

Centers for Disease Control and
Prevention Guideline on the
Diagnosis and Management of Mild
Traumatic Brain Injury Among
Children September 2018 and
Concussion Clinical Trajectories

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CDC Guidelines- Objective

- Question- Based on current evidence, what are the best practices for diagnosis, prognosis, and management/treatment of pediatric mild traumatic brain injury (mTBI)?
- Objective- To provide a guideline based on systematic review of the literature to obtain and assess evidence toward developing clinical recommendations for health care professionals related to the diagnosis, prognosis, and management/treatment of pediatric mTBI.

CDC Guidelines Address Diagnosis, Prognosis and Treatment

- The CDC guidelines includes 19 sets of recommendations on the diagnosis, prognosis, and management/treatment of pediatric mTBI that were assigned a level of obligation (i.e. must, should, or may) based on confidence in the evidence.
- Recommendations address: 1) Imaging, symptom scales, cognitive testing, and standardized assessment for DIAGNOSIS; 2) History and risk factor assessment, monitoring, and counseling for PROGNOSIS; and 3) Patient/family education, rest, support, return to school, and symptom management for TREATMENT; in children 18 years or younger.

CDC- Concussion vs mTBI

- Although “concussion,” “minor head injury,” and mTBI are frequently used interchangeably, they have different connotations for families, researchers, and health care professionals, allowing for misinterpretation. Therefore, the guideline recommends the clinical use of the single term Mild Traumatic Brain Injury.

Concussion/mTBI Defined

- Definition- (1) One or more of the following: confusion or disorientation, loss of consciousness for 30 minutes or less, post-traumatic amnesia for less than 24 hours, and/or other transient neurological abnormalities such as focal signs, symptoms, or seizure; (2) Glasgow Coma Scale score of 13-15 after 30 minutes post-injury or later upon presentation for healthcare.

Guideline Confidence Levels

- **Level A:** The recommendation almost always should be followed.
- **Level B:** The recommendation usually should be followed.
- **Level C:** The recommendation may sometimes be followed.
- **Level U:** There is insufficient evidence to make a recommendation.
- **Level R:** The intervention generally should not be done outside of a research setting.

Diagnostic Recommendation #1- To CT or Not CT that is the Question!

- **Recommendation 1A:** Health care professionals should not routinely obtain head CT for diagnostic purposes in children with mTBI. *Level B*
- **Recommendation 1B:** ...use validated clinical decision rules to identify children at higher risk of intracranial injury: 1) Age younger than 2, 2) Vomiting, 3) Loss of consciousness, 4) Severe mechanism of injury, 5) Severe or worsening headache, 6) Amnesia, 7) Nonfrontal scalp hematoma, 8) Glasgow Coma Scale <15, 9) Clinical suspicion for skull fracture. *Level B*
- **Recommendation 1C:** ...health care professionals should discuss the risks of pediatric head CT in the context of risk factors for intracranial injury with the patient and family. *Level B*

Diagnostic Recommendation #3- Single-Photon Emission CT

- **Recommendation 3:** Health care professionals should not use single-photon emission CT (SPECT) in the acute evaluation of suspected or diagnosed mTBI. *Level B*

Diagnostic Recommendation #2- Brain MRI

- **Recommendation 2:** Health care professionals should not routinely use magnetic resonance imaging (MRI) in the acute evaluation of suspected or diagnosed mTBI. *Level B.* (However, rapid-sequence MRI in nonsedated patients has recently been successfully used in children with suspected acute TBI.)

Diagnostic Recommendation #4- Skull Radiograph

- **Recommendation 4A:** Skull radiographs should not be used in the diagnosis of pediatric mTBI. *Level B*
- **Recommendation 4B:** Skull radiographs should not be used in the screening for intracranial injury. *Level B* (Head CT better detects ICIs and better characterizes skull fractures, making it the more appropriate diagnostic imaging choice when such imaging is clinically indicated.)

Concussion Symptom Scale

Please rate your symptoms based on how much you have felt in the last 24 hours.

| | None | | Moderate | | | Severe | |
|---------------------------|------|---|----------|---|---|--------|---|
| Headache | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Nausea | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Vomiting | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Drowsiness | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Numbness or tingling | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Dizziness | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Balance problems | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sleeping more than usual | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sensitivity to light | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sensitivity to noise | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Feeling slowed down | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Feeling as if "in a fog" | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Difficulty concentrating | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Difficulty remembering | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Trouble falling asleep | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| More emotional than usual | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Irritability | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sadness | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Nervousness | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Fatigue | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sleeping less than usual | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Visual problems | 0 | 1 | 2 | 3 | 4 | 5 | 6 |

Diagnostic Recommendation #5- Symptom Scales, Computer Cognitive Testing and SAC

- **Recommendation 5A:** Health care professionals should use an age-appropriate, validated symptom rating scale as a component of the diagnostic evaluation on children seen with acute mTBI. *Level B* (The guideline review concluded that the Graded Symptom Checklist is useful in distinguishing children 6 years and older with mTBI within the first 2 days after injury.) *Level B*
- **Recommendation 5B:** Health care professionals may use validated, age-appropriate computerized cognitive testing in the acute period of injury as a component of the diagnosis of mTBI. *Level C*
- **Recommendation 5C:** The Standardized Assessment of Concussion should not be exclusively used to diagnose mTBI in children age 6 to 18. *Level B*

Standardized Assessment of Concussion-SAC

| | | | |
|--|-----|---|-----------------------|
| 1) ORIENTATION: | | 3) CONCENTRATION: | |
| Month: _____ | 0 1 | <i>Digits Backward</i> (If correct, go to next string length. If incorrect, read trial 2. Stop after incorrect on both trials.) | |
| Date: _____ | 0 1 | 4-9-3 _____ | 6-2-9 _____ 0 1 |
| Day of week: _____ | 0 1 | 3-8-1-4 _____ | 3-2-7-9 _____ 0 1 |
| Year: _____ | 0 1 | 6-2-9-7-1 _____ | 1-5-2-8-6 _____ 0 1 |
| Time (within 1 hr): _____ | 0 1 | 7-1-8-4-6-2 _____ | 5-3-9-1-4-8 _____ 0 1 |
| Orientation Total Score _____ | / 5 | <i>Months in Reverse Order</i> (entire sequence correct for 1 point) | |
| 2) IMMEDIATE MEMORY: (all 3 trials are completed regardless of score on trial 1 & 2; total score equals sum across all 3 trials) | | Dec-Nov-Oct-Sep-Aug-Jul _____ | 0 1 |
| | | Jun-May-Apr-Mar-Feb-Jan _____ | 0 1 |
| | | Concentration Total Score _____ | / 5 |

| List | Trial 1 | Trial 2 | Trial 3 |
|--------|---------|---------|---------|
| Word 1 | 0 1 | 0 1 | 0 1 |
| Word 2 | 0 1 | 0 1 | 0 1 |
| Word 3 | 0 1 | 0 1 | 0 1 |
| Word 4 | 0 1 | 0 1 | 0 1 |
| Word 5 | 0 1 | 0 1 | 0 1 |
| Total | | | |

Immediate Memory Total Score _____ / 15
(Note: Subject is not informed of delayed recall testing of memory)

EXERCUTIONAL MANEUVERS (when appropriate):
5 jumping jacks _____
5 sit-ups _____
5 push-ups _____
5 knee bends _____

4) DELAYED RECALL:

| | |
|----------------------------|-----------|
| Word 1 | 0 1 |
| Word 2 | 0 1 |
| Word 3 | 0 1 |
| Word 4 | 0 1 |
| Word 5 | 0 1 |
| Delayed Recall Total Score | _____ / 5 |

SUMMARY OF TOTAL SCORES:

| | |
|---------------------|------------|
| ORIENTATION | _____ / 5 |
| IMMEDIATE MEMORY | _____ / 15 |
| CONCENTRATION | _____ / 5 |
| DELAYED RECALL | _____ / 5 |
| OVERALL TOTAL SCORE | _____ / 30 |

NEUROLOGIC SCREENING:
Loss of Consciousness: (occurrence, duration) _____
Retrograde & Posttraumatic Amnesia: (recollection of events pre- and post-injury) _____
Strength: _____
Sensation: _____
Coordination: _____

SEE END OF HANDOUT

Diagnostic Recommendation #6- Serum Markers

- Recommendation 6:** Health care professionals should not use biomarkers outside of a research setting for the diagnosis of children with mTBI. *Level R* (There is insufficient evidence to currently recommend any of the studied biomarkers for the diagnosis of children with mTBI.)

Prognostic Recommendation #8- Premorbid Conditions

- Recommendation 8A:** Health care professionals should assess the premorbid history of children...after mTBI injury to assist in determining prognosis.
- Recommendation 8B:** Health care professionals should counsel children and families...that recovery from mTBI might be delayed in those with the following: 1) Premorbid history of mTBI. 2) Lower cognitive ability. 3) Neurological or Psychiatric disorder. 4) Learning difficulties. 5) Increased preinjury symptoms. 6) Family and social stressors. *Level B*

Computer Cognitive Testing



ImPACT™ Clinical Report

| Exam Type | Baseline | Post-Injury 1 | Post-Injury 2 | Post-Injury 3 |
|-----------------|------------|---------------|---------------|---------------|
| Date Tested | 08/17/2010 | 01/10/2011 | 01/17/2011 | 01/27/2011 |
| Last Concussion | | 01/08/2011 | 01/09/2011 | 01/09/2011 |
| Exam Language | English | English | English | English |
| Test Version | 2.0 | 2.0 | 2.0 | 2.0 |

| Composite Scores | Percentile scores if available are listed in small type. | | | | | | | |
|----------------------------|--|-----|------|-----|-------|-----|-------|-----|
| Memory composite (verbal) | 76 | 15% | 61 | 1% | 68 | 4% | 93 | 71% |
| Memory composite (visual) | 85 | 86% | 56 | 14% | 63 | 21% | 81 | 73% |
| Vis. motor speed composite | 36.8 | 35% | 30.3 | 6% | 31.08 | 9% | 44.05 | 70% |
| Reaction time composite | 0.58 | 29% | 0.79 | 2% | 0.81 | 1% | 0.52 | 75% |
| Impulse control composite | 11 | | 13 | | 9 | | 7 | |
| Total Symptom Score | 4 | | 19 | | 28 | | 3 | |

Cognitive Efficiency Index: 0.16 0.13 0.3 0.53

Prognostic Recommendation #7- Reassurance Counseling

- Recommendation 7A:** Health care professionals should counsel patients and families that most (70-80%) children with mTBI do not show significant difficulties that last more than 1 to 3 months after injury. *Level B* (Studies in children and adults with mTBI report direct patient benefits of counseling by health care professionals.)
- Recommendation 7B:** Health care professionals should counsel patients and families that, although some factors predict an increased or decreased risk for prolonged symptoms, each child's recovery from mTBI is unique and will follow its own trajectory. *Level B*

Prognostic Recommendation #9- Assessment of Cumulative Risk Factors

- Recommendation 9A:** Health care professionals should screen for known risk factors for persistent symptoms in children with mTBI. *Level B*
- Recommendation 9B:** Health care professionals may use validated prediction rules, which combine information about multiple risk factors for persistent symptoms, to provide prognostic counseling to children with mTBI. (Symptoms may last longer in adolescents, children of Hispanic race, children of lower socioeconomic status, children with more severe presentations of mTBI- reporting more postconcussion symptoms. In addition, headaches persist longer in girls.)

Prognostic Recommendation #10- Assesment Tools and Prognosis

- **Recommendation 10A:** Health care professionals should use a combination of tools to assess recovery in children with mTBI. *Level B*
- **Recommendation 10B:** Health care professionals should use validated symptom scales to assess recovery in children with mTBI. *Level B*
- **Recommendation 10C:** Health care professionals may use validated cognitive testing to assess recovery in children with mTBI. *Level C*

Prognostic Recommendation #11- Interventions for mTBI, Poor Prognosis

- **Recommendation 11A:** Health care professionals should closely monitor children with mTBI who are determined to be at high risk for persistent symptoms based on premorbid history, demographics and injury characteristics. *Level B*
- **Recommendation 11B:** For children with mTBI whose symptoms do not resolve as expected with standard care (4-6 weeks), health care professional should provide or refer for appropriate assessment and/or interventions. *Level B*
- Most children with mTBI resolve within 1-3 months...Children with mTBI who are at high risk for persistent symptoms or delayed recovery may require intervention.

Management Recommendation #13- Cognitive/Physical Rest and Aerobic Treatment

- **Recommendation 13A:** Health care professionals should counsel patients to observe more restrictive physical and cognitive activity during the first several days after mTBI in children. *Level B*
- **Recommendation 13B:** Following these first several days, health care professionals should counsel patients to resume a gradual schedule of activity that does not exacerbate symptoms, with close monitoring of symptom expression (symptom scales) *Level B*

Prognostic Recommendation #10- Assesment Tools and Prognosis – cont.

- **Recommendation 10D:** Health care professionals may use balance testing to assess recovery in adolescent athletes with mTBI. *Level C*
- **Rationale:** No single assessment tool is strongly predictive of outcome in children with mTBI. However, multiple tools have shown utility in the assessment of individual patients and their recovery from mTBI- Symptoms scales and cognitive testing have the strongest evidence of predicting outcomes assessing recovery.

Management Recommendation #12- Education and Reassurance

- **Recommendation 12:** Education and reassurance for mTBI should include:
 - Warning signs of more serious injury.
 - Description of injury and expected course of symptoms and recovery.
 - Instructions on how to monitor postconcussion symptoms.
 - Prevention of further injury.
 - Management of cognitive and physical activity/rest.
 - Instructions regarding return to play/recreation and school.
 - Clear clinician follow-up instructions. *Level A*
 - Patient and family education and reassurance are key components of mTBI care initiatives and provide significant benefit with respect to pediatric patient mTBI outcomes.

Management Recommendation #13- Cognitive/Physical Rest and Aerobic Treatment

- **Recommendation 13C:** After successful resumption of a gradual schedule of activity...an active rehabilitation program of progressive reintroduction of noncontact aerobic activity that does not exacerbate symptoms, with close monitoring of symptoms. *Level B*
- **Recommendation 13D:** Health care professionals should counsel patients to return to full activity when they return to preinjury performance and have remained symptom free at rest and on exertion. *Level B*

Concussion Treatment- “Rest”, How long and how much?

- **CDC:** Evidence suggests that rest or reduction in cognitive/physical activity is beneficial immediately after mTBI and, for those who are slow to recover, may help accelerate recovery. The optimal timing to initiate an aerobic program after pediatric mTBI has not been established...Related evidence suggests that early rest (within the first 3 days of injury) may be beneficial, but that inactivity beyond this period for most children may worsen symptoms.

Management Recommendation #14- Psychosocial/Emotional Support

- **Recommendation #14:** Health care professionals may assess the extent and types of social support (i.e. emotional, informational, and appraisal) available to children with mTBI and emphasize social support as a key element in the education of caregivers and educators. *Level C*
- **Rationale:** Social support has proved useful in promoting the recovery of persons with TBI...

Management Recommendation #15- Return to School Continued

- **Recommendation 15C:** For any student with prolonged symptoms that interfere with academic performance, school-based teams should assess the educational needs of that student and determine the student’s need for additional educational supports, including those described under pertinent federal statutes (eg Individuals With Disabilities Education Act 504) *Level B*
- **Recommendation 15D:** Postconcussion symptoms and academic progress in school should be monitored collaboratively by the student, family, health care professionals, and school teams, who jointly determine what modifications or accommodations are needed to maintain an academic workload without significantly exacerbating symptoms. *Level B*

Concussion Treatment- “Rest”, How long and how much?

- **AAP:** Research has demonstrated that light exercise can be safe and may help hasten recovery from a concussion starting with 20-30 minutes a day of light aerobic exercise such as walking or stationary bike. Children should be allowed to return to school with symptoms after only a few days (typically missing no more than 1-2 days). Adjustments will be needed for the majority of athletes to recover while at school with help with curriculum and environment that can minimize worsening of symptoms in the classroom. Athletes should follow appropriate multistep return to activity. Complete removal or elimination of all electronic use is not necessary in concussion recovery. Their use may need to be reduced...

Management Recommendation #15- Return to School

- **Recommendation 15A:** To assist children returning to school after mTBI, medical and school-based teams should counsel the student and family regarding the process of gradually increasing the duration and intensity of academic activities as tolerated, with the goal of increasing participation without significantly exacerbating symptoms. *Level B*
- **Recommendation 15B:** Return-to-school protocols should be customized based on the severity of postconcussion symptoms in children with mTBI as determined jointly by medical and school-based teams. *Level B*

Management Recommendation #15- Return to School Continued

- **Recommendation 15E:** The provision of educational supports should be monitored and adjusted on an ongoing basis by the school-based team until the student’s academic performance has returned to preinjury levels. *Level B*
- **Recommendation 15F:** For students who demonstrate prolonged symptoms and academic difficulties despite an active treatment approach, health care professionals should refer the child for a formal evaluation by a specialist in pediatric mTBI. *Level B*

Management Recommendation #16- Posttraumatic Headache

- **Recommendation 16A:** Health care professionals in the ED should clinically observe and consider obtaining a head CT in children seen with severe headache, especially when associated with other risk factors and worsening headache after mTBI, to evaluate for ICI. *Level B*
- **Recommendation 16B:** Children undergoing observation periods for headache with acutely worsening symptoms should undergo emergent neuroimaging. *Level B*

Management Recommendation #16- Posttraumatic Headache

- **Recommendation 16D:** Health care professionals should not administer 3% hypertonic saline to children with mTBI for treatment of acute headache outside of a research setting. *Level B*
- **Recommendation 16E:** Chronic headache after mTBI is likely to be multifactorial; therefore, health care professionals should refer children with chronic headache after mTBI for multidisciplinary evaluation and treatment, with consideration of analgesic overuse as a contributory factor. *Level B*

Management Recommendation #18- Sleep Treatment

- **Recommendation 18A:** Health care professionals should provide guidance on proper sleep hygiene methods to facilitate recovery from pediatric mTBI. *Level B*
- **Recommendation 18B:** If sleep problems emerge or continue despite appropriate sleep hygiene measures, health care professionals may refer children with mTBI to a sleep disorder specialist for further assessment. *Level C*

Management Recommendation #16- Posttraumatic Headache

- **Recommendation 16C:** Health care professionals and caregivers should offer nonopioid analgesia (ibuprofen or acetaminophen) to children with painful headache after acute mTBI, but also provide counseling to the family regarding the risks of analgesic overuse, including rebound headache. *Level B*
- **Rebound Headache-** Headache medication used more than 10-15 days per month can cause rebound or medication overuse headaches. Can occur with acetaminophen, ibuprofen, naproxen, and caffeine containing migraine meds. Limit OTC medication use for postconcussion headaches to 5-7 days consistently, then prn.

Management Recommendation #17- Vestibulo-Oculomotor Dysfunction

- **Recommendation 17:** Health care professionals may refer children with subjective or objective evidence of persistent vestibulo-oculomotor dysfunction (dizziness) after mTBI to a program of vestibular rehabilitation. *Level C*

Management Recommendation #19- Cognitive Impairment

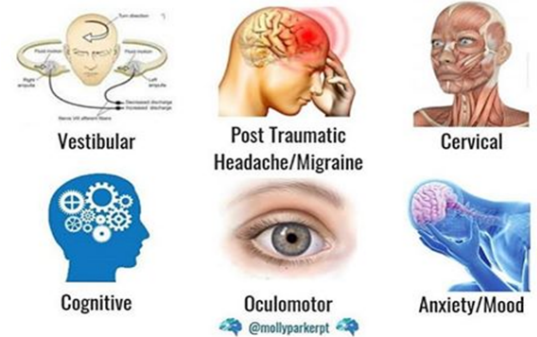
- **Recommendation 19A:** Health care professionals should attempt to determine the etiology of cognitive dysfunction within the context of other mTBI symptoms. *Level B*
- **Recommendation 19B:** Health care professionals should recommend treatment for cognitive dysfunction that reflects its presumed etiology. *Level B*
- **Recommendation 19C:** Health care professionals may refer children with persisting problems related to cognitive function for a formal neuropsychological evaluation to assist in determining the etiology and recommendation for targeted treatment. *Level C*

Management Recommendation #19- Cognitive Impairment

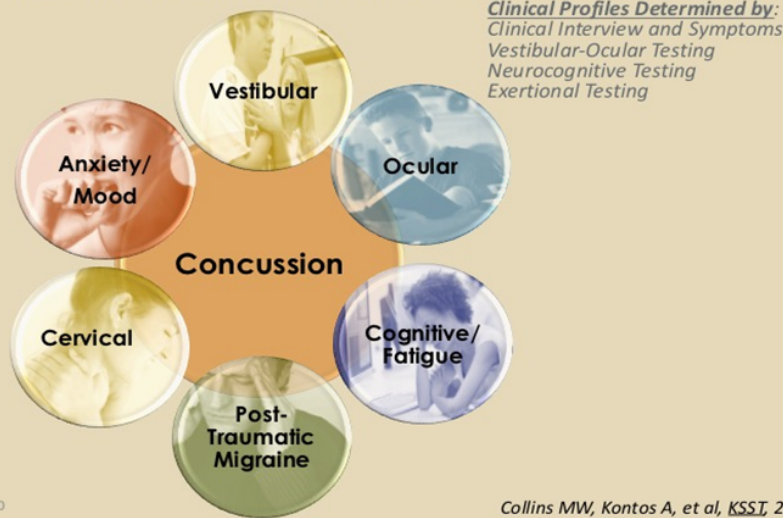
- Cognitive impairment may be directly related to the pathology of the brain injury (impaired neurotransmission), but may also reflect secondary effects of other symptoms (e.g. ongoing headache pain, fatigue/low energy, and low frustration tolerance) that may produce a disruption in cognitive processing.

Concussion Clinical Trajectories

Concussion Clinical Trajectories



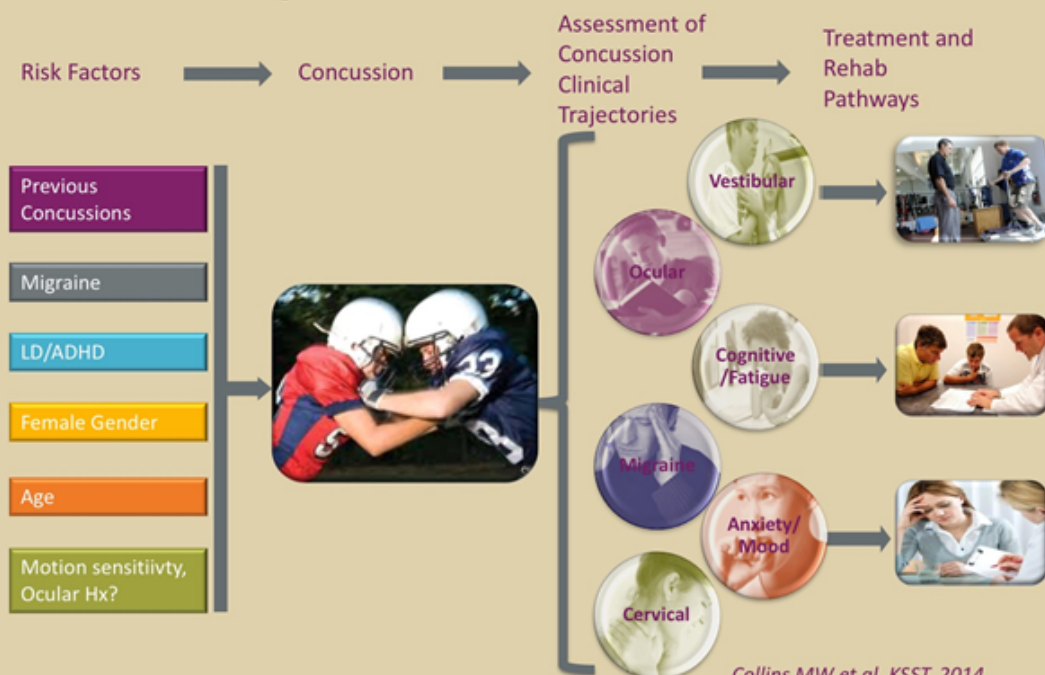
Concussion Clinical Trajectories: A Model for Understanding Assessment, Treatment and Rehabilitation



10

Collins MW, Kontos A, et al, *KSSJ*, 2014

Using Concussion Clinical Trajectories to Inform Targeted Treatment Pathways



Collins MW et al, *KSSJ*, 2014

Concussion Clinical Trajectory- Anxiety/Mood

■ Anxiety/Mood

- Feeling overwhelmed
- Ruminative thoughts
- Hypervigilance
- Sad, hopeless
- Sleep trouble due to inability to settle down
- Often personal/family history of anxiety
- Symptoms may be reported as headache, foggy, dizzy, fatigued
- Symptoms more noted when quiet, inactive

Concussion Clinical Trajectory Anxiety/Mood Treatment

- Supervised exercise as soon as possible
- Emotional release, Relaxation techniques
- Regulate sleep and hydration
- Psychotherapy - CBD
- Antidepressants if needed



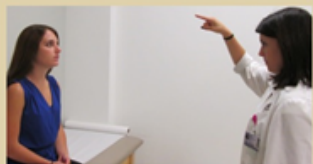
Concussion Clinical Trajectory- Vestibular

■ Vestibular

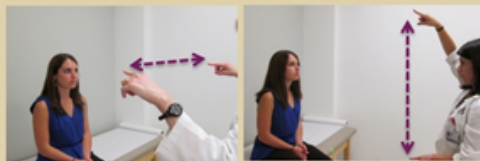
- Dizziness, nausea, fogginess, detachment
- Anxiety
- Overstimulation in complex environments
- Rapid head/body movements can trigger symptoms
- Symptoms provoked with horizontal/vertical gaze stability
- May not have balance problems

Concussion Clinical Trajectory Vestibular/Ocular Screening (VOMS)

Identifying Vestibular and Ocular Problems after Concussion: UPMC VOMS



Horizontal & Vertical Pursuits



Horizontal & Vertical Saccades



Near Point Convergence



Horizontal & Vertical VOR

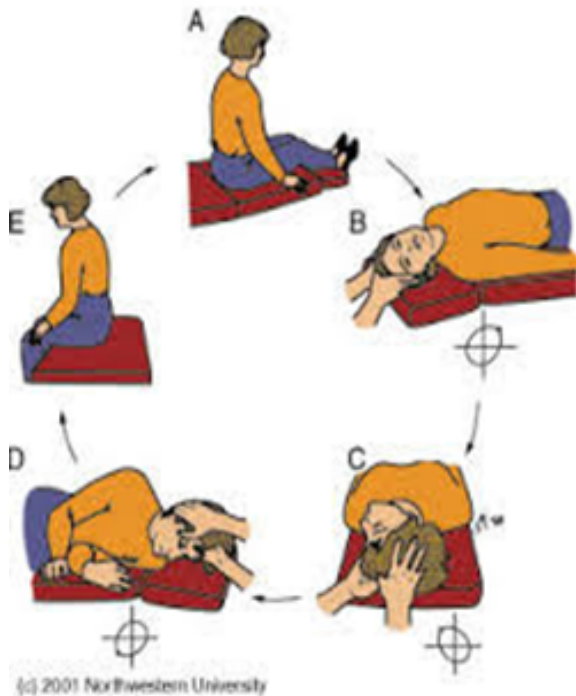


Visual Motion Sensitivity

- A brief 5 minute **clinical screening** tool to identify additional vestibular and ocular motor impairment and symptoms following concussion
- Used in conjunction with symptom reporting, neurocognitive assessment, balance testing, cervical and exertion screening in order to provide more complete clinical picture

Concussion Clinical Trajectory Vestibular Treatment

- Vestibular Therapy
- Medications for associated headache or emotional symptoms



Concussion Clinical Trajectory Ocular Motor

■ Ocular Motor

- Frontal headaches
- Fatigue
- Distractibility
- Trouble in visually-based activities (classroom, screens)
- Trouble reading
- Worse with effort at school, better over weekends
- Blurred or double vision?
- Marked by problems with near-point convergence or accommodation (near > far > near)

Concussion Clinical Trajectory Ocular Motor Treatment

- Evaluation with Neuro-Ophthalmologist
- Reduce eye strain: audiobooks, less reading, limit screen time
- Can continue with aerobic exercise as tolerated



Concussion Clinical Trajectory Migraine Headache

- Unilateral, moderate to severe headache following head trauma with pulsating quality, associated with nausea, light and noise sensitivity, aggravated by exercise
- Usually intermittent
- Exacerbated by sleep dysregulation, stress, anxiety, dietary triggers (caffeine)
- Check for personal/family history of migraine



Concussion Clinical Trajectory Migraine Headache Treatment

- Medications
 - Tricyclic Antidepressants (Amitriptyline, Nortriptyline)
 - Anticonvulsants (Topamax, Gabapentin)
 - Amantadine
 - Beta Blockers
 - Calcium Channel Blockers
 - Triptans (Abortive)

Amantadine for Post Concussion Syndrome Mayo Clinic Proceedings February 2019

Abstract: The development of postconcussion syndrome after traumatic brain injury can result in a wide range of potentially debilitating symptoms that includes headaches, cognitive dysfunction and mood disorders. Unfortunately, data on helpful medications are quite limited, particularly on the treatment of persistent headaches attributed to trauma. This retrospective medical record review used data collected from patients with a diagnosis of postconcussion syndrome in Mayo Clinic's Neurology and Physical Medicine and Rehab outpatient clinics to evaluate the response of postconcussion symptoms to amantadine. A complete trial of amantadine was defined as 100 mg twice per day for 2 months. 33 patients were prescribed amantadine for postconcussion syndrome after traumatic brain injury. One third of patients discontinued the medication because of adverse effects. However, posttraumatic headaches were improved in 80% of patients who completed a full trial of amantadine. Surprisingly, patients had improvement in headaches even if the medication was prescribed years after the initial trauma. Little improvement was noted in other symptoms such as poor memory, dizziness and personality changes. Although additional research is certainly needed, amantadine may be a reasonable medication to consider for the treatment of persistent headaches attributed to trauma, even if the initial injury is remote.

Concussion Clinical Trajectories Cognitive/Fatigue



- Fatigue, decreased energy
- Poor concentration
- Increased headache with cognitive activity
- Sleep disruption
- Symptoms worsen as day goes on

Concussion Clinical Trajectory Cognitive/Fatigue Treatment

- Informing School of need for Academic Accommodation
- Frequent breaks from studying
- Regulate sleep cycle, diet and hydration
- Regular physical activity as tolerated
- Formal Neuropsych testing
- Neurostimulant meds: Amantadine, Ritalin, Adderall, Etc.
- Cognitive/Speech Therapy

Concussion Clinical Trajectory Cervical

- **Cervical (whiplash)**
 - Headache
 - Neck pain
 - Numbness/tingling of extremities
 - Evaluation by PT or physical medicine

Concussion Clinical Trajectory Cervical Treatment

- **Cervical Treatment**
 - Range of motion exercises
 - Physical Therapy
 - Biofeedback
 - Meds: analgesics, anti-inflammatories, muscle relaxants

Return to Sports Post Concussion

Graded Return to Play Protocol

| Rehabilitation Stage | Functional exercise at each stage of rehabilitation | Objective of each stage |
|----------------------------|--|---|
| 1. No activity | Complete physical and cognitive rest | Recovery |
| 2. Light aerobic exercise | Walking, swimming, stationary bike with HR<70% maximum | Increased heart rate |
| 3. Sport specific exercise | Running drills without contact | Add movement |
| 4. Non-contact training | More complex drills without contact | Exercise, coordination and cognitive load |
| 5. Full contact | Normal training | Restore confidence |
| 6. Return to play | Game play | |

Association Between the Experimental Kickoff Rule and Concussion Rates in Ivy League Football - JAMA Nov 20, 2018

- In 2016, the kickoff line was moved from the 35 to the 40 yard line. The intention was to have more kickoffs land in the end zone and thereby reduce the likelihood the receiving player will advance the ball, thus increasing touchbacks.
- Results: During 68,479 plays from 2013 through 2017, 159 concussions occurred (126 before and 33 after the rule)...Kickoffs resulting in touchbacks increased from a mean of 17.9% annually before the rule change to 48.0% after. The mean annual concussion rate per 1,000 plays during kickoff plays was 10.93 before the rule change and 2.04 after.

Association Between the Experimental Kickoff Rule and Concussion Rates in Ivy League Football - JAMA Nov 20, 2018

- Discussion: The kickoff rule change in Ivy League football was associated with a reduction in concussions... The action taken by Ivy League leadership based on epidemiologic evidence demonstrates how targeted policy changes can reduce sport-related concussion.

EyeBOX for Diagnosis of Concussion

Breaking news: FDA grants EyeBOX marketing authorization, making it the first non-invasive, baseline-free aid in diagnosis of concussion in patients age 5-67. "In one journal article in children with suspected concussion, the test achieved 72% sensitivity with a 84% specificity..."



Concussion Summary

- Use concussion symptom score sheets
- Reassurance- Recovery will happen
- Encourage early return to school with accommodations even with some symptoms
- Encourage some early physical activity even with some symptoms
- Evaluate and treat specific Concussion Clinical Trajectories especially with any delayed recovery

Concussion Grading Scale

The Post concussion Symptom Scale is essentially a "state" measure of perceived symptoms associated with concussion. That is, the athlete is asked to report his or her "current" experience of the symptoms. This allows tracking of symptoms over very short intervals, such as consecutive days or every few days.

Directions: After reading each symptom, please circle the number that best describes the way the athlete has been feeling today. A rating of 0 means they have not experienced this symptom today. A rating of 6 means they have experienced severe problems with this symptom today.

| | | | | | | | |
|--|-------------|-------------|---|-----------------|---|---------------|---|
| Date tested | | | | | | | |
| Date of Last known concussion(s) | | | | | | | |
| | | | | | | | |
| SYMPTOM | None | Mild | | Moderate | | Severe | |
| Headache | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Nausea | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Vomiting | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Balance Problems | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Dizziness | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Fatigue | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Trouble Falling Asleep | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sleeping More Than Usual | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sleeping Less Than Usual | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Drowsiness | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sensitivity to Light | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sensitivity to Noise | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Irritability | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sadness | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Nervousness | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Feeling More Emotional | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Numbness or Tingling | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Feeling Slowed Down | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Feeling Mentally "Foggy" | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Difficulty Concentrating | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Difficulty Remembering | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Visual Problems (double vision, blurring, etc) | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| TOTAL SYMPTOM SCORE: | | | | | | | |
| GRAND TOTAL OF ALL SYMPTOMS: | | | | | | | |

IMPACT requires the subject to rate the severity of 22 concussive symptoms (e.g. headache, dizziness, sensitivity to light, etc), via a 7-point Likert scale.