>
<td>1</td>
<td>Return to school, partial days (0–1)</td>
<td>Allowed to three classes, with improvement monitored, breaks as needed.</td>
<td>To move to stage 2: student symptom status improving, able to tolerate 0–1 h of activity with breaks in cognitive and physical activity built into school day.</td>
</tr>
<tr>
<td>2</td>
<td>Full day, moderate support required throughout the day</td>
<td>Allowed to three classes, with breaks, moderate modifications to cognitive and physical activity.</td>
<td>To move to stage 3: student symptom status improving, able to tolerate 2–3 h of activity with breaks in cognitive and physical activity.</td>
</tr>
<tr>
<td>3</td>
<td>Return to full-day, moderate support provided in assignment to symptoms during the day</td>
<td>Allowed to four classes with one to two breaks (20–30 min),lengthen homework (45–90 min).</td>
<td>To move to stage 5: continue symptom improvement, needs no more than one cognitive and physical activity per day.</td>
</tr>
<tr>
<td>4</td>
<td>Return to full-day, minimal support (monitoring final recovery)</td>
<td>Allowed to four classes with one to two breaks (20–30 min), lengthen homework (45–90 min).</td>
<td>To move to stage 5: continue symptom improvement, no symptoms with cognition or physical needs during full school day.</td>
</tr>
<tr>
<td>5</td>
<td>Full return, no support needed</td>
<td>Full class schedule, no rest breaks.</td>
<td>N/A.</td>
</tr>
</tbody>
</table>

N/A: Not applicable.

Strategies/Accommodations for Academic Success

- Excused absences from work/classes (during rest phase)
- Modifications to physical activity per medical recommendations
- Schedule accommodations
- Limit distractions
- Additional time to complete coursework
- Accommodations for testing
  - Additional time to complete testing
  - Environmental modifications
  - Staggering, postponing
  - Rescheduling of multiple tests
- Dividing tasks/assignments into steps/smaller quantity
- Use of written schedule/planner
- Use of external monitor (peer/teacher) to check to ensure using schedule/assignments are being recorded/completed down, down and materials needed
- Provide written notes or make sue of a peer note taker
- Auditory Accommodations/strategies
  - Ear plugs
  - Limit auditory distractions
  - Preferential seating to improve auditory attention
Strategies/Accommodations for Academic Success

- Visual Accommodations/strategies
  - Reduce lighting
  - Sunglasses
  - Changing lighting on screens
  - Increasing font sizes
  - Reducing amount of information on a page
  - Use of line blockers when reading
  - Preferential seating for visual attention
  - Limiting screen time
- Tutoring
- One on one instruction
- Use of a reader
- Use of a computer or recording lectures.
- Alarms/timers

- Memory Strategies
  - External memory devices
  - Provide written and verbal instructions
  - Consistency of schedule
  - Overlearning strategies
    - repetition
    - rehearsal
    - review
- Planning/Organization/Task completion Strategies
  - Establish routines
  - Plan ahead
  - To do lists
  - Monitor use of planning/organization strategies
  - External cues for moving from step to step
    - Verbal prompt
    - Written/picture instructions
  - Incorporate use of awareness/metacognitive skills

CONCUSSION & THE LAW

- All 50 states and Washington D.C. have passed concussion laws
- Concussion laws vary greatly across states

Link to Ohio concussion law
References