CONCUSSION / MILD TRAUMATIC BRAIN INJURY

Goals and Objectives

Course Description
“Concussion / Mild Traumatic Brain Injury” is a home study continuing education course for rehabilitation professionals. This course presents updated information about minor traumatic brain injuries including sections on neuropathophysiology, symptomology, evaluation, clinical management, return to activity, sports related mTBI, pediatric mTBI, and complications.

Course Rationale
The purpose of this course is to present course participants with current information about concussions / mTBI. A greater understanding of these types of injuries will enable therapists and assistants to provide more effective and efficient care to individuals affected by minor head trauma.

Course Goals and Objectives
Upon completion of this course, the therapist or assistant will be able to:
1. differentiate between mild, moderate, and severe traumatic brain injuries
2. identify the symptoms associated with mild traumatic brain injury
3. outline the components of a thorough concussion assessment
4. demonstrate an understanding of the Acute Concussion Evaluation form
5. identify appropriate interventions for common mTBI symptoms
6. identify the role physical rehabilitation plays in recovery
7. outline the parameters that guide an individual's return to activity after mTBI
8. demonstrate an understanding of the SCAT2 for use with sports related mTBI
9. identify the unique issues associated with pediatric mTBI
10. identify common communication challenges experienced by individuals with mTBI
11. identify sequelae associated with post-concussion syndrome

Course Instructor
Michael Niss, DPT

Target Audience
Physical therapists, physical therapist assistants, occupational therapists, and occupational therapist assistants interested in increasing their knowledge about mild traumatic brain injury.

Course Educational Level
This course is applicable for introductory learners.

Course Prerequisites
None

Criteria for issuance of Continuing Education Credits
A documented score of 70% or greater on the written post-test.

Continuing Education Credits
Four (4) hours of continuing education credit (4 NBCOT PDUs/4 contact hours)
AOTA - .4 AOTA CEU, Cat 1: Domain of OT – Client Factors, Context; Cat 2: OT Process - Eval

Determination of Continuing Education Contact Hours
“Concussion / Mild Traumatic Brain Injury” has been established as a 4 hour continuing education program. This determination is based on an accepted standard for home-based self-study courses of 10-12 pages of text (12 pt font) per hour. The complete instructional text for this course is 50 pages (excluding References and Post-Test).

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# Concussion / Mild Traumatic Brain Injury

## Outline

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Overview

The Centers for Disease Control and Prevention (CDC) has estimated that each year, approximately 1.5 million Americans survive a traumatic brain injury (TBI), among whom approximately 230,000 are hospitalized. Approximately 50,000 Americans die each year following traumatic brain injury, representing one third of all injury-related deaths. The leading causes of TBI are falls (28%), motor vehicle-traffic accidents (20%), struck by/against events (19%) and assaults (11%). It is estimated that of the total reported TBIs, the vast majority (75%-90%) of these fit the categorization of concussion/mild-TBI (the terms concussion and mTBI can be used interchangeably). Approximately ninety percent (90%) of these follow a predictable course and experience few, if any, ongoing symptoms and do not require any special medical treatment. More than 1.1 million patients with mTBI are treated and released from an emergency department each year. Only a small sub-set of these patients (10%) experience post-injury symptoms of a long lasting nature.

Definition of Traumatic Brain Injury

A traumatically induced structural injury and/or physiological disruption of brain function as a result of an external force that is indicated by new onset or worsening of at least one of the following clinical signs, immediately following the event:

- Any period of loss of or a decreased level of consciousness (LOC)
- Any loss of memory for events immediately before or after the injury (post-traumatic amnesia)
- Any alteration in mental state at the time of the injury (confusion, disorientation, slowed thinking, etc.)
- Neurological deficits (weakness, loss of balance, change in vision, praxis, paresis/plegia, sensory loss, aphasia, etc.) that may or may not be transient.
- Intracranial lesion.

External forces may include any of the following events: the head being struck by an object, the head striking an object, the brain undergoing an acceleration/deceleration movement without direct external trauma to the head, a foreign body penetrating the brain, forces generated from events such as a blast or explosion, or other forces yet to be defined.

The above criteria define the event of a TBI. Not all individuals exposed to an external force will sustain a TBI, but any person who has a history of such an event with immediate manifestation of any of the above signs and symptoms can be said to have had a TBI.
Classification of Brain Injury

TBI is further categorized as to severity into mild, moderate, or severe based on the length of loss of consciousness (LOC), Alteration of consciousness (AOC), or post-traumatic amnesia (PTA). Acute injury severity is determined at the time of the injury.

The patient is classified as mild/moderate/severe if s/he meets any of the criteria within a particular severity level. If a patient meets criteria in more than one category of severity, the higher severity level is assigned.

Classifications

Mild
- Loss of consciousness - < 30 minutes
- Alteration of consciousness - < 24 hours
- Post-traumatic amnesia – 0-1 days
- Glasgow Coma Scale (GCS) – 13-15

Moderate
- Loss of consciousness - 30 minutes – 24 hours
- Alteration of consciousness - > 24 hours
- Post-traumatic amnesia – 1-7 days
- Glasgow Coma Scale – 9-12

Severe
- Loss of consciousness - >24 hours
- Alteration of consciousness - > 24 hours
- Post-traumatic amnesia – >7 days
- Glasgow Coma Scale – <9

The Significance of Loss of Consciousness
In the overall management of moderate to severe traumatic brain injury, duration of loss of consciousness (LOC) is an acknowledged predictor of outcome. While LOC is associated with specific early cognitive deficits, it has not been noted as a measure of injury severity.

The Significance of Amnesia and Other Symptoms
There is renewed interest in the role of posttraumatic amnesia and its role as a surrogate measure of injury severity. Evidence suggests that the nature, burden, and duration of the clinical post-concussive symptoms may be more important than the presence or duration of amnesia alone. Further, it must be noted that retrograde amnesia varies with the time of measurement post-injury and, hence, is poorly reflective of injury severity.
Motor and Convulsive Phenomena
A variety of immediate motor phenomena (e.g., tonic posturing) or convulsive movements may accompany a concussion. Although dramatic, these clinical features are generally benign and require no specific management beyond the standard treatment of the underlying concussive injury.

The severity level has prognostic value, but does not necessarily predict the patient’s ultimate level of functioning. There is substantial evidence that the epidemiology, pathophysiology, natural history, and prognosis for concussion/mTBI are different than for moderate and severe TBI. For example, moderate and severe TBI are often associated with objective evidence of brain injury on brain scan or neurological examination (e.g., neurological deficits) and objective deficits on neuropsychological testing, whereas these evaluations are frequently not definitive in persons with concussion/mTBI. The natural history and prognosis of moderate and severe TBI are much more directly related to the nature and severity of the injury in moderate and severe TBI, whereas factors unrelated to the injury (such as co-existing mental disorders) have been shown to be the strong predictors of symptom persistence after a concussion/mTBI.

Neuropathophysiology
Unlike more severe TBIs, the disturbance of brain function from mTBI is related more to dysfunction of brain metabolism rather than to structural injury or damage. The current understanding of the underlying pathology of mTBI involves a paradigm shift away from a focus on anatomic damage to an emphasis on neuronal dysfunction involving a complex cascade of ionic, metabolic and physiologic events.

The primary elements of the pathophysiologic cascade include abrupt neuronal depolarization, release of excitatory neurotransmitters, ionic shifts, changes in glucose metabolism, altered cerebral blood flow, and impaired axonal function. (Giza, 2001)

Clinical signs and symptoms of mTBI such as poor memory, speed of processing, fatigue, and dizziness result from this underlying neurometabolic cascade.

Symptomology
Symptoms Associated with Concussion/mTBI
Concussion/mTBI is associated with a variety of symptoms that will manifest immediately following the event, and may resolve quickly, within minutes to hours
after the injury event, or they may persist longer. The most typical signs and symptoms after concussion fall into one or more of the following three categories:

a. **Physical**: headache, nausea, vomiting, dizziness, fatigue, blurred vision, sleep disturbance, sensitivity to light/noise, balance problems, transient neurological abnormalities

b. **Cognitive**: attention, concentration, memory, speed of processing, judgment, executive function

c. **Behavioral/emotional**: depression, anxiety, agitation, irritability, impulsivity, aggression.

Signs and symptoms may occur alone or in varying combinations and may result in functional impairment.

Although a variety of symptoms can occur in association with TBI, they are not part of the definition of TBI, and there are no pathognomonic symptoms or signs. The term “mild TBI” refers only to the initial injury severity and should not be interpreted referring to the level of the severity of the symptoms.

Signs and symptoms, following the concussion, should not be attributed to concussion/mTBI if they are better explained by pre-existing conditions or other medical, neurological, or psychological causes except in cases of an immediate exacerbation of a pre-existing condition.

Symptoms associated with concussion/mTBI are not unique. These symptoms occur frequently in day-to-day life among healthy individuals and are often found in persons with other conditions such as chronic pain, depression or other traumatic injuries. These symptoms are also common to any number of pre-existing/pre-morbid conditions the patient may have had.

Each patient tends to exhibit a different mix of symptoms and the symptoms themselves are highly subjective in nature. Research studies do not offer strong support for a consistent pattern of the types of symptoms occurrence and resolution following mild TBI. Symptoms do not appear to cluster together in a uniform, or even in a consistent expected trend. The presence of somatic symptoms is not linked predictably to the presence of neuropsychiatric (i.e., cognitive, emotional, or behavioral) symptoms, and the neuropsychiatric consequences of mTBI are not linked consistently to one another. Additionally, there is little evidence of coupling of symptom resolution following mTBI.

Posttraumatic complaints after concussion/mTBI are not well understood. This ambiguity can be further attributed to:

- Issues associated with delays in seeking treatment.
- Providers’ lack of knowledge about the detection and diagnosis of mTBI.
Symptom overlap with other diagnoses or conditions
Patients seeking benefit from litigation claims
Underlying mood disorder

Unfortunately, there are no sensitive diagnostic tools or biochemical markers that correlate uniquely to concussion/mTBI symptom reports.

The following physical findings, signs and symptoms ("Red Flags") may indicate an acute neurologic condition that requires urgent specialty consultation (neurology, neuro-surgical):

- Altered consciousness
- Progressively declining neurological examination
- Pupillary asymmetry
- Seizures
- Repeated vomiting
- Double vision
- Worsening headache
- Cannot recognize people or is disoriented to place
- Behaves unusually or seems confused and irritable
- Slurred speech
- Unsteady on feet
- Weakness or numbness in arms / legs

Clinical Assessment

Although the initial part of the screening process for mild TBI depends on self-report, the second-level assessment relies on obtaining a careful detailed medical history, physical examination, and a psychosocial assessment. The goal of the assessment is to evaluate the symptoms in order to optimize care, to improve outcomes, and ultimately reduce disability following a concussion/mTBI.

It is recognized that patients may not present for medical care immediately following concussion/mTBI. Therefore, the purpose of the assessment may vary slightly based on the timing of the presentation following injury. For patients presenting immediately after the injury event, assessment will include the necessity to rule out neurosurgical emergencies. In patients who present with delayed injury-to-assessment intervals, the assessment will include confirmation linking the symptoms to the concussive event. Regardless of the time that has elapsed since injury, management should begin with the patient’s first presentation for treatment.
History

Taking an accurate history is an essential part of the diagnostic work-up. The first and most critical step in the evaluation of persons with possible concussion symptoms should clearly characterize the initial injury and determine whether the symptoms are temporally related to the event characterized as a concussion/mTBI.

Medical history should include the following:

a. Obtaining detailed information on the patient's symptoms and health concerns.

b. Obtaining detailed information of the injury event including mechanism of injury, duration and severity of alteration of consciousness, immediate symptoms, symptom course and prior treatment.

c. Screening for pre-morbid conditions, potential co-occurring conditions or other psychosocial risk factors, such as substance use disorders that may exacerbate or maintain current symptom presentation.

d. Evaluating signs and symptoms indicating potential for neurosurgical emergencies that require immediate referrals.

Physical Examination

The physical examination of the person sustaining a concussion/mTBI should focus on the following:

a. A focused neurologic examination, including a Mental Status Examination (MSE), cranial nerve testing, extremity tone testing, deep tendon reflexes, strength, sensation, and postural stability (Romberg’s Test, dynamic standing).

b. A focused vision examination including gross acuity, eye movement, binocular function and visual fields/attention testing.

c. A focused musculoskeletal examination of the head and neck, including range of motion of the neck and jaw, and focal tenderness and referred pain.

Imaging

Neuroimaging is not recommended in patients who sustained a concussion/mTBI beyond the emergency phase (72 hours post-injury) except if the condition deteriorates or red flags are noted.

The role of neuroimaging in diagnosing concussion/mTBI continues to evolve and be debated in the literature. Various neuroimaging modalities can be employed in helping to identify structural neuropathology. Structural imaging modalities include Computed Tomography (CT) Scan, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), and Functional Magnetic Resonance Imaging (fMRI).
Imaging (MRI) Diffusion Tensor Imaging (DTI). Functional imaging modalities include Single Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET) and functional MRI (fMRI). However, many of these modalities are still at the preliminary/research stage of development. Currently, CT scan is the modality of choice as a diagnostic tool for acute concussion/mTBI. The absence of abnormal findings on CT does not preclude the presence of concussion/mTBI.

A patient who presents with any signs or symptoms that may indicate an acute neurologic condition that requires urgent intervention should be referred for evaluation that may include neuroimaging studies.

In general, structural imaging techniques play a role in acute diagnosis and management, while functional imaging techniques are being evaluated in an attempt to clarify the pathophysiology, symptom genesis and mechanism of recovery from concussion/mTBI. The primary objective of the initial clinical evaluation of patients sustaining a concussion/mTBI is the immediate detection of any neurological deterioration. In particular, patients who exhibit a declining neurologic status, including progressive lethargy, pupillary dilatation, or focal neurologic deficit not explained by systemic sources, should have an urgent CT scanning and neurosurgical consultation. Patients with signs and symptoms indicating an acute neurologic condition should be referred for urgent evaluation.

After a concussion/mTBI, there is a very small risk of intracranial hematoma. The presence of this potentially fatal complication may become apparent only after there is clinical deterioration. Consequently, a cranial CT may be utilized in the acute evaluation of concussion/mTBI to exclude the possibility of occult hematoma. Other imaging techniques may be used to investigate persistent symptoms and deterioration. The provider requires very clear decision rules for the appropriate use of a CT in the acute evaluation of concussion/mTBI.

**Multiple Concussions**

Some patients presenting for an initial evaluation may report a history of repeated concussions that have worsened their symptoms. The approach of symptom-based assessment and treatment of repeated concussion should be similar to the management of exposure to a single injury.

The evidence is inconsistent regarding whether or not cumulative concussions are associated with worse or longer recovery.

Most studies are based on self-reported data of historical concussions. As a whole, many studies are difficult to interpret because of potential confounders. Some research tools have demonstrated subtle abnormalities in the presence of normal clinical presentations and neuropsychological test performance.
Patient Perception of Symptoms

Patients should be given the opportunity to relate their experiences and complaints at each visit in their own way. Although time-consuming and likely to include much seemingly irrelevant information, this has the advantage of providing considerable information concerning the patient’s intelligence, emotional make-up, and attitudes about their complaints. This also provides patients with the satisfaction that they have been "heard-out" by the clinician, rather than merely being asked a few questions and exposed to a series of laboratory tests.

As the patient relates the history, important nonverbal clues are often provided. The clinician should observe the patient’s attitude, reactions, and gestures while being questioned, as well as his or her choice of words or emphasis. The impact from the symptoms may range from annoying to totally disabling and patient perceptions regarding the cause and impact are important to understand in managing the disorder. Stressors such as occupational and family issues should also be explored.

Acute Concussion Evaluation (ACE)

Diagnosing mTBIs can be challenging as symptoms of mTBI are common to those of other medical conditions (such as post-traumatic stress disorder [PTSD], depression, and headache syndromes), and the onset and/or recognition of symptoms may occur days or weeks after the initial injury. Currently, diagnosis of concussion/mTBI is based primarily on the characteristics of the injury event and not by the severity of symptoms at random points after the trauma. A systematic assessment of the injury and its manifestations is essential to proper management and reduced morbidity.

The Acute Concussion Evaluation (ACE) form was developed to provide clinicians with an evidence-based protocol to conduct an initial evaluation and diagnosis of patients (both children and adults) with known or suspected mTBI.

The ACE can also be used serially to track symptom recovery over time. It provides a systematic protocol for assessing the key components for diagnosing an mTBI and serves as the basis for management and referral recommendations provided by the ACE Care Plan. These tools were developed to provide clinicians with a more individualized assessment of mTBI and to help guide the management and recovery, as well as the referral of patients with such injuries.

The ACE contains three major components that require evaluation:

- Characteristics of the injury;
- Types and severity of the symptoms; and
- Risk factors that can lead to a protracted period of recovery.
The ACE should be administered to patients for whom concussion is clearly indicated (e.g., loss of consciousness or change in mental status, confusion or amnesia) and to those for whom concussion should be suspected (e.g., other traumatic injuries are observed or reported; forcible blow to the head with functional changes).

For example, concussions are often not recognized among children with orthopedic injuries. Clinicians should consider screening for possible concussion among patients with various other types of injuries such as:

- High-speed activities (motor vehicle crashes, bicycle riding, skateboarding)
- Sports and recreation activities
- Falls (including those among older adults), especially from a significant distance (e.g., off a ladder, from a tree)
- Suspected child maltreatment (e.g., shaking, hitting, throwing)
- Exposure to blasts (includes military personnel returning from war zones)
- Injuries to the external parts of the head and/or scalp (e.g., lacerations)

The following summarizes the information contained on the ACE and outlines steps for assessing a patient with a known or suspected mTBI.

**Injury Characteristics**

1. **Injury Description.** Ask the patient (and/or parent, if child) about how the injury occurred, type of force, and location on the head or body where the force (blow) was received. Different biomechanics of injury may result in varied symptom patterns. For example, an injury that occurs to the posterior aspect of the head may result in visual changes, balance problems, and fatigue.

2. **Cause.** The cause of the injury may also help to estimate the force of the hit or blow the patient sustained. The greater the force associated with the injury, the more likely the patient will present with more severe symptoms. Conversely, significant symptoms associated with a relatively light force might indicate an increased vulnerability to mTBI (especially among patients with a history of multiple mTBIs or preexisting history of migraine) or the presence of other physical or psychological factors contributing to symptom exacerbation.

3. **Amnesia (Retrograde).** Determine whether amnesia (memory loss) has occurred for events before the injury and attempt to determine the length of time of memory dysfunction. Research indicates that even seconds of amnesia may predict more serious injury.
4. **Amnesia (Anterograde).** Determine whether amnesia has occurred for events after the injury and attempt to determine the length of time of memory dysfunction. Anterograde amnesia is also referred to as post-traumatic amnesia (PTA).

5. **Loss of Consciousness (LOC).** Inquire whether LOC occurred or was observed and the length of time the patient lost consciousness. (Up to 90% of concussions do not involve LOC.)

6. **Early Signs Observed by Others.** Ask those who know the patient (parent, spouse, friend, etc) about specific signs of the mTBI that they may have observed. These signs are typically observed early after the injury.

7. **Seizures.** Inquire whether seizures were observed (although this is uncommon).

**Symptom Check List**

Record the presence and severity of physical, cognitive, emotional, and sleep symptoms and the early signs since the injury.

1. **Signs and Symptoms.** Use the ACE to record symptoms reported by the patient (and/or parent, if child) in each of the four symptom areas (physical, cognitive, emotional, and sleep). Determine if each symptom is present. If not present, circle “0” for No. If symptom is present (within the past 24 hours), circle “1” for Yes. Since symptoms can be present prior to the injury (e.g., inattention, headaches), it is important to assess any changes from usual symptom presentation. Sum the total number of symptoms for each of the four symptom areas and for the Total Symptom Score. Any Total Symptom Score greater than “0” indicates a positive symptom profile. (Note: any presentation of lingering and/or persistent symptoms associated with mTBI indicates incomplete recovery and prudent management is indicated, especially pertaining to activities such as work, school, and sports.)

2. **Exertion.** Inquire whether any symptoms worsen with exertion, that is, with physical activity (e.g., running, climbing stairs, bike riding) and/or cognitive activity (e.g., academic studies, multi-tasking at work, reading or other tasks requiring focused concentration). Clinicians should be aware that symptoms will typically worsen or re-emerge with exertion, indicating incomplete recovery, which may also be protracted with over-exertion.

3. **Overall “Difference” Rating.** Obtain an overall rating from the patient (and/or parent, if child) regarding their overall perceived change from their pre-injury self. This rating is helpful in summarizing the overall impact of the symptoms. Use the 7 point scale with “0” reflecting no change from normal, to “6” reflecting a major change.
Concussion / Mild Traumatic Brain Injury

ACUTE CONCUSSION EVALUATION (ACE)  
PHYSICIAN/CLINICIAN OFFICE VERSION

Gerard Gioia, PhD & Micky Collins, PhD  
Children’s National Medical Center  
University of Pittsburgh Medical Center

A. Injury Characteristics  
Date/Time of Injury:  
Reporter: __ Patient  __ Parent  __ Spouse  __ Other  

1. Injury Description:  

1a. Is there evidence of a forcible blow to the head (direct or indirect)?  
   Yes  No  Unknown  

1b. Is there evidence of intracranial injury or skull fracture?  
   Yes  No  Unknown  

1c. Location of impact: __ Frontal  __ Lt Temporal  __ Rt Temporal  __ Lt Parietal  __ Rt Parietal  __ Occipital  __ Neck  __ Indirect Force  

2. Cause: MVC  __ Pedestrian-MVC  __ Fall  __ Assault  __ Sports (specify)  __ Other  

3. Amnesia Before (Retrograde): Are there any events just BEFORE the injury that you/your person has no memory of (even brief)?  
   Yes  No  Duration  

4. Amnesia After (Anterograde): Are there any events just AFTER the injury that you/your person has no memory of (even brief)?  
   Yes  No  Duration  

5. Loss of Consciousness: Did you/your person lose consciousness?  
   Yes  No  Duration  

6. EARLY SIGNS: __ Appears dazed or stunned  __ Is confused about events  __ Answers questions slowly  __ Repeats Questions  __ Forgetful (recent info)  

7. Seizures: Were seizures observed?  
   No  Yes  Details  

B. Symptom Check List: Since the injury, has the person experienced any of these symptoms any more than usual today or in the past day? Indicate presence of each symptom (0=No, 1=Yes).

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<td>0 1</td>
<td>Drowsiness</td>
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<td>Feeling slowed down</td>
<td>0 1</td>
<td>Sleeping less than usual</td>
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<tr>
<td>Vomiting</td>
<td>0 1</td>
<td>Difficulty concentrating</td>
<td>0 1</td>
<td>Sleeping more than usual</td>
</tr>
<tr>
<td>Balance problems</td>
<td>0 1</td>
<td>Difficulty remembering</td>
<td>0 1</td>
<td>Trouble falling asleep</td>
</tr>
<tr>
<td>Dizziness</td>
<td>0 1</td>
<td>COGNITIVE Total (0-4)</td>
<td></td>
<td>SLEEP Total (0-4)</td>
</tr>
<tr>
<td>Visual problems</td>
<td>0 1</td>
<td>EMOTIONAL (4)</td>
<td></td>
<td>Exertion: Do these symptoms worsen with:</td>
</tr>
<tr>
<td>Fatigue</td>
<td>0 1</td>
<td>Irritability</td>
<td>0 1</td>
<td>Physical Activity  Yes  No  N/A</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0 1</td>
<td>S darkness</td>
<td>0 1</td>
<td>Cognitive Activity  Yes  No  N/A</td>
</tr>
</tbody>
</table>
| Sensitivity to noise | 0 1 | More emotional        | 0 1 | Overall Rating: How different is the person acting compared to his/her usual self? (circle)
| Numbness/Tingling | 0 1 | Nervousness           | 0 1 | Normal 0 1 2 3 4 5 6 Very Different |
| PHYSICAL Total (0-10) | | EMOTIONAL Total (0-4) |   |
| (Add Physical, Cognitive, Emotional, Sleep totals) | Total Symptom Score (0-22) |

C. Risk Factors for Protracted Recovery (check all that apply)

| Concussion History? Y  N  
| Previous # 1 2 3 4 5 6 7  
| Longest symptom duration | Days__ Weeks__ Months__ Years__ |
| Headache History? Y  N  
| History of migraine headache  
| Personal  
| Family  
| If multiple concussions, less force caused reinjury?  Y  N  
| If multiple concussions, less force caused reinjury?  Y  N  
| If multiple concussions, less force caused reinjury?  Y  N  

List other comorbid medical disorders or medication usage (e.g., hypertension, seizures).

D. RED FLAGS for acute emergency management: Refer to the emergency department with sudden onset of any of the following:

- Headaches that worsen
- Looks very drowsy can’t be awakened
- Can’t recognize people or places
- Neck pain
- Seizures
- Repeated vomiting
- Increasing confusion or irritability
- Unusual behavioral change
- Focal neurologic signs
- Slurred speech
- Weakness or numbness in arms/legs
- Change in state of consciousness

E. Diagnosis (ICD): __ Concussion w/o LOC 850.0  
   __ Concussion w/ LOC 850.1  
   __ Concussion (Unspecified) 850.9  
   __ Other 854  
   _ No diagnosis _

F. Follow-Up Action Plan: Complete ACE Care Plan and provide copy to patient/family.  
   __ Follow-Up Needed  
   __ Physician/clinician office monitoring: Date of next follow-up  
   __ Referral:  
   __ Neuropsychological testing  
   __ Physician: Neurology  
   __ Neurosurgery  
   __ Neurology  
   __ Sports Medicine  
   __ Psychiatrist  
   __ Other  
   __ Emergency Department  

ACE Completed by: ____________  
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A concussion (or mild traumatic brain injury [MTBI]) is a complex pathophysiologic process affecting the brain, induced by traumatic biomechanical forces secondary to direct or indirect forces to the head. Disturbance of brain function is related to neurometabolic dysfunction, rather than structural injury, and is typically associated with normal structural neuroimaging findings (i.e., CT scan, MRI). Concussion may or may not involve a loss of consciousness (LOC). Concussion results in a constellation of physical, cognitive, emotional, and sleep-related symptoms. Symptoms may last from several minutes to days, weeks, months or even longer in some cases.

ACE Instructions

The ACE is intended to provide an evidence-based clinical protocol to conduct an initial evaluation and diagnosis of patients (both children and adults) with known or suspected MTBI. The research evidence documenting the importance of these components in the evaluation of an MTBI is provided in the reference list.

A. Injury Characteristics:

1. Obtain description of the injury – how injury occurred, type of force, location on the head or body (if force transmitted to head). Different biomechanics of injury may result in differential symptom patterns (e.g., occipital blow may result in visual changes, balance difficulties).

2. Indicate the cause of the injury. Greater forces associated with the traumatic brain injuries are likely to result in more severe presentation of symptoms.

3. Amnesia: Amnesia is defined as the failure to form new memories. Determine whether amnesia has occurred and attempt to determine length of time of memory dysfunction – before (retrograde) and after (anterograde) injury. Even seconds to minutes of memory loss can be predictive of outcome. Recent research has indicated that amnesia may be up to 4-10 times more predictive of symptoms and cognitive deficits following concussion than LOC (losses less than 1 minute).5

4. Loss of consciousness (LOC) – If occurs, determine length of LOC.

5. Early signs: If present, ask the individual who knows the patient (parent, spouse, friend, etc.) about specific signs of the concussion that may have been observed. These signs are typically observed early after the injury.

6. Inquire whether seizures were observed or not.

B. Symptom Checklist:

1. Take patient (and/or parent, if child) to report presence of the four categories of symptoms since injury. It is important to assess all listed symptoms as different parts of the brain control different functions. One or all symptoms may be present depending upon mechanisms of injury.6 Record “1” for Yes or “0” for No for their presence or absence, respectively.

2. For all symptoms, indicate presence of symptom as experienced within the past 24 hours. Since symptoms can be present at any time after injury, it is important to assess change from their usual presentation.

3. Scoring: Sum total number of symptoms present per area, and sum all four areas into Total Symptom Score (score range 0-22). (Note: Most sleep symptoms are only applicable after a night has passed since the injury. Drowsiness may be present on the day of injury. If symptoms are now and present, there is no lower limit symptom score. Any score >2 indicates positive symptom history.

4. Exertion: Inquire whether any symptoms worsen with physical (e.g., running, climbing stairs, bike riding) and/or cognitive (e.g., academic studies, multi-tasking at work, reading) or other tasks requiring focused concentration exertion. Clinicians should be aware that symptoms will typically worsen or re-emerge with exertion, indicating incomplete recovery. Over-exertion may protract recovery.

5. Overall Rating: Determine how different the person is from their usual self. Circle “0” (Normal) to “6” (Very Different).

C. Risk Factors for Protracted Recovery:

1. Concussion history: Assess the number and date(s) of prior concussions, the duration of symptoms for each injury, and whether less biomechanical forces resulted in the current injury. Research indicates that cognitive and symptom effects of concussion may be cumulative, especially if there is minimal duration of time between injuries and less biomechanical force results in subsequent concussion (which may indicate incomplete recovery from initial trauma).7

2. Headache history: Assess personal and/or family history of diagnosis/treatment for headaches. Research indicates headache (migraine in particular) can result in protracted recovery from concussion.8-10

3. Developmental history: Assess history of learning disabilities, Attention-Deficit/Hyperactivity Disorder or other developmental disorders. Research indicates that there is the possibility of a longer period of recovery with these conditions. Consultation with a psychologist to review this is recommended.

4. Psychiatric history: Assess for history of depression/mood disorder, anxiety, and/or sleep disorder.11-13

D. Red Flags: The patient should be carefully observed over the first 24-48 hours for these serious signs. Red flags are to be assessed as possible signs of deteriorating neurological functioning. Any positive result should prompt strong consideration of referral for emergency medical evaluation (e.g., CT scan to rule out intracranial bleed or other medical pathology).14

E. Diagnosis: The following ICD diagnostic codes may be applicable.

850.0 (Concussion, with no loss of consciousness) – Positive injury description with evidence of forcible direct/indirect blow to the head (A1a), plus evidence of active symptoms (B) of any type and number related to the trauma (Total Symptom Score >0); no evidence of LOC (A5), skull fracture or intracranial injury (A1b).

850.1 (Concussion, with brief loss of consciousness < 1 hour) – Positive injury description with evidence of forcible direct/indirect blow to the head (A1a); plus evidence of active symptoms (B) of any type and number related to the trauma (Total Symptom Score >0); positive evidence of LOC (A5), skull fracture or intracranial injury (A1b).

850.9 (Concussion, unspecified) – Positive injury description with evidence of forcible direct/indirect blow to the head (A1a); plus evidence of active symptoms (B) of any type and number related to the trauma (Total Symptom Score >0); unclear/unknown injury details; unclear evidence of LOC (A5), no skull fracture or intracranial injury.

Other Diagnoses: If the patient presents with a positive injury description and associated symptoms, but additional evidence of intracranial injury (A1b) such as from neuroimaging, a moderate TBI and the diagnostic category of E54 (intracranial injury) should be considered.

F. Follow-Up Action Plan: Develop a follow-up plan of action for symptomatic patients. The physician/clinician may decide to (1) monitor the patient in the office or hospital (2) refer them to a specialist. Serial evaluation of the concussion is critical as symptoms may resolve, worsen, or ebb and flow depending upon many factors (e.g., cognitive/physical exertion, comorbidities). Referral to a specialist can be particularly valuable to help manage certain aspects of the patient's condition. (Physician/Clinician should also complete the ACE Care Plan included in this tool kit.)

1. Physician/Clinician serial monitoring – Particularly appropriate if number and severity of symptoms are steadily decreasing over time and for fully resolve within 3-5 days. If steady resolution is not evident, referral to a specialist is warranted.

2. Referral to a specialist – Appropriate if symptom reduction is not evident in 3-5 days, or sooner if symptom profile is concerning in terms of severity.

Neurocognitive/Neuropsychological Testing can provide valuable information to help assess the patient's brain function and impairment and assist with treatment planning, such as return to play decisions.

Physicians specializing in sports medicine or specific conditions related to concussion management are particularly relevant for medical evaluation and management of concussion. It is also critical for evaluating and managing focal neurologic, sensory, vestibular, and motor concerns. It may be useful for medication management (e.g., headaches, sleep disturbance, depression) if post-concussive problems persist.

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Concussion / Mild Traumatic Brain Injury

ACUTE CONCUSSION EVALUATION (ACE)
CARE PLAN
Gerard Gioia, PhD & Micky Collins, PhD
*Children’s National Medical Center
*University of Pittsburgh Medical Center

You have been diagnosed with a concussion (also known as a mild traumatic brain injury). This personal plan is based on your symptoms and is designed to help speed your recovery. Your careful attention to it can also prevent further injury.

REST IS THE KEY. You should not participate in any high risk activities (e.g., sports, physical education (PE), riding a bike, etc.) if you still have any of the symptoms below. It is important to limit activities that require a lot of thinking or concentration (homework, job-related activities), as this can also make your symptoms worse. If you no longer have any symptoms and believe that your concentration and thinking are back to normal, you can slowly and carefully return to your daily activities. Children and teenagers will need help from their parents, teachers, coaches, or athletic trainers to help monitor their recovery and return to activities.

Today the following symptoms are present (circle or check).

| Physical          | Thinking                      | Emotional                   | Sleep            |
|-------------------|------------------------------|                            |                  |
| Headaches         | Sensitivity to light         | Feeling mentally foggy     | Irritability     |
| Nausea            | Sensitivity to noise         | Problems concentrating     | Sadness          |
| Fatigue           | Numbness/Tingling            | Problems remembering      | Feeling more emotional |
| Visual problems   | Vomiting                     | Feeling more slowed down   | Nervousness       |
| Balance Problems  | Dizziness                    | Drowsiness                 |                  |

RED FLAGS: Call your doctor or go to your emergency department if you suddenly experience any of the following:

| Headaches that worsen | Look very drowsy, can’t be awakened | Can’t recognize people or places | Unusual behavior change |
| Seizures             | Repeated vomiting               | Increasing confusion         | Increasing irritability |
| Neck pain            | Slurred speech                  | Weakness or numbness in arms or legs | Loss of consciousness |

Returning to Daily Activities

1. Get lots of rest. Be sure to get enough sleep at night- no late nights. Keep the same bedtime weekdays and weekends.
2. Take daytime naps or rest breaks when you feel tired or fatigued.
3. Limit physical activity as well as activities that require a lot of thinking or concentration. These activities can make symptoms worse.
   - Physical activity includes PE, sports practices, weight-training, running, exercising, heavy lifting, etc.
   - Thinking and concentration activities (e.g., homework, classwork load, job-related activity).
4. Drink lots of fluids and eat carbohydrates or protein to main appropriate blood sugar levels.
5. As symptoms decrease, you may begin to gradually return to your daily activities. If symptoms worsen or return, lessen your activities, then try again to increase your activities gradually.
6. During recovery, it is normal to feel frustrated and sad when you do not feel right and you can’t be as active as usual.
7. Repeated evaluation of your symptoms is recommended to help guide recovery.

Returning to School

1. If you (or your child) are still having symptoms of concussion you may need extra help to perform school-related activities. As your (or your child’s) symptoms decrease during recovery, the extra help or supports can be removed gradually.
2. Inform the teacher(s), school nurse, school psychologist or counselor, and administrator(s) about your (or your child’s) injury and symptoms. School personnel should be instructed to watch for:
   - Increased problems paying attention or concentrating
   - Increased problems remembering or learning new information
   - Longer time needed to complete tasks or assignments
   - Greater irritability, less able to cope with stress
   - Symptoms worsen (e.g., headache, tiredness) when doing schoolwork

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Returning to School (Continued)

Until you (or your child) have fully recovered, the following supports are recommended: (check all that apply)

- No return to school. Return on (date)______________________________
- Return to school with following supports. Review on (date)______________________________
- Shortened day. Recommend ___ hours per day until (date)______________________________
- Shortened classes (i.e., rest breaks during classes). Maximum class length: _____ minutes.
- Allow extra time to complete coursework/assignments and tests.
- lessen homework load by ______%. Maximum length of nightly homework: ______ minutes.
- No significant classroom or standardized testing at this time.
- Check for the return of symptoms (use symptom table on front page of this form) when doing activities that require a lot of attention or concentration.
- Take rest breaks during the day as needed.
- Request meeting of 504 or School Management Team to discuss this plan and needed supports.

Returning to Sports

1. **You should NEVER return to play if you still have ANY symptoms** – (Be sure that you do not have any symptoms at rest and while doing any physical activity and/or activities that require a lot of thinking or concentration.)
2. Be sure that the PE teacher, coach, and/or athletic trainer are aware of your injury and symptoms.
3. It is normal to feel frustrated, sad, and even angry because you cannot return to sports right away. With any injury, a full recovery will reduce the chances of getting hurt again. It is better to miss one or two games than the whole season.

The following are recommended at the present time:

- Do not return to PE class at this time
- Return to PE class
- Do not return to sports practices/games at this time
- **Gradual** return to sports practices under the supervision of an appropriate health care provider (e.g., athletic trainer, coach, or physical education teacher).
  - Return to play should occur in gradual steps beginning with aerobic exercise only to increase your heart rate (e.g., stationary cycle); moving to increasing your heart rate with movement (e.g., running); then adding controlled contact if appropriate; and finally return to sports competition.
  - Pay careful attention to your symptoms and your thinking and concentration skills at each stage of activity. Move to the next level of activity only if you do not experience any symptoms at the each level. If your symptoms return, let your health care provider know, return to the first level, and restart the program gradually.

Gradual Return to Play Plan

1. No physical activity
2. Low levels of physical activity (i.e., symptoms do not come back during or after the activity). This includes walking, light jogging, light stationary biking, light weightlifting (lower weight, higher reps, no bench, no squat).
3. Moderate levels of physical activity with body/head movement. This includes moderate jogging, brief running, moderate-intensity stationary biking, moderate-intensity weightlifting (reduced time and/or reduced weight from your typical routine).
4. Heavy non-contact physical activity. This includes sprinting/running, high-intensity stationary biking, regular weightlifting routine, non-contact sport-specific drills (in 3 planes of movement).
5. Full contact in controlled practice.
6. Full contact in game play.

*Neuropsychological testing can provide valuable information to assist physicians with treatment planning, such as return to play decisions.

This referral plan is based on today’s evaluation:

- Return to this office. Date/Time_______________
- Refer to: Neurology___, Sports Medicine___, Physiatrist____, Psychiatrist____, Other______
- Refer for neuropsychological testing
- Other______

ACE Care Plan Completed by:_________________________ © Copyright G. Glick & M. Collins, 2006
ACUTE CONCUSSION EVALUATION (ACE) CARE PLAN
Gerard Giola, PhD, Micky Collins, PhD
Children's National Medical Center
University of Pittsburgh Medical Center

You have been diagnosed with a concussion (also known as a mild traumatic brain injury). This personal plan is based on your symptoms and is designed to help speed your recovery. Your careful attention to it can also prevent further injury.

**Rest is the key.** You should not participate in any high risk activities (e.g., sports, physical education (PE), riding a bike, etc.) if you still have any of the symptoms below. It is important to limit activities that require a lot of thinking or concentration (homework, job-related activities), as this can also make your symptoms worse. If you no longer have any symptoms and believe that your concentration and thinking are back to normal, you can slowly and carefully return to your daily activities. Children and teenagers will need help from their parents, teachers, coaches, or athletic trainers to help monitor their recovery and return to activities.

**Today the following symptoms are present (circle or check).**

<table>
<thead>
<tr>
<th>Physical</th>
<th>Thinking</th>
<th>Emotional</th>
<th>Sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headaches</td>
<td>Sensitivity to light</td>
<td>Feeling mentally foggy</td>
<td>Irritability</td>
</tr>
<tr>
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</tr>
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<td>Vomiting</td>
<td>Feeling more slowed down</td>
<td>Nervousness</td>
</tr>
<tr>
<td>Balance Problems</td>
<td>Dizziness</td>
<td></td>
<td>Drowsiness</td>
</tr>
</tbody>
</table>

**RED FLAGS:** Call your doctor or go to your emergency department if you suddenly experience any of the following:

- Headaches that worsen
- Look very drowsy, can't be awakened
- Can't recognize people or places
- Unusual behavior changes
- Seizures that repeat
- Vomiting
- Increasing confusion
- Increasing irritability
- Neck pain
- Slurred speech
- Weakness or numbness in arms or legs
- Loss of consciousness

**Returning to Daily Activities**

1. Get lots of rest. Be sure to get enough sleep at night- no late nights. Keep the same bedtime weekdays and weekends.
2. Take daytime naps or rest breaks when you feel tired or fatigued.
3. Limit physical activity as well as activities that require a lot of thinking or concentration. These activities can make symptoms worse.
   - Physical activity includes PE, sports practices, weight-training, running, exercising, heavy lifting, etc.
   - Thinking and concentration activities (e.g., homework, classwork load, job-related activity).
4. Drink lots of fluids and eat carbohydrates or protein to maintain appropriate blood sugar levels.
5. As symptoms decrease, you may begin to gradually return to your daily activities. If symptoms worsen or return, lessen your activities, then try again to increase your activities gradually.
6. During recovery, it is normal to feel frustrated and sad when you do not feel right and you can't be as active as usual.
7. Repeat evaluation of your symptoms is recommended to help guide recovery.

**Returning to Work**

1. Planning to return to work should be based upon careful attention to symptoms and under the supervision of an appropriate health care professional.
2. Limiting the amount of work you do soon after your injury, may help speed your recovery. It is very important to get a lot of rest. You should also reduce your physical activity as well as activities that require a lot of thinking or concentration.
   - Do not return to work. Return on (date) ____________________.
   - Return to work with the following supports. Review on (date) ____________________.

<table>
<thead>
<tr>
<th>Schedule Considerations</th>
<th>Safety Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortened work day ___ hours</td>
<td>No driving</td>
</tr>
<tr>
<td>Allow for breaks when symptoms worsen</td>
<td>No heavy lifting or working with machinery</td>
</tr>
<tr>
<td>Reduced task assignments and responsibilities</td>
<td>No heights due to possible dizziness, balance problems</td>
</tr>
</tbody>
</table>

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Treatment

Treatment Plan

After the screening, assessment, and diagnosis of concussion/mTBI are completed decisions are made about treatment. Treatment for patients with concussion/mTBI focuses on symptom management and education of patient and family. Education should emphasize recovery, gradual resumption of work and social responsibilities, and teaching compensatory strategies and environmental modifications. Most patients with symptoms following a single concussion/mTBI of recent onset can be successfully managed without the need for specialty intervention.

Patients should be encouraged to implement changes in life-style including exercise, diet, sleep hygiene, stress reduction, relaxation training, scheduling leisure activities and pacing to improve treatment outcomes.

Early Education

Education provided to patients and their support system about the nature and common manifestations of concussion/mTBI is a critical aspect of intervention. Communication of health information from providers helps manage patient expectations and can prevent the development of concussion/mTBI symptoms and/or reduce their duration, number, and severity. It is generally recommended that the initial educational intervention occur at the time of establishing the concussion/mTBI diagnosis. Follow-up education should take place at intervals and in a format that is appropriate to the treatment and services provided. Additionally, the patient’s learning needs, reading skills, vision or hearing difficulties, cultural and religious beliefs, and emotional or cognitive limitations should be taken into consideration when delivering educational information.

1. Patients who sustain a concussion/mTBI should be provided with information and education about concussion/mTBI symptoms and recovery patterns as soon as possible after the injury. Education should be provided in printed material combined with verbal review and consist of:

- Symptoms and expected outcome
- Normalizing symptoms (education that current symptoms are expected and common after injury event)
- Reassurance about expected positive recovery
- Techniques to manage stress (e.g., sleep education, relaxation techniques; minimize consumption of alcohol, caffeine and other stimulants).

2. Information and education should also be offered to the patient’s family, friends, employers, and/or significant others.
3. Symptomatic management should include tailored education about the specific signs and symptoms that the patient presents and the recommended treatment.

4. Patients should be provided with written contact information and be advised to contact their healthcare provider for follow-up if their condition deteriorates or if symptoms persist for more than 4-6 weeks.

**Early Intervention**

Concussion/mTBI can significantly impact some patients’ physical, mental and social well-being. Treatment should address these three main areas. Initial interventions expected to improve physical well-being include education, improved sleep habits, a graduated exercise regimen (monitored through physical therapy, exercise trainers, and social supports), and medication (monitored by a clinician). Mental well-being may be improved through stress relief and relaxation, medication, and creating a supportive social network. Social well-being may be improved through resolving legal, financial, occupational, or recreational problems.

**Symptom Management**

Concussion/mTBI is associated with a variety of symptoms that will manifest immediately following the event, and may resolve quickly, within minutes to hours after the injury event, or they may persist longer. Signs and symptoms may occur alone or in varying combinations and may result in functional impairment.

There is a complex relationship among concussion/mTBI symptoms (sleep, headache, cognition, and mood) and it is clinically reasonable to expect that alleviating/improving one symptom may lead to improvement in other symptom clusters. The presence of comorbid psychiatric problems such as a major depressive episode, anxiety disorders (including post-traumatic stress disorder [PTSD]), or substance use disorder (SUD) – whether or not these are regarded as etiologically related to the concussion/mTBI – should be treated aggressively using appropriate psychotherapeutic and pharmacologic interventions.

The expected outcome of intervention should be to improve the identified problem areas, rather than discover a disease etiology or “cure.” The persistence of some concussion related symptoms despite the effective treatment for others does not necessarily suggest treatment failure, but may instead indicate the need for additional therapies targeting specific residual symptoms.
Headache

Post-traumatic headaches occur acutely in up to 90% of all individuals who sustain a concussion. Post-traumatic headaches usually develop within 7 days of head trauma. The International Headache Society classification category is headaches associated with head and neck trauma. The category was established because the most frequent forms of head trauma also cause injury to the cervical spinal column, spinal cord and neck musculature. Cervicogenic pain can include headache as well as neck pain. Individuals who sustain head and neck injury can have headaches in which the pain originates from both the head and the neck. Although post-traumatic headaches represent a unique category of headache, they often share features of other types of headaches.

Assessment

Acute assessment focuses on determining if an individual has intracranial pathology as a consequence of the head injury. Include examination of the head and neck; cranial nerve examination including: test of olfaction, funduscopic evaluation, measurement of pupil size and reaction to light, and observation of eye movements. The examination also evaluates muscle strength and tone, gait and upper and lower extremity coordination. Warning signs of intracranial pathology that will require neurosurgical intervention include: drowsiness, impaired motor function (hemiparesis or hemi-ataxia), unsteady gait or inability to stand, vomiting with or without head pain, headache with valsalva maneuvers such as coughing, papilledema or pupil asymmetry of size or reactivity to light. Patients with warning signs of intracranial pathology need to have additional assessment including intracranial imaging.

The lack of sleep can cause or exacerbate headaches and/or light sensitivity as well as problems with many cognitive/emotional functions. Ascertain current sleep/wake cycles and provide counseling regarding appropriate sleep hygiene (limiting use of stimulants, encouraging exercise, reducing pre-sleep stimuli from lights/noise, reducing pre-sleep fluid intake, discouraging naps). Concussion is also associated with impaired sleep; i.e., disturbed abnormal breathing patterns, or disruptions in progression of sleep cycles.

Treatment

A medication review is recommended for people with headaches that have been present for more than two weeks and for individuals with frequent or daily headaches. Chronic use (particularly daily) of non-steroidal anti-inflammatory drugs (NSAIDs) or acetaminophen (alone or combined with caffeine) particularly daily, may lead to rebound headaches that are similar to tension-type headaches in character. Headaches associated with chronic NSAID/acetaminophen usage should be addressed to a headache specialist. Excessive use or rapid withdrawal of caffeine or tobacco can also trigger headaches. Particular caution is required for individuals who have frequent headaches and who state that headaches
Concussion / Mild Traumatic Brain Injury

respond only to opioid medications. Such individuals should be directed to a pain clinic or headache specialist.

Pharmacotherapy and non-pharmacologic treatments to reduce the frequency of headaches and to treat acute headaches are based upon the character of the headaches. Patients who have mixed migraine/tension-like headaches may need treatment for both headache types. Based upon currently available information, most individuals with concussion/mTBI will have improvement in their headaches during the first 3 months of treatment. Consider referring patients who do not respond to treatments to headache specialists or pain treatment programs. It is important to maintain a positive outlook and to encourage active patient ownership and involvement in the care plan. It is also important to recognize co-morbid conditions, especially sleep disorders, anxiety disorders (PTSD) and depression. Treatment of these conditions may also improve headache.

**Pharmacological Treatment** - Episodic tension-type headaches usually respond to non-steroidal anti-inflammatory medications (NSAID) that can be obtained over-the-counter. Unfortunately, tension-type headaches associated with concussion may be resistant to medication alone. Patients may achieve better pain relief if medication treatment is coupled with other treatment modalities such as relaxation training and biofeedback. Patients should be encouraged to engage in physical therapy to exercise neck muscles and maintain appropriate range of motion. Increased physical activity may help to reduce the frequency and intensity of tension headaches. These non-pharmacologic modalities may help patients control or moderate their headaches enabling them to gain control of their pain.

NSAID medications including aspirin, ibuprofen or choline-magnesium-trisalisylate and acetaminophen are the first-line medications for treating tension headaches. The choice of an NSAID or acetaminophen depends upon individual response and severity of side effects. Aspirin is more likely to produce gastrointestinal distress and upper gastrointestinal bleeding than other NSAID medications. Acetaminophen is often the best tolerated in terms of lower likelihood to produce gastrointestinal distress. When used appropriately, side effects with acetaminophen are rare. The most serious side effect is liver damage due to large doses, chronic use or concomitant use with alcohol or other drugs that also damage the liver. Acetaminophen should be avoided in individuals with hepatitis. Choline-magnesium-trisalisylate occasionally provides a good balance of efficacy and reduced likelihood of gastrointestinal distress. Ibuprofen can also be used to treat episodic tension headaches. If patients exhibit gastrointestinal side effects, therapy with proton-pump inhibitors and histamine blockers may be considered. Pain treatment is more likely to be successful if the medication is taken at the onset of a headache rather than waiting for the headache pain to escalate.
Combination medications can be effective in treating episodic tension headaches, but persistent usage can lead to rebound headaches. Aspirin, acetaminophen, or both are often combined with caffeine or a sedative drug in a single medication. Combination drugs may be more effective than NSAIDs or acetaminophen alone. Analgesic-sedative combinations can be obtained only by prescription because they may produce dependency, or trigger addiction in vulnerable individuals. This may lead to chronic daily headache. Combinations of acetaminophen or aspirin and an opioid should be used with great caution. These drugs should not be used more than two days a week due to concern for side effects and the potential for dependency.

Patients who experience more than three tension headaches per week may benefit from prophylactic therapy designed to prevent tension headaches. Poorly controlled tension headaches may indicate that attention should be directed to physical or psychological factors that may be triggering the headaches.

**Dizziness and Disequilibrium**

Dizziness and disequilibrium are common symptoms/signs of many diagnoses, concussion/mTBI being one of them. Dizziness, impaired balance and altered coordination have been reported in as many as 30% of people after mTBI (Cicerone, 1995). Dizziness and disequilibrium disorders that may result from concussion/mTBI can be organized into the following disorders: inner ear disorders (peripheral vestibular disorders), central nervous system disorders, psychological disorders and musculoskeletal disorders.

**Assessment**

Observation and patient interview are key elements to the exam and often guide the clinician in determining the plan of care. Evaluation should include a thorough neurologic examination and the following systems review: vision (acuity, tracking, saccades, nystagmus), auditory (hearing screen, otoscopic exam), sensory (sharp, light touch, proprioception, vibration), motor (power, coordination) and vestibular (dynamic acuity, positional testing). Evaluation of functional activities should include sitting and standing (Romberg with eyes open/closed, single leg stance) balance, transfers (supine↔sit, sit↔stand) and gait (walking, tandem walking, turning).

**Treatment**

**Medication Review** - A detailed medication history is warranted. Numerous medications include dizziness as a potential side effect. The following classes of medication can cause or aggravate dizziness: stimulants, benzodiazepines, tricyclics, monoamine oxidase inhibitors, tetracyclics, neuroleptics, anticonvulsants, selective serotonin agonists, beta blockers and cholinesterase inhibitors. The temporal relationship to the onset of dizziness and the initiation/dosing of these medications should be investigated.
Non-Pharmacologic Treatment - Non-pharmacologic interventions for post-traumatic dizziness may be useful as an alternative to pharmacotherapies, although the effectiveness of such interventions is not fully established with concussion/mTBI. Efficacy of vestibular and balance rehabilitation has been found in different populations with vestibular disorders. Patients with vestibular disorders who received customized programs showed greater improvement than those who received generic exercises. Studies utilizing vestibular exercises have shown up to 85% success rate in reducing symptoms and improving function in the population with peripheral vestibular disorders (Krebs et al, 2003). With concussion/mTBI, recovery of vestibular lesions is often limited or protracted due to the co-existence of central or psychological disorders.

Pharmacologic Treatment - Initiating vestibular suppressants for dizziness may delay central compensation or promote counterproductive compensation. Vestibular suppressants might be helpful during the acute period of several vestibular disorders but have not been shown to be effective in chronic dizziness after concussion. Medications should only be considered if symptoms are severe enough to significantly limit functional activities. Trials should be limited to 2 weeks. With concussion/mTBI, clinicians should be particularly careful regarding dosing and titration due to the effects on arousal and memory as well as potential addictive qualities of these medications. The first line medication choice is meclizine, followed by scopolamine and dimenhydrinate depending upon symptom presentation. Pharmacotherapy with clonazepam, diazepam or lorazepam should be carefully considered due to their sedating and addictive qualities.

Fatigue

Fatigue is the third most common symptom reported in concussion/mTBI. It can be due to a primary effect related to central nervous system dysfunction or a secondary effect such as common co-existing disorders in concussion/mTBI such as depression or sleep disturbances. Medications, substance use and lifestyle may also contribute to fatigue.

Assessment

A detailed history looking at pre/post-injury level of physical activity, cognitive function and mental health is important to determine the effects of fatigue in relation to the injury. The ability to maintain a job is often a good measure of the impact of this symptom. Several outcome measures exist for fatigue and many have been studied in other diagnostic populations. Common measures in TBI include the Multidimensional Assessment of Fatigue (available at: http://www.son.washington.edu/research/maf/protected/MAForiq.doc), Fatigue Impact Scale (FIS) or Fatigue Assessment Instrument (FAI.) For concussion/mTBI there is no specific scale recommended. Laboratory tests may include blood count, metabolic panel, vitamin B12 and folate levels, thyroid function test and Erythrocyte Sedimentation Rate (ESR).
Treatment
Education is important in the treatment of fatigue. Educational efforts should be in the areas of factors contributing to fatigue, importance of well balanced meals, promotion of sleep hygiene and regular exercise. Exercise routines should be individualized to maximize benefit and promote proper ratio of activity/rest. Scheduling of exercise may need to be addressed depending upon when the patient is at his or her best. Cognitive-behavioral and physical therapy can be tried to decrease fatigue level and improve functional performance in patients with concussion/mTBI.

Modifiable factors should be addressed and typical conservative measures taken prior to initiating pharmacotherapy for fatigue. Several stimulants have had success in other disease states associated with fatigue. Although widely used in TBI, there is limited evidence in use of these medications for treatment of fatigue in concussion/mTBI.

Sleep Dysfunction

Sleep disturbance often occurs acutely after concussion. Persistent difficulty falling asleep or staying asleep despite the opportunity (insomnia) is a common symptom of post trauma. Concussion/mTBI might contribute to the emergence of circadian rhythm sleep disorders. Two types of these disorders have been observed: delayed sleep phase syndrome and irregular sleep–wake pattern. Sleep apnea, depression, pain, and other conditions may contribute to the overall poor quality of sleep.

1. Pharmacological approaches to sleep regulation may prove beneficial.
2. Cognitive behavioral sleep interventions have also been shown to be effective in normalizing sleep; these might include sleep restriction, sleep hygiene education, relaxation training and others. The goals of sleep management should be to establish a regular, unbroken, night-time sleep pattern and to improve perceptions of the quality of sleep.
3. If a patient with concussion/mTBI has a concurrent primary sleep disorder (e.g., sleep apnea, restless leg syndrome, or narcolepsy) a specific appropriate intervention may be required.
4. The aim of sleep management is to establish a regular, normalized sleep-wake pattern. Patients should be encouraged to:
   - Avoid alcohol
   - Restrict the night-time sleep period to about eight hours
   - Void going to bed too early in the evening
   - Void stimulants, caffeinated beverages, power drinks, and nicotine during the evening period
   - Rise from bed at a regular time in the morning (e.g., by 8 a.m.)
   - Wake at a regular time in the morning (e.g., 7 a.m.)
   - Reduce (to less than 30 minutes) or abolish daytime naps
Persistent Pain

Pain other than headache pain is common in patients with concussion/mTBI. Musculoskeletal pain is a common comorbid condition in concussion. Evaluating pain and treating it symptomatically is important as pain is associated with poor outcomes in TBI. Pain can be caused by any of a number of co-morbid conditions as well as musculoskeletal injuries or secondary damage to soft tissue.

Assessing patients for pain and its underlying causes is an essential component of the clinical work-up. It is important to attribute symptoms correctly and to identify and treat any comorbid conditions.

Other Symptoms

Vision Difficulties
Vision difficulties, including sensitivity to light, diplopia, blurring and other difficulties seeing, occur acutely in up to half of all individuals who sustain a concussion. Symptoms are either blurring of vision ("double vision") that worsens over the course of the day or difficulty with visual stimulation with resultant pain (headache, eye ache) or sensitivity. The vast majority resolve within a month.

Aggressive, focal treatments aimed at symptom management (reassurance, pain management, controlling environmental light, sunglasses, intermittent patching for double vision) in the first 4-6 weeks are usually effective. True abnormalities in visual acuity, visual fields or structural damage the eye are extremely rare with mTBI. Other causes of problems are also extremely rare and often not related directly to the concussion injury. Pre-injury visual deficits are common and need to be ruled out.

Hearing Difficulties
Hearing difficulties, including altered acuity and sensitivity to noise, occur acutely in up to three-quarters of all individuals who sustain a blast related concussion. Symptoms are either of decreased auditory acuity or sensitivity to noise. The vast majority of those symptoms resolve within a month, unless there is significant or permanent injury to the ear drum.

Aggressive, focal treatments aimed at symptom management (reassurance, pain management, controlling environmental noise, white noise generators) in the first 4-6 weeks are usually effective. True abnormalities in central auditory acuity or processing are extremely rare with mTBI. Other causes of problems are also
extremely rare and often not related directly to the concussion injury. Pre-injury hearing deficits are common and need to be ruled out.

**Smell (Olfactory Deficits)**
Post-traumatic olfactory deficits (anosmia) are not common in individuals who sustain a concussion, occurring in less than 25%. Symptoms are typically seen with a decreased appetite, but this may be a sign of a significant injury to the frontal lobe and other central difficulties must be ruled out. The vast majority resolve within a 6 month period. Treatments have limited effect and are usually aimed at flavoring/spicing food to enhance taste. Other causes are also extremely rare and often not related directly to the concussion injury. Pre-injury causes of anosmia need to be ruled out.

**Changes in Appetite**
Post-traumatic appetite deficits are not common in individuals who sustain a concussion, occurring in less than 5%. When a change in appetite is noted, it may be related to mood, medications, smell, or other factors and will likely resolve. Treatments have limited effect and are usually aimed at flavoring/spicing food to enhance taste or managing depression. Other causes are also extremely rare and often not related directly to the concussion injury.

**Numbness**
It is extremely rare to see numbness with mTBI in the absence of peripheral nerve injury, and it usually represents somatization. If neurologic status is stable and no objective findings then reassurance and monitoring is appropriate.

**Nausea**
Post-traumatic nausea occurs occasionally acutely after concussion, most often in combination with dizziness, as a secondary effect of medications (pain), or due to an exacerbation of underlying GERD/GI dysfunction. Assessment initially is limited and focus should be on rapid management of dizziness and return to activity.

**Persistent Symptoms**
The vast majority of individuals with concussion/mTBI will have no difficulties or complaints following injury. While early interventions have been shown to prevent physical, cognitive and behavioral deficits, certain individuals will have persistent difficulties. Additionally, a significant percentage of individuals with concussion/mTBI will not receive early diagnosis or will not seek treatment, and therefore their symptoms will be addressed only after a temporal delay.

Somatic, cognitive and behavioral symptoms after concussion/mTBI rapidly resolve by 2 to 4 weeks in the majority individuals. The term post-concussion syndrome (PCS), also known as post-concussive syndrome (PCS) or post-
Concussion disorder (PCD) is used for individuals who have persistent non-focal, neurologic symptoms (at least 2), most commonly dizziness, headache, cognitive deficits (attention, memory, and judgment), behavioral changes (irritability, depression, nightmares) and/or sleep disturbance.

**Risk Factors for Persistent Symptoms**

Identifying risk factors for persisting symptoms and understanding the relationship between risk factors and short- and long-term outcomes can help enhance assessment and treatment. Some risks are pre-existing factors that may predispose an individual to worse outcomes following a concussion/mTBI; others are potentially directly causative (e.g., the injury itself or medical/legal iatrogenic factors); and still others are potentially perpetuating factors which may occur during the peri-injury or post-injury timeframe.

1. Assessment of the patient with concussion/mTBI should include a detailed history regarding potential pre-injury, peri-injury, or post-injury risk factors for poorer outcomes. These risk factors include:

   a. *Pre-injury*: older age, female gender, low socio-economic status, low education or lower levels of intellectual functioning, poorer coping abilities or less resiliency, pre-existing mental health conditions (e.g., depression, anxiety, PTSD, substance use disorders).
   b. *Peri-injury*: lower levels of or less available social support
   c. *Post-injury*: injury-related litigation or compensation, comorbid mental health conditions or chronic pain, lower levels of or less available social support,

2. Any substance abuse and/or intoxication at the time of injury should be documented.

3. Establish and document if the patient with concussion/mTBI experienced headaches, dizziness, or nausea in the hours immediately following the injury.

**Persistent Cognitive Difficulties**

Although initial cognitive complaints and problems are common in the first hours and days after a concussion/mTBI, the vast majority of individuals recover within one to four weeks. However, a small minority either continue to report cognitive problems or report worsening symptoms over the months and even years post-injury. This subgroup frequently has premorbid or comorbid conditions such as depression, anxiety, poor health, and chronic pain or poor psychosocial support or other coping resources.
Compensation Seeking/Non-Validated Symptoms

The majority of people with concussion/mTBI will have no difficulties or complaints following injury. However, a minority of patients will continue to have ongoing symptoms that may result in a disability. Though these symptoms lose specificity with time and may be wrongly attributed to the mTBI/concussion, they may also interfere with an individual’s recovery. Even after a careful differential diagnosis, it remains a challenge for providers to quantify non-specific, subjective complaints for the purposes of disability compensation.

Although there is compelling evidence of a relationship between persistence of symptoms and litigation/compensation seeking, this relationship is complex, and there is no therapeutic benefit to attributing symptom expression to malingering or intentional efforts to receive compensation.

- Multiple researchers have found that there is compelling evidence that individuals in litigation or seeking compensation following concussion/mTBI have poorer long-term outcomes. Binder & Rohlings (1996), in a meta-analysis looking at the effect of money on recovery after mTBI, recommended that clinicians consider the effects of financial incentives.
- Individuals in litigation or seeking compensation following mTBI have poorer long-term outcomes, including requiring more days to return to work (Gottshall et al., 2007), greater symptom severity and poorer neuropsychological functioning.
- Compensation-seeking behavior resolves more rapidly with immediate compensation, such as sick pay and/or worker’s compensation (Rose et al., 2005).
- Non-validated symptoms occur with higher frequency in individuals with mTBI who are seeking compensation and that the incidence of such symptoms increases with higher financial incentives.

Physical Rehabilitation

Therapeutic Exercise

Therapeutic exercise has been shown to positively impact the vast majority of disabilities. These exercises can be general and directed at an overall improvement in cardiopulmonary health, physical strength and power, and overall well-being; or focused at specific musculoskeletal, sensory or neuromuscular impairments that limit performance of daily activities. Following concussion/mTBI, those individuals that have persistent symptoms will often lapse in their overall conditioning. This will in turn result in a decrease in short- and long-term global
Concussion / Mild Traumatic Brain Injury

health (physical and behavioral) and put them at an elevated risk for disability, pain, and handicap (i.e., difficulty with return to work, maintaining peer networks.)

There is no contraindication for return to aerobic, fitness and therapeutic activities after concussion/mTBI. Non-contact, aerobic and recreational activities should be encouraged within the limits of the patient’s symptoms to improve physical, cognitive and behavioral complaints and symptoms after concussion/mTBI.

Specific vestibular, visual, and proprioceptive therapeutic exercise is recommended for dizziness, disequilibrium, and spatial disorientation impairments after concussion/mTBI.

Specific therapeutic exercise is recommended for acute focal musculoskeletal impairments after concussion/mTBI.

**General Exercise**
Symptoms of concussion/mTBI amenable to general fitness programs are multiple somatic complaints without specific identified mechanisms of injury and an absence of physical findings. The type of exercise (strength training, core stability, aerobic activities, ROM) is no different than those recommended for individuals without concussion/mTBI. However, one should consider a gradual increase in duration and intensity due to the activity intolerance and fatigue that is commonly associated with concussion/mTBI. Implementation of a scheduled daily routine and incorporation of peer networks may improve compliance.

**Focused Exercise**
Focal impairments (e.g., upper cervical root entrapment, impaired gaze stability, oculomotor dysfunction) benefit from tailored exercise programs that promote adaptation of or compensation for the affected systems (vestibular, visual, and proprioceptive) or specific musculoskeletal/neuromuscular impairments (decreased ROM, weakness, timing). The exercises that are commonly prescribed for these systems/impairments will be warranted. It is the delivery of instruction, guidance and follow-up needs that will be greater for those with mTBI. As well, the duration and intensity level may need to be considered when looking at the overall presentation of the individual.

**Alternative Modalities**
The vast majority of individuals with concussion/mTBI will have no difficulties or complaints following injury. While early interventions have been shown to prevent and treat persistent somatic, cognitive and behavioral deficits, certain individuals will have persistent difficulties. Additionally, a significant percentage of individuals with concussion/mTBI will not receive early diagnosis or will not seek treatment, and therefore their symptoms will be addressed only after a temporal delay. In
many of these individuals with chronic persistent symptoms after mTBI, traditional medical interventions are less than successful. Complementary alternative medicine (CAM) may be sought by the patient or patient’s family. CAM interventions may assist in the treatment of certain symptoms associated with concussion/mTBI. An evidence-based approach to the implementation of complementary medicine strategies will be useful to prevent over- or underutilization of CAM.

Return to Activity

A successful treatment outcome for a patient who has sustained a concussion is the return to duty/work/school or other usual daily activities. Part of the early intervention for concussion/mTBI involves protecting the patient from a secondary insult or further injury by limiting or eliminating their duty status or job requirements until proper recovery is obtained. Although rare, the possibility of second impact syndrome (discussed later in the text) must be prevented by altering a concussed patient’s vocational duties when they are high risk for re-injury. Exertional testing prior to the return to work or military duty may help to ensure adequate resolution of symptoms in a high stress state or combat environment.

Return to activity assessment is based on an inventory of symptoms and their severity and the patient’s job-specific tasks.

Activity restrictions are an important part of the treatment regimen for patients with concussion/mTBI. Activity restriction does not imply complete bed rest but rather a restful pattern of activity throughout the day with minimal physical and mental exertion.

Patients must not return to high risk activities (e.g., sports, physical education (PE), high speed activity (riding a bicycle or carnival rides), if any post-concussion symptoms are present or if results from cognitive testing show persistent deficits. When symptoms are no longer reported or experienced, a patient may slowly, gradually, and carefully return to their daily activities (both physical and cognitive). Children and adolescents will need the help of their parents, teachers, coaches, therapists, athletic trainers, etc. to monitor and assist with their recovery. Management planning should involve all aspects of the patient’s life including home life, school, work, and social-recreational activities.

Returning to ADLs

Increased rest and limited exertion are important to facilitate the patient’s recovery. Clinicians should be cautious about allowing patients to return to driving, especially if the patient has problems with attention, processing speed, or
reaction time. Patients should also be advised to get adequate sleep at night and to take daytime naps or rest breaks when significant fatigue is experienced.

Symptoms typically worsen or re-emerge with exertion. Let any return of a patient’s symptoms be the guide to the level of exertion or activity that is safe. Patients should limit both physical and cognitive exertion accordingly.

- Physical activity includes PE, sports practices, weight-training, running, exercising, heavy lifting, etc.
- Cognitive activity includes heavy concentration or focus, memory, reasoning, reading or writing (e.g., homework, classwork, job-related mental activity)

As symptoms decrease, or as cognitive test results show improvement, patients may return to their regular activities gradually. However, the patient’s overall status should continue to be monitored closely.

**Returning to School**

Symptomatic students may require active supports and accommodations in school, which may be gradually decreased as their functioning improves. Inform the student’s teacher(s), the school nurse, psychologist/counselor, and administrator of the student’s injury, symptoms, and cognitive deficits.

School personnel should be advised to monitor the student for the following signs:

- Increased problems paying attention/concentrating
- Increased problems remembering/learning new information
- Longer time required to complete tasks
- Increased symptoms (e.g., headache, fatigue) during schoolwork
- Greater irritability, less tolerance for stressors

Until a full recovery is achieved, students may need the following supports:

- Time off from school
- Shortened day
- Shortened classes (i.e., rest breaks during classes)
- Rest breaks during the day
- Allowances for extended time to complete coursework/assignments and tests
- Reduced homework/classwork load (it is best to specify for teachers the percent of workload that the student can reasonably handle, e.g., 50% homework load)
- No significant classroom or standardized testing at this time
Clinicians and school personnel should monitor the student’s symptoms with cognitive exertion (mental effort such as concentration, studying) to evaluate the need and length of time supports should be provided.

**Returning to Work**

Return-to-work planning should be based upon careful evaluation of symptoms and neurocognitive status. To help expedite recovery from mTBI, patients may initially need to reduce both physical and cognitive exertion. Rest is key. Restricting work during initial stages of recovery may be indicated to help facilitate recovery. Repeated evaluation of both symptoms and cognitive status is recommended to help guide management considerations.

Until a full recovery is achieved, patients may need the following supports:

**Schedule Considerations**
- Shortened work day (e.g. 8am-12pm)
- Allow for breaks when symptoms increase
- Reduced task assignments and responsibilities

**Safety Considerations**
- No driving
- No heavy lifting/No working with machinery
- No heights due to risk of dizziness, balance problems

**Concussion in Sport**

In November of 2008, The 3rd International Conference on Concussion in Sport was held in Zurich. From this meeting, the “Consensus Statement on Concussion in Sport: The 3rd International Conference on Concussion in Sport Held in Zurich, November 2008” was developed and published. This consensus document reflects the current state of knowledge. It provides an overview of issues that may be of importance to health care providers involved in the management of sports-related concussion.

**On-Field or Sideline Evaluation of Acute Concussion**

When a player shows ANY features of a concussion
(a) The player should be medically evaluated onsite using standard emergency management principles, and particular attention should be given to excluding a cervical spine injury.
(b) The appropriate disposition of the player must be determined by the treating health care provider in a timely manner. If no health care provider is available, the player should be safely removed from practice or play and urgent referral to a physician arranged.
(c) Once the first aid issues are addressed, then an assessment of the concussive injury should be made using the SCAT2 or other similar tool.
(d) The player should not be left alone following the injury, and serial monitoring for deterioration is essential over the initial few hours following injury.
(e) A player with diagnosed concussion should not be allowed to return to play (RTP) on the day of injury. Occasionally, in adult athletes, there may be RTP on the same day as the injury.

Sufficient time for assessment and adequate facilities should be provided for the appropriate medical assessment, both on and off the field, for all injured athletes.

Sideline evaluation of cognitive function is an essential component in the assessment of this injury. Brief neuropsychological test batteries that assess attention and memory function have been shown to be practical and effective. Such tests include the Maddocks questions and the Standardized Assessment of Concussion (SAC). It is worth noting that standard orientation questions (e.g., time, place, person) have been shown to be unreliable in the sporting situation when compared with memory assessment. It is recognized, however, that abbreviated testing paradigms are designed for rapid concussion screening on the sidelines and are not meant to replace comprehensive neuropsychological testing, which is sensitive to detecting subtle deficits that may exist beyond the acute episode, nor should they be used as a stand-alone tool for the ongoing management of sports concussions. It should also be recognized that the appearance of symptoms might be delayed several hours following a concussive episode.

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**Pocket SCAT2**

Concussion should be suspected in the presence of any one or more of the following symptoms (such as headache, or physical signs such as unsteadiness), or impaired basic function (e.g., confusion, or altered behavior).

1. **Symptoms**
   - Loss of consciousness
   - Seque or amnesia
   - Amnesia
   - Headache
   - “Feeling in head”
   - Neck pain
   - Nausea or vomiting
   - Dizziness
   - Blurred vision
   - Balance problems
   - Sensitivity to light
   - Sensitivity to noise
   - Feeling slowed down
   - Feeling like “in a fog”
   - “Don’t feel right”
   - Difficulty concentrating
   - Difficulty remembering
   - Fatigue or low energy
   - Confusion
   - Drowsiness
   - More emotional
   - Irritability
   - Soreness
   - Nervous or anxious

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2. **Memory function**
   
   **Instructions for tandem stance**
   
   "Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. You should try to maintain stability for 30 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue following. I will start timing when you are set and have closed your eyes.”
   
   Count the errors for 30 seconds. If you make more than 5 errors such as either hands off their feet, loses their balance, or falls to the ground out of the start position for more than 5 seconds then this may suggest a concussion.

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3. **Balance testing**

   **Instructions for tandem stance**
   
   "Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. You should try to maintain stability for 30 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue following. I will start timing when you are set and have closed your eyes.”
   
   Count the errors for 30 seconds. If you make more than 5 errors such as either hands off their feet, loses their balance, or falls to the ground out of the start position for more than 5 seconds then this may suggest a concussion.

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Any athlete with a suspected concussion should be IMMEDIATELY REMOVED FROM PLAY, urgently assessed medically, should not be left alone and should not drive a motor vehicle.
Concussion / Mild Traumatic Brain Injury

**SCAT2**
Sport Concussion Assessment Tool 2

**Symptom Evaluation**

**How do you feel?**
You should score yourself on the following symptoms, based on how you feel now.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>&quot;Pressure in head&quot;</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Neck pain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Dizziness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Blurred vision</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Balance problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling like “in a fog”</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>“Don’t feel right”</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fatigue or low energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Confusion</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Drowsiness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Trouble falling asleep at night</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>More emotional</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Irritability</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sadness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nervous or Anxious</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total number of symptoms**
Minimum possible 0, Maximum possible 12

**Symptom severity score**
(Multiply all scores in table, maximum possible 22 x 6 = 132)

| Do the symptoms get worse with physical activity? | Y | N |
| Do the symptoms get worse with mental activity?  | Y | N |

**Overall rating**
If you know the athlete well prior to the injury, how different is the athlete acting compared to his/her usual self? Please rate one response.

| no different | very different | unsure |

---

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Cognitive & Physical Evaluation

1. Symptom score (from page 1)
   22 minus number of symptoms
   of 22

2. Physical signs score
   - Was there a loss of consciousness or unresponsiveness? Y N
   - If yes, how long? minutes
   - Was there a balance problem/unsteadiness? Y N
   Physical signs score (1 point for each negative response)
   of 2

3. Glasgow coma scale (GCS)
   - Best eye response (E)
     No eye opening 1
     Eye opening in response to pain 2
     Eye opening to speech 3
     Eyes opening spontaneously 4
   - Best verbal response (V)
     No verbal response 1
     Incomprehensible sounds 2
     Inappropriate words 3
     Confused 4
     Oriented 5
   - Best motor response (M)
     No motor response 1
     Extension to pain 2
     Abnormal flexion to pain 3
     Flexion/Withdrawal to pain 4
     Localizes to pain 5
     Obey simple commands 6
   Glasgow Coma scale (E + V + M)
   of 15

GCS should be recorded for all athletes in case of subsequent deterioration.

4. Sideline Assessment – Maddocks Score
   “I am going to ask you a few questions, please listen carefully and give your best effort.”
   Modified Maddocks questions (3 points for each correct answer)
   At what venue are we at today? 0 1
   Which half is it now? 0 1
   Who scored last in this match? 0 1
   What team did you play last week/game? 0 1
   Did your team win the last game? 0 1
   Maddocks score
   of 3

Maddocks score is validated for sideline diagnosis of concussive only and is not included in SCAT-2 summary score for severe testing.

5. Cognitive assessment
   Standardized Assessment of Concussion (SAC)
   Orientation (1 point for each correct answer)
   What month is it? 0 1
   What is the date today? 0 1
   What is the day of the week? 0 1
   What year is it? 0 1
   What time is it right now? (within 1 hour) 0 1
   Orientation score
   of 5

Immediate memory
   “I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order.”
   Trials 2 & 3:
   “I am going to repeat the same list again. Repeat back as many words as you can remember in any order, even if you said the word before.”
   Complete all trials regardless of score on trial 1 & 2. Read the words at a rate of one per second. Score 1 pt. for each correct response. Total score equals sum across all 3 trials. Do not inform the athlete that delayed recall will be tested.

List | Trial 1 | Trial 2 | Trial 3 | Alternative word list
---|---|---|---|---
elbow 0 1 0 0 1 candle baby finger
apple 0 1 0 0 1 paper monkey penny
carpet 0 1 0 0 1 sugar perfume blanket
saddle 0 1 0 0 1 sandwich sunset lemon
bubble 0 1 0 0 1 wagon iron insect

Total

Immediate memory score
of 15

Concentration
Digits Backward:
   “I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-9-1, you would say 9-1-7.”
   If correct, go to next string length. If incorrect, read trial 2. One point possible for each string length. Stop after incorrect on both trials. The digits should be read at the rate of one per second.

List | Trial 1 | Trial 2 | Trial 3 | Alternative digit list
---|---|---|---|---
4-9-3 0 1 6-2-9 5-2-6 4-1-5
3-8-1-4 0 1 3-2-7-9 1-7-9-5 4-9-6-8
6-2-9-7-1 0 1 1-6-2-9-7 3-8-5-2-7 6-1-8-4-3
7-1-8-6-4-2 0 1 5-3-9-7-4-8 8-2-1-9-6-4 7-2-4-8-5-6

Months in Reverse Order:
   “Now tell me the months of the year in reverse order. Start with the last month and go backwards. So you’ll say December, November, … Go ahead”
   1 pt. for entire sequence correct

of 5

Concentration score
of 5

---

3. Concussion / Mild Traumatic Brain Injury

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Balance examination
This balance testing is based on a modified version of the Balance Error Scoring System (BESS). A top-of-the-stool or chair with a second hand is required for this testing.

Balance testing
"I am now going to test your balance. Please take your shoes off, roll up your pant legs above your ankles (if applicable), and remove any ankle taping (if applicable). This test will consist of three twenty-second tests with different stances."

(a) Double leg stance:
"The first stance is standing with your feet together with your hands on your hips and with your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes."

(b) Single leg stance:
"If you were to kick a ball, which foot would you use? This will be the dominant foot. Now stand on your non-dominant foot. The dominant leg should be held in approximately 30 degrees of hip flexion and 45 degrees of knee flexion. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."

(c) Tandem stance:
"Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."

Balance testing - types of errors
1. Hand lifted off the crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting foot off or heel
6. Remaining out of test position > 5 sec

Each of the 20-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the athlete. The examiner will begin counting errors only after the individual has assumed the proper start position. The Modified BESS is calculated by adding one error point for each error during the three 20-second tests. The maximum total number of errors for any single condition is 10. If a subject commits multiple errors simultaneously, only one error is recorded but the subject should quickly return to the testing position, and counting should resume once subject is set. Subjects that are unable to maintain the testing procedure for a minimum of five seconds at the start are assigned the highest possible score, i.e., for that testing condition.

Which foot was tested: [ ] Left [ ] Right
(i.e., which is the non-dominant foot)

Condition | Total errors
--- | ---
Double leg stance (left together) | 0 of 10
Single leg stance (non-dominant foot) | 0 of 10
Tandem stance (non-dominant foot at back) | 0 of 10
Balance examination score (30 minus total errors) | 30 of 30

Coordination examination
Upper limb coordination
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Coordination score

Cognitive assessment
Standardized Assessment of Concussion (SAC)
Delayed recall
"Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order."

List
elbow, candle, baby, finger, apple, paper, monkey, penny, carrot, sugar, perfume, blanket, sandwich, sunny, lemon, bubble, wagon, iron, insect

Delayed recall score

Overall score

<table>
<thead>
<tr>
<th>Test domain</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom score</td>
<td>22</td>
</tr>
<tr>
<td>Physical signs score</td>
<td>2</td>
</tr>
<tr>
<td>Glasgow Coma score (E + V + M)</td>
<td>15</td>
</tr>
<tr>
<td>Balance examination score</td>
<td>30</td>
</tr>
<tr>
<td>Coordination score</td>
<td>5</td>
</tr>
<tr>
<td>Subtotal</td>
<td>70</td>
</tr>
<tr>
<td>Orientation score</td>
<td>5</td>
</tr>
<tr>
<td>Immediate memory score</td>
<td>5</td>
</tr>
<tr>
<td>Concentration score</td>
<td>15</td>
</tr>
<tr>
<td>Delayed recall score</td>
<td>5</td>
</tr>
<tr>
<td>SAC subtotal</td>
<td>30</td>
</tr>
<tr>
<td>SCAT2 total</td>
<td>100</td>
</tr>
<tr>
<td>Middendorf Score</td>
<td>5</td>
</tr>
</tbody>
</table>

SCAT2 SPORT CONCUSSION ASSESSMENT TOOL 2 | PAGE 3

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Concussion / Mild Traumatic Brain Injury

Athlete Information

Any athlete suspected of having a concussion should be removed from play, and then seek medical evaluation.

Signs to watch for
Problems could arise over the first 24-48 hours. You should not be left alone and must go to a hospital at once if you:
• Have a headache that gets worse
• Are very dizzy or can’t be awakened (woken up)
• Can’t recognize people or places
• Have repeated vomiting
• Behave unusually or seem confused, are very irritable
• Have seizures (arms and legs jerk uncontrollably)
• Have weak or numb arms or legs
• Are unsteady on your feet. Have slurred speech

Remember, it is better to be safe. Consult your doctor after a suspected concussion.

Return to play
Athletes should not be returned to play the same day of injury.
When returning athletes to play, they should follow a stepwise symptom-limited program, with stages of progression. For example:
1. Rest until asymptomatic (physical and mental rests)
2. Light aerobic exercise (e.g., stationary cycle)
3. Sport-specific exercise
4. Non-contact training drills (start light resistance training)
5. Full contact training after medical clearance
6. Return to competition (same or different sport)

There should be approximately 24 hours (or longer) for each stage and the athlete should return to stage 1 if symptoms recur. Resistance training should only be added in the later stages.
Medical clearance should be given before return to play.

Additional comments

Concussion injury advice (To be given to concussed athlete)

This patient has received an injury to the head. A careful medical examination has been carried out and no sign of any serious complications has been found. It is expected that recovery will be rapid, but the patient will need monitoring for a further period by a responsible adult. Your treating physician will provide guidance as to this timeframe.

If you notice any change in behaviour, vomiting, dizziness, worsening headache, double vision or excessive drowsiness, please telephone the clinic or the nearest hospital emergency department immediately.

Other important points:
• Rest and avoid strenuous activity for at least 24 hours
• No alcohol
• No sleeping tablets
• Use paracetamol or codeine for headache. Do not use aspirin or anti-inflammatory medication
• Do not drive until medically cleared
• Do not train or play sport until medically cleared

Clinic phone number

SCAT2 SPORT CONCUSSION ASSESSMENT TOOL 2 | PAGE 4
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Concussion Investigations

A range of additional investigations may be utilized to assist in the diagnosis and/or exclusion of injury. These include the following.

Neuroimaging
It was recognized by the panelists that conventional structural neuroimaging is normal in concussive injury. Given that caveat, the following suggestions are made:

Brain computed tomography (CT) (or, where available, MR brain scan) contributes little to concussion evaluation but should be employed whenever suspicion of an intracerebral structural lesion exists. Examples of such situations may include prolonged disturbance of conscious state, focal neurologic deficit, or worsening symptoms.

Newer structural MR imaging modalities, including gradient echo, perfusion, and diffusion imaging, have greater sensitivity for structural abnormalities. However, the lack of published studies as well as absent preinjury neuroimaging data limits the usefulness of this approach in clinical management at the present time. In addition, the predictive value of various MR abnormalities that may be incidentally discovered is not established at the present time.

Other imaging modalities such as functional magnetic resonance imaging (fMRI) demonstrate activation patterns that correlate with symptom severity and recovery in concussion. While not part of routine assessment at the present time, they nevertheless provide additional insight to pathophysiologic mechanisms. Alternative imaging technologies (e.g., positron emission tomography, diffusion tensor imaging, magnetic resonance spectroscopy, functional connectivity), while demonstrating some compelling findings, are still at early stages of development and cannot be recommended other than in a research setting.

Balance Assessment
Both sophisticated force plate technology as well as those using less sophisticated clinical balance tests (e.g., Balance Error Scoring System [BESS], available at: www.osma.us/09septlecturearchives/BESSProtocolINATA09.pdf) have identified postural stability deficits lasting approximately 72 hours following sport-related concussion. It appears that postural stability testing provides a useful tool for objectively assessing the motor domain of neurologic functioning and should be considered a reliable and valid addition to the assessment of athletes suffering from concussion, particularly when symptoms or signs indicate a balance component.
Neuropsychological Assessment
The application of neuropsychological (NP) testing in concussion has been shown to be of clinical value and continues to contribute significant information in concussion evaluation. Some of the most commonly used neuropsychological tests in include:

- ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing)
- ANAM (Automated Neuropsychological Assessment Metrics)
- CogState Sport
- HeadMinder CRI (Concussion Resolution Index)

Although in most cases cognitive recovery largely overlaps with the time course of symptom recovery, it has been demonstrated that cognitive recovery may occasionally precede or more commonly follow clinical symptom resolution, suggesting that the assessment of cognitive function should be an important component in any RTP protocol. It must be emphasized, however, that NP assessment should not be the sole basis of management decisions; rather, it should be seen as an aid to the clinical decision-making process in conjunction with a range of clinical domains and investigational results.

Neuropsychologists are in the best position to interpret NP tests by virtue of their background and training. However, there may be situations where neuropsychologists are not available and other medical professionals may perform or interpret NP screening tests. The ultimate RTP decision should remain a medical one, in which a multidisciplinary approach, when possible, has been taken.

In the absence of NP and other (e.g., formal balance assessment) testing, a more conservative return-to-play approach may be appropriate. In the majority of cases, NP testing will be used to assist RTP decisions and will not be done until the patient is symptom free. There may be persons (e.g., child and adolescent athletes) in whom testing may be performed early while the patient is still symptomatic to assist in determining management. This will normally be best determined in consultation with a trained neuropsychologist.

Genetic Testing
The significance of apolipoprotein (Apo) E4, ApoE promoter gene, tau polymerase, and other genetic markers in the management of sports concussion risk or injury outcome is unclear at this time. Evidence from human and animal studies in more severe traumatic brain injury demonstrates induction of a variety of genetic and cytokine factors, such as insulin-like growth factor-1 (IGF-1), IGF binding protein-2, fibroblast growth factor, Cu-Zn superoxide dismutase, superoxide dismutase-1 (SOD-1), nerve growth factor, glial fibrillary acidic protein (GFAP), and S-100. Whether such factors are affected in sport concussion is not known at this stage.
Experimental Concussion Assessment Modalities
Different electrophysiologic recording techniques (e.g., evoked response potential [ERP], cortical magnetic stimulation, and electroencephalography) have demonstrated reproducible abnormalities in the postconcussive state. However, not all studies reliably differentiated concussed athletes from controls. The clinical significance of these changes remains to be established.

In addition, biochemical serum and cerebrospinal fluid markers of brain injury (including S-100, neuron specific enolase [NSE], myelin basic protein [MBP], GFAP, tau, etc) have been proposed as means by which cellular damage may be detected if present. There is currently insufficient evidence, however, to justify the routine use of these biomarkers clinically.

Management
The cornerstone of concussion management is physical and cognitive rest until symptoms resolve and then a graded program of exertion prior to medical clearance and return to play (RTP). The recovery and outcome of this injury may be modified by a number of factors that may require more sophisticated management strategies. As described above, the majority of patients will recover spontaneously over several days. In these situations, it is expected that an athlete will proceed progressively through a stepwise RTP strategy. During this period of recovery while symptomatic following an injury, it is important to emphasize to the athlete that physical and cognitive rest is required. Activities that require concentration and attention (e.g., scholastic work, video games, text messaging, etc) may exacerbate symptoms and possibly delay recovery.

In such cases, apart from limiting relevant physical and cognitive activities (and other risk-taking opportunities for reinjury) while symptomatic, no further intervention is required during the period of recovery, and the athlete typically resumes sport without further problem.

Modifying Factors in Concussion Management
The consensus panel agreed that a range of “modifying” factors may influence the investigation and management of concussion and, in some cases, may predict the potential for prolonged or persistent symptoms. These modifiers would also be important to consider in a detailed concussion history and are outlined in the accompanying table.

It is envisioned that athletes with such modifying features would be managed in a multidisciplinary manner coordinated by a physician with specific expertise in the management of concussive injury.

The role of female gender as a possible modifier in the management of concussion was discussed at length by the panel. There was not unanimous agreement that the current published research evidence is conclusive that this
should be included as a modifying factor, although it was accepted that sex may be a risk factor for injury and/or influence injury severity.

**Modifying Factors**

<table>
<thead>
<tr>
<th>Factors</th>
<th>Modifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms</td>
<td>Number, Duration (greater than 10 days), Severity</td>
</tr>
<tr>
<td>Signs</td>
<td>Prolonged loss of consciousness (greater than 1 minute), Amnesia</td>
</tr>
<tr>
<td>Sequelae</td>
<td>Concussive convulsions</td>
</tr>
<tr>
<td>Temporal</td>
<td>Frequency: repeated concussions over time, Timing: injuries close together in time, Recency: recent concussion or traumatic brain injury</td>
</tr>
<tr>
<td>Threshold</td>
<td>Repeated concussions occurring with progressively less impact force or slower recovery after each successive concussion.</td>
</tr>
<tr>
<td>Age</td>
<td>Child or adolescent (less than 18 years old)</td>
</tr>
<tr>
<td>Comorbidities &amp; premorbidities</td>
<td>Migraine, depression, or other mental health, disorders, attention deficit hyperactivity disorder (ADHD), learning disabilities (LDs), sleep disorders</td>
</tr>
<tr>
<td>Medication</td>
<td>Psychoactive drugs, anticoagulants</td>
</tr>
<tr>
<td>Behavior</td>
<td>Dangerous style of play</td>
</tr>
<tr>
<td>Sport</td>
<td>High-risk activity, contact and collision sport, high sporting level</td>
</tr>
</tbody>
</table>

**Return to Play**

**Graduated RTP Protocol**

Return-to-play protocol following a concussion follows a stepwise process as outlined in the table below.

With this stepwise progression, the athlete should continue to proceed to the next level if asymptomatic at the current level. Generally each step should take 24 hours, so that an athlete would take approximately 1 week to proceed through the full rehabilitation protocol once asymptomatic at rest and with provocative exercise. If any postconcussion symptoms occur while in the stepwise program,
then the patient should drop back to the previous asymptomatic level and try to progress again after a further 24-hour period of rest has passed.

**Graduated RTP protocol**

<table>
<thead>
<tr>
<th>Rehabilitation Stage</th>
<th>Functional Exercise</th>
<th>Stage Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No activity</td>
<td>Complete physical and cognitive rest</td>
</tr>
<tr>
<td>1</td>
<td>Light aerobic exercise</td>
<td>Walking, swimming, or stationary cycling, keeping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>intensity to 70% of maximum predicted heart rate;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>no resistance training</td>
</tr>
<tr>
<td>3</td>
<td>Sport specific exercise</td>
<td>Skating drills in ice hockey, running drills in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>soccer; no head impact activities</td>
</tr>
<tr>
<td>4</td>
<td>Non-contact training drills</td>
<td>Progression to more complex training drills, eg,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>passing drills in football and ice hockey; may</td>
</tr>
<tr>
<td></td>
<td></td>
<td>start progressive resistance training</td>
</tr>
<tr>
<td>5</td>
<td>Full contact practice</td>
<td>Following medical clearance, participate in normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>training activities</td>
</tr>
<tr>
<td>6</td>
<td>Return to play</td>
<td>Normal game play</td>
</tr>
</tbody>
</table>

**Same-Day RTP**

With adult athletes, in some settings, where there are team physicians experienced in concussion management and sufficient resources (e.g., access to neuropsychologists, consultants, neuroimaging, etc) as well as access to immediate (i.e., sideline) neurocognitive assessment, RTP management may be more rapid. The RTP strategy must still follow the same basic management principles: namely, full clinical and cognitive recovery before consideration of RTP. This approach is supported by published guidelines, such as those from the American Academy of Neurology, US Team Physician Consensus Statement, and US National Athletic Trainers’ Association position statement.

**Pharmacologic Therapy**

Pharmacologic therapy in sports concussion may be applied in 2 distinct situations. The first of these situations is the management of specific, prolonged symptoms (e.g., sleep disturbance, anxiety, etc). The second situation is where drug therapy is used to modify the underlying pathophysiology of the condition with the aim of shortening the duration of the concussion symptoms. In broad terms, this approach to management should only be considered by clinicians experienced in concussion management.

An important consideration in RTP is that concussed athletes should not only be symptom free but also should not be taking any pharmacologic agents or medications that may mask or modify the symptoms of concussion.
Where antidepressant therapy may be commenced during the management of a concussion, the decision to RTP while still on such medication must be considered carefully by the treating clinician.

Pre-participation Concussion Evaluation

Recognizing the importance of a concussion history and appreciating the fact that many athletes will not recognize all the concussions they may have suffered in the past, a detailed concussion history is of value. Such a history may identify early those athletes who fit into a high-risk category and provides an opportunity for the health care provider to educate the athlete in regard to the significance of concussive injury. A structured concussion history should include specific questions as to previous symptoms of a concussion, not just the perceived number of past concussions. It is also worth noting that dependence upon the recall of concussive injuries by teammates or coaches has been demonstrated to be unreliable.

The clinical history should also include information about all previous head, face, and cervical spine injuries, as these may also have clinical relevance. It is worth emphasizing that in the setting of maxillofacial and cervical spine injuries, coexistent concussive injuries may be missed unless specifically assessed. Questions pertaining to disproportionate impact versus symptom severity may alert the clinician to a progressively increasing vulnerability to injury.

As part of the clinical history, it is advised that details regarding protective equipment employed at time of injury be sought, both for recent and remote injuries. A comprehensive preparticipation concussion evaluation allows for modification and optimization of protective behavior and an opportunity for education.

The Child or Adolescent Athlete

There was unanimous agreement by the panel that the evaluation and management recommendations contained herein could be applied to children and adolescents down to the age of 10 years. Below that age, children report different concussion symptoms from adults and would require age-appropriate symptom checklists as a component of assessment. An additional consideration in assessing the child or adolescent athlete with a concussion is that in the clinical evaluation by the health care professional, there may be the need to include both patient and parental input, as well as teacher and school input, when appropriate.

The decision to use NP testing is broadly the same as in the adult assessment paradigm. However, timing of testing may differ in order to assist planning in school and home management (and may be performed while the patient is still symptomatic). If cognitive testing is performed, then it must be developmentally
sensitive until the late teen years, due to the ongoing cognitive maturation that occurs during this period, which, in turn, makes the utility of comparison to either the person’s own baseline performance or to population norms limited.

In this age group, it is more important to consider the use of trained neuropsychologists to interpret assessment data, particularly in children with learning disorders and/or attention deficit hyperactivity disorder (ADHD), who may need more sophisticated assessment strategies.

The panel strongly endorsed the view that children should not be returned to practice or play until clinically completely symptom free, which may require a longer time frame than for adults.

In addition, the concept of “cognitive rest” was highlighted, with special reference to a child’s need to limit exertion with activities of daily living and to limit scholastic and other cognitive stressors (e.g., text messaging, video games, etc) while symptomatic.

School attendance and activities may also need to be modified to avoid provocation of symptoms.

Because of the different physiological response and longer recovery after concussion and specific risks (e.g., diffuse cerebral swelling) related to head impact during childhood and adolescence, a more conservative RTP approach is recommended. It is appropriate to extend the amount of time of asymptomatic rest and/or the length of the graded exertion in children and adolescents. It is not appropriate for a child or adolescent athlete with concussion to RTP on the same day as the injury, regardless of the level of athletic performance. Concussion modifiers apply even more to this population than to adults and may mandate more cautious RTP advice.

Elite Versus Non-Elite Athletes

The panel unanimously agreed that all athletes, regardless of level of participation, should be managed using the same treatment and RTP paradigm. A more useful construct was agreed to, whereby the available resources and expertise in concussion evaluation were of more importance in determining management than a separation between elite and non-elite athlete management. Although formal baseline NP screening may be beyond the resources of many sports or individuals, it is recommended that in all organized high-risk sports, consideration be given to having this cognitive evaluation, regardless of the age or level of performance.
Chronic Traumatic Brain Injury

Epidemiologic studies have suggested an association between repeated sports concussions during a career and late-life cognitive impairment. Similarly, case reports have noted anecdotal cases in which neuropathologic evidence of chronic traumatic encephalopathy was observed in retired football players. The panel discussed chronic traumatic brain injury in sport; however, no consensus was reached on this topic. Clinicians need to be mindful of the potential for long-term problems in the management of all athletes.

Protective Equipment

There is no good clinical evidence that currently available protective equipment will prevent concussion, although mouthguards have a definite role in preventing dental and orofacial injury. Biomechanical studies have shown a reduction in impact forces to the brain with the use of head gear and helmets, but these findings have not been translated to show a reduction in concussion incidence. For skiing and snowboarding, there are a number of studies to suggest that helmets provide protection against head and facial injury and, hence, should be recommended for participants in alpine sports. In specific sports such as cycling, motor, and equestrian sports, protective helmets may prevent other forms of head injury (eg, skull fracture) that are related to falling on hard road surfaces, and these may be an important injury prevention issue for those sports.

Children and mTBI

Very young children (i.e. infants, toddlers, and preschoolers) frequently sustain bumps and bruises to their heads from a host of mechanisms including falls (down stairs or from heights such as counter tops or beds), direct impacts (e.g. getting hit in the head with a ball), motor vehicle crashes, tricycle/bike accidents or child abuse.

Sometimes these events can be significant enough to result in a concussion. Deciding whether a child who has hit his or her head needs an immediate assessment to determine whether he or she has had a concussion can be difficult, as young children may have the same symptoms of a concussion as older children, but do not express them in the same way. For example, young children cannot explain a feeling of nausea or amnesia or even describe where they hurt. Clinicians should therefore keep this in mind when they ask parents about the presence of symptoms and have a low threshold for referring a child for immediate evaluation. Healthcare practitioners should ask caregivers about all “bumps on the head” and should consider referring a child with a “bump on the head” to the emergency department if they suspect a concussion but are unsure about the symptoms.
Follow-up in Young Children with mTBI

All children with concussion or suspected concussion should be followed closely by a health care professional. A follow up visit with the clinician after the event is recommended to assess the child for ongoing symptoms.

Although diagnosing post-concussion syndrome in young children is difficult, it is important to assess for these symptoms in order to determine whether need further evaluation. The follow-up visit can also provide an important opportunity for discussion of age-appropriate injury prevention which is important to minimize the possibility of subsequent concussions.

Persistent signs and symptoms to assess for during follow-up:

- Excessive crying
- Persistent headache
- Poor attention
- Change in sleeping patterns
- Change in nursing or eating habits
- Change in temperament
- Sad or lethargic
- Lack of interest in favorite toy

Children who display these persistent symptoms during the follow up exam require further assessment and/or evaluation by a neurologist or other specialist.

Abusive TBI

Young children may also sustain mild to severe TBIs from abuse.

- Approximately 1,400 cases of abusive TBI occur in the U.S. each year.
- Injuries resulting from abusive TBI are often unrecognized and underreported.
- In any young child with an injury to the head, it is imperative to assess whether the history provided for the injury is developmentally appropriate for a child that age.
- In many cases of abuse, caretakers do not report a history of any trauma either because a) they do not that there has been a trauma because it has been inflicted by someone else without their knowledge, or b) because they don’t want to tell.

If an infant of young child presents with the signs and symptoms listed above, it is important to consider the possibility of abusive TBI even in the absence of a history.
Communication Challenges

Patients with mTBI, particularly during the early post-injury phase, may have difficulties communicating. Obtaining an accurate report from the patient about the injury and its symptoms with tools such as the ACE is critical to proper management. The following provides a summary of types of communication problems related to expression and comprehension that individuals with MTBI may experience, and what therapists can do to improve communication with their patients.

Expression
Problem:
The patient may have trouble thinking of specific words (word finding problems) or expressing the specifics of their symptoms or functional difficulties

Solutions:
- Allow patients time to express themselves
- Ask questions about specific symptoms and problems (i.e., are you having headaches?)

Verbal Comprehension
Problems:
- May become confused if too much information is presented at once or too quickly.
- May need extra time to understand what others are saying.
- May have trouble following complex multi-step directions.
- May take longer than expected to answer questions

Solutions:
- Speak slowly and clearly
- Use short sentences
- Repeat complex sentences when necessary
- Allow extra time for patients to comprehend
- Provide both spoken and written instructions

Written comprehension
Problems
- May read slowly
- May have trouble reading material in complex formats or with small print
- May have difficulty filling out forms

Solutions
- Allow patients extra time to read and complete forms

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- Provide written materials in simple formats and large print when possible
- Have someone read the items and fill out the forms for the patient when needed.

In addition to the communications problems listed above, it is also important to note that patients may be sensitive to environmental stimuli. In particular, they may become disoriented or confused when exposed to:
- Bright lights;
- Complex visual stimuli such as busy carpet patterns; and/or
- Noise, including from radio or TV.

Second Impact Syndrome

Second-impact syndrome (SIS) is an extremely rare condition in which the brain swells rapidly and catastrophically after a person suffers a second concussion before symptoms from an earlier one have subsided. This deadly second blow may occur days or weeks after an initial concussion, and even the mildest grade of concussion can lead to SIS.

Pathophysiological changes that occur include a loss of autoregulation of the brain's blood vessels, which causes them to become congested. The vessels dilate, greatly increasing their diameter and leading to a large increase in cerebral blood flow. Progressive cerebral edema may also occur. The increase of blood and brain volume within the skull causes a rapid and severe increase in intracranial pressure, which can in turn cause uncal and cerebellar brain herniation, a disastrous and potentially fatal condition in which the brain is squeezed past structures within the skull.

The mortality rate for SIS approaches 50%, and morbidity (disability) is almost 100%. Since the condition is so rare, the connection between SIS and future disability has been difficult to establish and is therefore poorly understood. When SIS is not fatal, the effects similar to those of severe traumatic brain injury can occur, including persistent muscle spasms and tenseness, emotional instability, hallucinations, post-traumatic epilepsy, mental disability, paralysis, coma, and brain death. Most cases of SIS have occurred in young people, who are thought to be particularly vulnerable.

Post-Concussion Syndrome

The post-concussion syndrome (PCS) refers to a large number of symptoms and signs that may occur alone or in combination following usually mild head injury. The most common complaints are headaches, dizziness, fatigue, irritability, anxiety, insomnia, loss of consciousness and memory, and noise sensitivity.
No definition of PCS is accepted by all health professionals, and doubt exists about the validity of the diagnosis. One reason for this is that symptoms of PCS also occur in people who have no history of head injury, but who have other medical and psychological complaints.

In one study, 80% of healthy, uninjured people reported having three or more symptoms similar to those found after concussion. (Anderson, 2006) In another study, 64% of people with TBI met the criteria set out by the ICD-10 for post-concussion syndrome, but so did 40% of people that had injuries not to the head; 11% of those with brain injuries and 7% of those with other injuries met the DSM-IV criteria for post-concussion syndrome. (McCrea, 2008) Having depression, post-traumatic stress disorder, or chronic pain virtually guarantees that a person will report symptoms resembling those of PCS. One study found that while people with chronic pain without TBI do report many symptoms similar to those of post-concussion syndrome, they report fewer symptoms related to memory, slowed thinking, and sensitivity to noise and light than people with mTBI do. (Ryan, 2003)

In a syndrome, a set of symptoms is consistently present, and symptoms are linked such that the presence of one symptom suggests that of others. Because PCS symptoms are so varied and many can be associated with a large number of other conditions, doubt exists about whether the term "syndrome" is appropriate for the constellation of symptoms found after concussion. The fact that the persistence of one symptom is not necessarily linked to that of another has similarly led to doubt about whether "syndrome" is the appropriate term.

A longstanding controversy surrounding PCS concerns the nature of its etiology and the degree to which psychological factors and organic factors involving brain dysfunction are responsible. The debate has been referred to as 'psychogenesis versus physiogenesis.'

**Etiology**
Studies using positron emission tomography have linked PCS to a reduction in glucose use by the brain, and changes in cerebral blood flow have been found to exist for as long as three years after a concussion in studies using single photon emission computed tomography (SPECT). (Mittenberg, 2000) Functional magnetic resonance imaging (fMRI) has shown differences in brain function during tasks involving memory after mTBI, and fMRI has shown changes in the brains of athletes within a week of a concussion. Not all people with PCS have abnormalities on imaging, however, and abnormalities found in studies such as fMRI, PET, and SPECT could result from other comorbid conditions such as depression, chronic pain, and post-traumatic stress disorder (PTSD). Electroencephalograms, while usually normal in people with PCS, have occasionally been used to detect changes in brain function following mild head injury. Electrophysiological measures of brain function of people with PCS show
abnormal evoked potentials and event-related potentials compared to controls, supporting the hypothesis that PCS has an organic basis.

Proponents of the view that PCS has a physical or organic basis point to findings that people with post-concussive symptoms have deficits on standardized tests of cognitive function as an indication that brain dysfunction is a factor in PCS. Studies have shown that people with PCS score lower than controls on neuropsychological tests that measure attention, verbal learning, reasoning, and information processing. (Ryan, 2003) But although decreased scores on cognitive tests point to brain dysfunction, they cannot diagnose brain damage. Recovery as measured by scores on cognitive tests frequently do not correlate with resolution of symptoms; people may still report subjective symptoms after their cognitive function has returned to normal. (Jacobson, 1995) Another study found that although children with PCS had poorer scores on tests of cognitive functioning after the injury, they also had poorer behavioral adjustment before the injury than children with no persistent symptoms; these findings support the idea that PCS may result from a combination of factors such as brain dysfunction resulting from head injury and preexisting psychological or social problems. (Yeates, 2005)

Different symptoms may be predicted by different factors; for example, one study found that cognitive and physical symptoms were not predicted by the manner in which parents and family members coped with the injury and adjusted to its effects, but psychological and behavioral symptoms were. (Yeates, 2005)

**Prognosis**

The prognosis for PCS is generally considered excellent, with total resolution of symptoms in the large majority of cases. For most people, post-concussion symptoms go away within a few days to several weeks after the original injury occurs. In others, symptoms may remain for three to six months, but evidence indicates that most cases are completely resolved within that time. Symptoms are largely gone in about half of people with concussion one month after the injury, and about two thirds of people with minor head trauma are symptom-free within three months. It is frequently stated in the literature and considered to be common knowledge that 10–20% of people with PCS have not recovered by a year after the injury, but this may be an overestimate because it is based on studies of people admitted to a hospital, the methodologies of which have been criticized. (Iverson, 2005) In a small minority of people, symptoms may persist for years or be permanent; however, it has not been conclusively shown that permanent neurological symptoms ever result from an uncomplicated concussion.

If symptoms are not resolved by one year, they are likely to be permanent, though improvements may occur after even two or three years, or may suddenly occur after a long time without much improvement. Older people and those who have previously suffered another head injury are likely to take longer to recover.
References


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Post-Test

1. Which one of the following would be classified as a mild traumatic brain injury?
   A. LOC (5 min), AOC (36 hours), PTA (12 hours), GCS (14)
   B. LOC (24 min), AOC (12 hours), PTA (20 hours), GCS (13)
   C. LOC (1 min), AOC (5 hours), PTA (25 hours), GCS (12)
   D. LOC (10 min), AOC (30 hours), PTA (1 hour), GCS (14)

2. Which of the following is a “red flag” that may indicate an acute neurological condition that requires urgent specialty consultation?
   A. Sensitivity to light
   B. Sleep Disturbance
   C. Slurred speech
   D. Irritability

3. Which of the following statements is FALSE regarding the Acute Concussion Evaluation (ACE)?
   A. The ACE was developed for adults, and should not be used to assess children.
   B. The ACE can be used serially to track symptom recovery over time.
   C. The symptom checklist is comprised of four symptom categories: physical, cognitive, emotional, and sleep.
   D. The symptom checklist is scored using 0=no and 1=yes.

4. _______ is the most common symptom reported by individuals who have sustained a concussion.
   A. Headache
   B. Dizziness
   C. Fatigue
   D. Nausea

5. Which one of the following is NOT a component of the SCAT2?
   A. Maddocks Score
   B. Standardized Assessment of Concussion (SAC)
   C. Glickman Neurological Impairment Scale (GNIS)
   D. Modified version of the Balance Error Scoring System (BESS)
6. Which of the following is TRUE regarding neuropsychological assessment?
   A. Cognitive recovery always lags behind clinical symptom resolution.
   B. Neuropsychological (NP) testing must be performed and interpreted by a trained neuropsychologist.
   C. The Standardized Assessment of Concussion (SAC) is one of the commonly used neuropsychological tests.
   D. Neuropsychological testing is most often performed when the patient is symptom-free.

7. Which of the following is NOT considered to be a modifying factor in concussion management?
   A. The patient has attention deficit hyperactivity disorder.
   B. The patient experienced a 90 second loss of consciousness when injured.
   C. The patient is taking inhaled corticosteroids to control asthma.
   D. The patient plays rugby.

8. An athlete recovering from an mTBI experiences post-concussion symptoms while participating in a graduated return-to-play program. The athlete should __.
   A. stay at the current activity level for a minimum of 48 hours before progressing to the next level.
   B. drop back to the previous asymptomatic level and try to progress again after a further 24 hour rest period.
   C. stop all activity for at least 24 hours, and then resume at the same level once they are symptom-free.
   D. return to stage 1 of the graduated RTP protocol.

9. Which of the following is FALSE concerning Second Impact Syndrome (SIS)?
   A. SIS is extremely rare.
   B. The brain’s blood vessels lose their ability to properly auto-regulate.
   C. Death from cerebellar brain herniation may occur.
   D. Morbidity associated with SIS is nearly 50%

10. Which of the following statements is TRUE regarding Post Concussion Syndrome (PCS)?
    A. No definition of PCS is accepted by all health professionals, and doubt exists about the validity of the diagnosis.
    B. All people with PCS have abnormalities on imaging.
    C. The prognosis for PCS is generally considered fair.
    D. Both A & C are true