Clinical Practice Guideline for Management of Concussion (Mild Traumatic Brain Injury) in the Pediatric and Adolescent Patient

INTRODUCTION/PROBLEM STATEMENT

Concussion in children and adolescents continues to be a prevalent public health concern. Prior to 2018, there have not been any broad, evidence-based guidelines in the US for the purposes of diagnosis, prognosis and/or management of pediatric concussion/mild traumatic brain injury (mTBI). In September 2018, after an extensive review of literature, as well as feedback from clinical experts, the public, and professional organizations, the “Guideline on the Diagnosis and Management of Mild Traumatic Brain Injury Among Children” was published by the Centers for Disease Control and Prevention.1

The current data on the total numbers of mTBI are inconsistent and suggest that pediatric mTBI is underreported. The CDC reports that from 2005-2009 children with concussion/mTBI accounted for almost 3 million emergency department visits and more than 2 million outpatient visits.2 Epidemiologic data indicate a marked increase in visits to emergency departments for mTBI over the past decade.1 From 2001 to 2012, the rate of ED visits for sports and recreation-related injuries with a diagnosis of concussion or mTBI, alone or in combination with other injuries, more than doubled among children (age 19 or younger).2 Currently, rates of mTBI are determined based on data from the Emergency Department; however, patients are frequently sent to their primary care physician or concussion specialty clinics for care. Data on these groups of patients are not routinely collected. From collected data, falls continue to be the primary reason for mTBI-related ED visits in children 0-4 years, while assaults, falls, and motor vehicle traffic events are more common mechanisms of mTBI in the 15-24 yrs old age group.2 Recent sports-related research, published from Seattle Children's Research Institute and UW Medicine's Sports Health and Safety Institute in December 2018, found that concussion rates among football players ages 5-14 yrs were higher than previously reported with 5% of junior athletes included in the study sustaining a football-related concussion each season.3

The previous assumption that a child with a brain injury would recover better than an adult because a younger brain has more “neuro-plasticity” is untrue. The brain of a child is continuing to develop through adolescence and early adulthood. While the symptoms of a brain injury in children are similar to the symptoms experienced by adults, a brain injury of similar severity has a more significant impact on a child than an individual with a mature brain.4

It is imperative the care and education provided to children with concussion/mTBI and their families is evidence-based, regardless of the clinical and community setting. Clinical outcomes in this population are greatly affected by initial treatment guidelines. Although the most recent treatment guidelines are similar regarding initial management (short period of targeted brain rest), the advancement through recovery is...
individualized and should take into account pre-morbid risk factors that can affect the anticipated recovery.¹

**DEFINITION(S)**

According to the most recent published report by the CDC, the terms “concussion,” “minor head injury,” and “mTBI” can cause misinterpretation, therefore they recommend the clinical use of the single term “mild traumatic brain injury.”¹ A mTBI is defined as “an acute brain injury resulting from mechanical energy to the head from external physical forces including 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.”¹ The 5th International Conference on Concussion in Sport, published in 2017, defines concussion as “a traumatic brain injury induced by biomechanics forces;” “Sports-related concussion (SRC) may be caused either by a direct blow to the head, face, neck or elsewhere, with an impulsive force to the head.”² Mild traumatic brain injury results in an immediate onset and/or delayed onset of symptoms (physical, cognitive, mood and sleep related), which can be transient.⁵ Immediate onset symptoms include headache, dizziness, unsteadiness, confusion, amnesia (anterograde and/or retrograde), loss of consciousness, visual disturbances, nausea, vomiting and, rarely, tonic/clonic posturing. Delayed onset symptoms may begin hours to days after injury (usually within 72 hours) and typically involve physical symptoms (e.g., headaches, sleep changes, visual disturbances), mood changes (e.g., irritability, easily frustrated, sadness, nervousness or anxiety, feeling more emotional) and cognitive symptoms (e.g., trouble focusing, confusion, trouble concentrating and/or memory disturbances). Approximately 70-80% of children with mTBI do not show significant difficulties that last more than 1-3 months, although recovery is variable.¹ Loss of consciousness is present in fewer than 10% of children and is not a predictor of severity of injury.⁶

**RATIONALE AND SUPPORTING INFORMATION**

mTBI results in somatic complaints as well as changes in cognition, mood, visual motor functioning and balance. There is no single risk factor that can predict outcome, but a complete understanding of pre-morbid and historical conditions that can prolong recovery should be understood by the medical team. These conditions include: history of mTBI, lower cognitive ability, neurological or psychological disorder, learning disability, Attention Deficit Disorder/Attention Deficit Hyperactivity Disorder (ADD/ADHD), headaches/migraines, family and social stressors, lower socioeconomic status, Hispanic ethnicity, older children and adolescents, and severe symptom burden.¹ In the past, providers made an injury designation of mild, moderate or severe based on factors associated with the injury, but the medical community has deemed this classification obsolete. Rather, injury severity is based on a retrospective assessment of length of recovery. In those individuals who are identified as having a concussion, a slower recovery—one greater than 4 weeks in duration—is associated with a more severe injury.¹

The decision to recommend evaluation in an emergency department is based on the likelihood of significant injury other than concussion and the need to evaluate for clinically important intracranial or other significant injury that may require possible neuroimaging and/or intervention. Indications for immediate referral include a prolonged loss of consciousness (>1 minute), concern for cervical neck injury, or high-impact or high-risk mechanism for intracranial bleed, exam findings suggestive of skull fracture, post-traumatic seizure, or any significant acute worsening in the patient’s status.⁶ Although routine neuroimaging with brain CT is not recommended and does not have diagnostic value in mTBI, it is important to identify the patients at risk for clinically significant intracranial injury.¹ The Pediatric Emergency Care Applied Research Network (PECARN) algorithm is a well-validated, commonly used clinical decision tool that allows providers to safely rule out the presence of clinically important
traumatic brain injuries among pediatric patients without the need of CT imaging, including those that would require neurosurgical intervention.\(^7\)

After the diagnosis of concussion, there should be a combination of tools used by nurses and the health care provider to assess and monitor recovery. No single assessment tool is strongly predictive of outcome, but multiple tools are available that have demonstrated utility. Validated symptom scales and cognitive testing (including reaction time measurement) provide the strongest evidence in terms of their contribution to outcome predictions. Over the last few years, vestibulo-ocular motor screening has been recognized as an important component of the concussion evaluation.\(^8\) The cognitive control of eye movements is complicated and utilizes almost half of the brain’s pathways involving the fronto-parietal circuits and subcortical nuclei. These pathways are particularly susceptible to injury in concussion. The Vestibular-Ocular motor screen (VOMS) takes only a few minutes to perform, but provides the clinician with valuable information. The exam accounts for both movement abnormalities and symptom provocation. The VOMS includes the assessment of smooth pursuits which test the ability of the eyes to follow a slow moving target. Horizontal and vertical saccades evaluate the ability of the eyes to move quickly between targets. Convergence measures the ability to view a near target without double vision.\(^6\) Saccades, smooth pursuits and convergence are the most commonly observed abnormalities. Saccades are of particular interest as they have been shown to be abnormal in both subacute and acute mTBI. Abnormalities in these domains are persistent in patients exhibiting slower recovery from concussion.\(^9\) Balance abnormalities are commonly seen in these patients as well. Key features of the balance exam should include gait evaluation, tandem gait, single foot stance (eyes open), single foot stance (eyes closed) and tandem stance (eyes open and closed).\(^6\)

Neuropsychologists who are specialized in concussion evaluation are important members of the multi-disciplinary team and help direct management based on the individual and their pre-injury level of academic functioning. Neuropsychologists evaluate patients to assess memory, attention, reasoning and other cognitive skills. Mood screens, effort testing and reaction times are also evaluated. Results of this evaluation will help identify ongoing cognitive impairments and specify what domains have been most affected. Repeat testing can be useful to document improvement over time.\(^10\) Since standard of care dictates assessing cognitive function in patients with mTBI, in the absence of properly trained neuropsychologists, computerized neurocognitive measures are commonly used as screening tools.

In the child and adolescent, successful return to a learning environment is a precursor to returning to play. Physical activity early on is not prohibited, but formal return to contact activities must be directed by a clinician. A Return to Learn plan is important for patients and families to better understand the gradual advancement in learning. In patients with a slower recovery, individualization of return to school activities is continued through a collaboration between the medical team, neuropsychology, therapy services, school and family. Students with pre-existing academic learning needs may require additional support during recovery. Prolonged absence from school is strongly discouraged and can contribute to increased recovery times. Active participation that does not increase the risk of repeat injury has shown to lead to improved outcomes.\(^1\)

Once the patient is cleared to begin the return to play process by a trained health-care professional, the standard for guiding this process in athletics is the Graduated Return to Sport Strategy.\(^5\) This process should be implemented for all mTBI patients, regardless of mechanism of injury. This graduated protocol recommends progression to the next stage of activity only when the individual is asymptomatic during the previous stage, allowing at least 24 hours between stages.\(^5\) Nurses need to be aware that every state and the District of Columbia have enacted legislation related to how concussions are managed in athletes under the age of 18 and/or participating in school or private sports leagues. In addition, it must be known that:
1. An athlete must be removed immediately from play if a concussion is suspected.
2. The athlete cannot return to play while concussion symptoms are present.
3. Student athletes require approval from a health-care provider in order to return to play.
4. Coaches, students, and parents must receive training in concussion symptoms, treatment and management.

**CLINICAL PRACTICE RECOMMENDATIONS**

To assist healthcare providers, the CDC developed supporting tools and materials, ranging from screening forms to assess young patients, to discharge instructions and recovery tips for parents. These resources help healthcare providers take action to improve the care of young Americans with mTBI. These tools and materials are available at www.cdc.gov/HEADSUP.

In an effort to address issues related to how nurses care, educate, and advocate for the child or adolescent with a concussion, The Society of Pediatric Nurses recommends the following for nurses educating and caring/advocating children and adolescents with concussion/mTBI:

1. Thorough assessment of the patient’s history, including risk factors that may prolong recovery, such as history of previous mTBI, severe symptom burden, learning differences, Attention Deficit Hyperactivity Disorder (ADHD) or Attention Deficit Disorder (ADD), Autism Spectrum Disorder (ASD) and/or mood disorders, and family/social stressors
2. Use of validated, age-appropriate symptom scales
3. Referral to emergency department when necessary
4. Avoidance of routine imaging in patients with mTBI for diagnostic purposes.
5. Provision of education to the family regarding all aspects of recovery.
6. Education of patient/family to ensure patient receives a short period of cognitive brain rest, followed by a graduated entry into school with individualized academic accommodations as well as physical restrictions
7. Recommendation of objective cognitive assessment which may include neuropsychological testing or computer based screening
8. Adherence to a graduated Return to School strategy (Table 1)
9. Adherence to a graduated Return to Sport strategy (Table 2)
10. Promotion of education to schools, communities and coaches regarding the range of concussion symptoms, differences in recovery, risk factors that can prolong recovery and risks associated with returning to play while recovering from mTBI
11. Promotion of the awareness and continued advancement of state laws that improve the management and monitoring of concussions in school age athletes, including the need for laws to extend to private sports organizations

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<th>Level</th>
<th>Description</th>
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<tr>
<td>A</td>
<td>Meta-analysis of multiple controlled studies or meta-synthesis of qualitative studies with results that consistently support a specific action, intervention or treatment</td>
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<tr>
<td>B</td>
<td>Well-designed controlled studies, both randomized and nonrandomized, with results that consistently support a specific action, intervention or treatment</td>
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<tr>
<td>C</td>
<td>Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results</td>
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<tr>
<td>D</td>
<td>Peer reviewed professional organizational standards, with clinical studies to support the recommendations</td>
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Level E  Theory-based evidence from expert opinion or multiple case reports
Level M  Manufacturers’ recommendations only

ATTACHMENT(S)

Table 1 Graduated return-to-school strategy

<table>
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<tr>
<th>Stage</th>
<th>Aim</th>
<th>Activity</th>
<th>Goal of each step</th>
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<tbody>
<tr>
<td>1</td>
<td>Daily activities at home that do not give the child symptoms</td>
<td>Typical activities of the child during the day as long as they do not increase symptoms (e.g., reading, texting, screen time). Start with 5–15 min at a time and gradually build up</td>
<td>Gradual return to typical activities</td>
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<tr>
<td>2</td>
<td>School activities</td>
<td>Homework, reading or other cognitive activities outside of the classroom</td>
<td>Increase tolerance to cognitive work</td>
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<tr>
<td>3</td>
<td>Return to school part-time</td>
<td>Gradual introduction of schoolwork. May need to start with a partial school day or with increased breaks during the day</td>
<td>Increase academic activities</td>
</tr>
<tr>
<td>4</td>
<td>Return to school full time</td>
<td>Gradually progress school activities until a full day can be tolerated</td>
<td>Return to full academic activities and catch up on missed work</td>
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Table 2 Graduated return-to-sport (RTS) strategy

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<tr>
<th>Stage</th>
<th>Aim</th>
<th>Activity</th>
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<tbody>
<tr>
<td>1</td>
<td>Symptom-limited activity</td>
<td>Daily activities that do not provoke symptoms</td>
<td>Gradual reintroduction of work/school activities</td>
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<tr>
<td>2</td>
<td>Light aerobic exercise</td>
<td>Walking or stationary cycling at slow to medium pace. No resistance training</td>
<td>Increase heart rate</td>
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<tr>
<td>3</td>
<td>Sport-specific exercise</td>
<td>Running or skating drills. No head impact activities</td>
<td>Add movement</td>
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<td>4</td>
<td>Non-contact training drills</td>
<td>Harder training drills, eq., passing drills. May start progressive resistance training</td>
<td>Exercise, coordination and increased thinking</td>
</tr>
<tr>
<td>5</td>
<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>6</td>
<td>Return to sport</td>
<td>Normal gameplay</td>
<td></td>
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NOTE: An initial period of 24–48 hours of both relative physical rest and cognitive rest is recommended before beginning the RTS progression.
There should be at least 24 hours (or longer) for each step of the progression. If any symptoms worsen during exercise, the athlete should go back to the previous step.
Resistance training should be added only in the later stages (stage 3 or 4 at the earliest). If symptoms are persistent (e.g., more than 10–14 days in adults or more than 1 month in children), the athlete should be referred to a healthcare professional who is an expert in the management of concussion.

REFERENCES


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