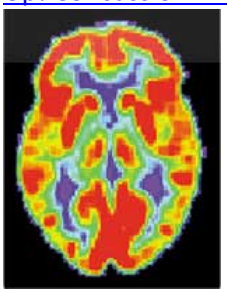
Concussion Management

Heads Up CDC

Content Source: National Center for Injury Prevention and Control, Division of Injury Response Heads Up! Concussion Information for Physicians Centers for Disease Control and Prevention



Concussion Overview

A concussion is a disturbance in brain function that occurs following either a blow to the head or as a result of the violent shaking of the head.

In the United States, the annual incidence of sports-related concussion is estimated at 300,000. Estimates regarding the likelihood of an athlete in a contact sport experiencing a concussion may be as high as 19% per season.

Common Signs and Symptoms | Post-Concussion Syndrome | Concussion Assessment | Concussion Management Guidelines | Concussion Recommendations | Concussion Treatment | Concussion Recovery

Common Signs and Symptoms of a Concussion

Signs observed	Signs reported by athlete
• Appears to be dazed or stunned • Is confused about assignment • Forgets plays • Is unsure of game, score, or opponent • Moves clumsily • Answers questions slowly • Loses consciousness (even temporarily) • Shows behavior or personality change • Forgets events prior to hit (retrograde amnesia) • Forgets events after hit (anterograde amnesia)	• Headache • Nausea • Balance problems or dizziness • Double or fuzzy vision • Sensitivity to light or noise • Feeling sluggish • Feeling "foggy" • Change in sleep pattern • Concentration or memory problems

In a University of Pittsburgh Medical Center (UPMC) study of high school and college athletes with concussion, **on-the-field amnesia, not loss of consciousness, as long thought, was predictive of post-injury symptom severity and neurocognitive deficits.**

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Post-Concussion Syndrome

Although the majority of athletes who experience a concussion are likely to recover, an unknown number of these individuals may experience chronic cognitive and neurobehavioral difficulties related to recurrent injury. Symptoms may include:

- Chronic headaches
- Fatigue
- Sleep difficulties
- Personality changes (e.g. increased irritability, emotionality)

- Sensitivity to light or noise
- Dizziness when standing quickly
- Deficits in short-term memory, problem solving and general academic functioning

This constellation of symptoms is referred to "Post-Concussion Syndrome" and can be quite disabling for an athlete. In some cases, such difficulties can be permanent and disabling.

In addition to Post-Concussion Syndrome, suffering a second blow to the head while recovering from an initial concussion can have catastrophic consequences as in the case of "Second Impact Syndrome," which has led to approximately 30-40 deaths over the past decade.

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Concussion Assessment

Upon ruling out more severe injury, acute evaluation continues with assessment of the concussion. First, the clinician should establish the presence of any loss or other alteration of consciousness (LOC). LOC is relatively rare and occurs in less than 10% of concussions.

The identification of LOC can be very tricky, as the athlete may lose consciousness very briefly and this event may not be directly observed by others. By definition, LOC represents a state of brief coma in which the eyes are typically closed and the athlete is unresponsive to external stimuli. LOC is most obvious when an athlete makes no attempt to brace his or her fall following a blow to the head. Any athlete with documented LOC should be managed conservatively, and return to play is contraindicated.

Although helpful in identifying more serious concerns (e.g. skull fracture, hematoma, contusion), traditional neurological and radiologic procedures, such as CT, MRI, and EEG, are not useful in identifying the effects of concussion. Such tests are typically unremarkable or normal, even in athletes sustaining a severe concussion. The reason for this issue is that concussion is a metabolic rather than structural injury. Thus, structural neuroimaging techniques are insensitive to the effects of concussion.

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Concussion Management Guidelines

At the forefront of proper concussion management is the implementation of baseline and/or post-injury neurocognitive testing. Such evaluation can help to objectively evaluate the concussed athlete's post-injury condition and track recovery for safe return to play, thus preventing the cumulative effects of concussion. In fact, neurocognitive testing has recently been called the "cornerstone" of proper concussion management by an international panel of sports medicine experts.

Current management guidelines (i.e. Grade 1, 2, 3 of concussion) are not evidenced-based and little to no scientific data support the arbitrary systems that are in place to manage concussion. As a result, there are currently 19 different management criteria available for concussion management, which are often misused and misinterpreted.

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Concussion Recommendations

According to the Vienna, Prague and Zurich Conference Recommendations, athletes should complete the following step-wise process prior to return to play following concussion:

- Removal from contest following signs and symptoms of concussion
- No return to play in current game
- Medical evaluation following injury
- Rule out more serious intracranial pathology
- Step-wise return to play

1. No activity - rest until asymptomatic
2. Light aerobic exercise
3. Sport-specific training
4. Non-contact drills
5. Full-contact drills

6. Game play

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Concussion Treatment

The goal of concussion treatment is to allow the brain injury to heal. Treatment of concussions differs depending on the level of severity. Concussion treatment may include:

- **Rest.** Provide adequate time for recovery from a concussion. Do not rush back into daily activities for work or school.
- **Preventing re-injury.** Avoid activities that might jolt or jar your head. Never return to a sports activity until your doctor has given you clearance. Ask when it's safe to drive a car, ride a bike, work or play at heights, or use heavy equipment.
- **Limiting exposure to drugs.** Do not take medicines without your doctor's permission. This is especially true with aspirin, blood thinners, and drugs that cause drowsiness. Avoid the use of alcohol or illicit drugs.
- **Consult with a Credentialed ImPACT Consultant for a full recovery.**

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Concussion Recovery

Athletes who are not fully recovered from an initial concussion are significantly vulnerable for recurrent, cumulative, and even catastrophic consequences of a second concussion.

Such difficulties are prevented if the athlete is allowed time to recover from a concussion and return to play decisions are carefully made. No athlete should return to sport or other at-risk participation when symptoms of concussion are present and recovery is ongoing.

In summary, the best way to prevent difficulties with concussion is to manage the injury properly when it does occur.

Mild Traumatic Brain Injury (MTBI)

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Physicians can play a key role in helping to prevent mild traumatic brain injury (MTBI or concussion) and in appropriately identifying, diagnosing, and managing it when it does occur. Physicians can also improve patient outcomes when MTBI is suspected or diagnosed by implementing early management and appropriate referral. MTBI symptoms may appear mild, but can lead to significant, life-long impairment affecting an individual's ability to function physically, cognitively, and psychologically. Appropriate diagnosis, referral, and patient and family/caregiver education are critical for helping patients with MTBI achieve optimal recovery and to reduce or avoid significant sequelae.

The Heads Up! tool kit was developed to provide physicians with a more individualized assessment of MTBI and to help guide the management and recovery of patients with MTBI.

The tool kit includes:

- A patient assessment tool, titled "Acute Concussion Evaluation;"
- An information sheet for patients who recently sustained a concussion, titled "Acute Concussion Evaluation Care Plan (work and school versions);"
- A palm card with information about the on-field management of concussion, titled "Concussion in Sports;"
- A general fact sheet for patients, titled, "Heads Up: Preventing Concussion (in English and Spanish);" and
- A CD-ROM with downloadable tool kit materials and additional resources.

Definition of Mild Traumatic Brain Injury (MTBI)

The term mild traumatic brain injury (MTBI) is used interchangeably with the term concussion. An MTBI or concussion is defined as a complex pathophysiologic process affecting the brain, induced by traumatic biomechanical forces secondary to direct or indirect forces to the head. MTBI is caused by a blow or jolt to the head that disrupts the function of the brain. This disturbance of brain function is typically associated with normal structural neuroimaging findings (i.e., CT scan, MRI). MTBI results in a constellation of physical, cognitive, emotional and/or sleep-related symptoms and may or may not involve a loss of consciousness (LOC). Duration of symptoms is highly variable and may last from several minutes to days, weeks, months, or even longer in some cases.[1,2]

Magnitude of TBI and MTBI

- An estimated 75%-90% of the 1.4 million traumatic brain injury (TBI)-related deaths, hospitalizations, and emergency department visits that occur each year are concussions or other forms of MTBI.[3-6]
- Approximately 1.6 - 3.8 million sportsand recreation-related TBIs occur in the United States each year.[7] Most of these are MTBIs that are not treated in a hospital or emergency department.
- Blasts are an important cause of MTBI among military personnel in war zones.[8]
- Direct medical costs and indirect costs such as lost productivity from MTBI totaled an estimated $12 billion in the United States in 2000.[9]
- Individuals with a history of concussion are at an increased risk of sustaining a subsequent concussion.[10]
- Duration of symptoms is highly variable and may last from several minutes to days, weeks, months, or even longer in some cases. Research shows that recovery time may be longer for children and adolescents.[11,12]
- Symptoms or deficits that continue beyond three months may be a sign of post-concussion syndrome.[13] (See the list of common signs and symptoms of MTBI.)
- With proper diagnosis and management, most patients with MTBI recover fully.[14,15]

Leading causes of MTBI (seen in emergency departments)16	**Groups at highest risk for MTBI16**
• Falls; • Motor vehicle trauma; • Unintentionally struck by/against events; • Assaults; and • Sports.	• Infants and children (ages 0 to 4); • Children and young adults (ages 5 to 24); and • Older adults (ages 75 or older).

Neuropathophysiology of MTBI

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. Clinical signs and symptoms of MTBI such as poor memory, speed of processing, fatigue, and dizziness result from this underlying neurometabolic cascade.[17]

Preventing Traumatic Brain Injury (TBI)

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To reduce the risk of sustaining a concussion or a more serious TBI, patients should be advised to:

- Wear a seat belt every time they drive or ride in a motor vehicle.
- Buckle their child in the car using a child safety seat, booster seat, or seat belt (according to the child's height, weight, and age).
- Children should start using a booster seat when they outgrow their child safety seats (usually when they weigh about 40 pounds). They should continue to ride in a booster seat until the lap/shoulder belts in the car fit properly, typically when they are approximately 4'9" tall.[36]
- Never driving while under the influence of alcohol or drugs.
- Wear a helmet and make sure their children wear helmets when:
- Riding a bike, motorcycle, snowmobile, scooter, or all-terrain vehicle;
- Playing a contact sport, such as football, ice hockey, or boxing;
- Using in-line skates or riding a skateboard;
- Batting and running bases in baseball or softball;
- Riding a horse; or
- Skiing or snowboarding.
- Ensure that during athletic games and practices that they and/or their children:
- Use the right protective equipment;
- Follow the rules for safety and the rules of the sport;
- Practice good sportsmanship; and
- Do not return to play with a known or suspected concussion until evaluated and given permission by an appropriate health care professional.
- Maintain a regular physical activity program, if their health care provider agrees, to improve lower body strength and balance.[14-16]
- Make living areas safer for seniors, by:
- Removing tripping hazards such as throw rugs and clutter in walkways;
- Using nonslip mats in the bathtub and on shower floors;
- Installing grab bars next to the toilet and in the tub or shower;
- Installing handrails on both sides of stairways;
- Improving lighting throughout the home; and
- Maintaining a regular physical activity program, if their health care provider agrees, to improve lower body strength and balance.[37-40]
- Make living areas safer for children, by:

- Installing window guards to keep young children from falling out of open windows;
- Using safety gates at the top and bottom of stairs when young children are around;
- Keeping stairs clear of clutter;
- Securing rugs and using rubber mats in bathtubs; and
- Not allowing children to play on fire escapes or on other unsafe platforms.
- Make sure playground surfaces are made of shock-absorbing material, such as hardwood mulch or sand, and are maintained to an appropriate depth.[41,42]

Concussion Diagnosis

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Concussion Signs and Symptoms | Diagnosis | Injury Characteristics | Symptom Check List | Signs of Deteriorating Neurological Function | Identify Risk Factors that may Complicate the Recovery Process | Establishing the Diagnosis

Concussion Signs and Symptoms

Concussion signs and symptoms generally fall into four categories: physical symptoms, cognitive symptoms, emotional symptoms, and sleep symptoms, and may include:

Physical	Cognitive	Emotional	Sleep
• Headache • Nausea • Vomiting • Balance Problems • Dizziness • Visual Problems • Fatigue • Sensitivity to light • Sensitivity to noise • Numbness/Tingling • Dazed or Stunned	• Feeling mentally "foggy" • Feeling slowed down • Difficulty concentrating • Difficulty remembering • Forgetful of recent information or conversations • Confused about recent events • Answers questions slowly • Repeats questions	• Irritability • Sadness • More emotional • Nervousness	• Drowsiness • Sleeping less than usual • Sleeping more than usual • Trouble falling asleep

Diagnosis

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.[14,18]A systematic assessment of the injury and its manifestations is essential to proper management and reduced morbidity. The Acute Concussion Evaluation (ACE) form included in this tool kit was developed to provide physicians with an evidence-based 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. 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 (two versions). These tools were developed to provide physicians 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. Physicians 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 diagnosing a patient with a known or suspected MTBI. Detailed instructions about how to use the ACE are provided on the back page of the form.

A. 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. The force to the head may be indirect, such as with an individual being struck in the body resulting in the head accelerating forward and then backward
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.[19]
4. **Loss of Consciousness (LOC).** Inquire whether LOC occurred or was observed and the length of time the patient lost consciousness. (Note: Research indicates that up to 90% of concussions do not involve LOC.)[19,20]
5. **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. Record their presence or absence with a checkmark.

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

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B. 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.[19,21] 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). Physicians 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

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C. Signs of Deteriorating Neurological Function

It is important to assess whether the patient with an MTBI exhibits any signs or reports any symptoms that would indicate deteriorating neurological functioning. Patients should be carefully observed over the first 24-48 hours for the serious signs listed below.[22] If any of these signs are reported, they should be referred to an emergency department for an

- Headaches that worsen
- Seizures
- Focal neurologic signs
- Looks very drowsy or can't be awakened
- Repeated vomiting
- Slurred speech
- Can't recognize people or places
- Increasing confusion or irritability
- Weakness or numbness in arms or legs
- Neck pain
- Unusual behavior change
- Significant irritability

- Any loss of consciousness greater than 30 seconds or longer. (Brief loss of consciousness (under 30 seconds) should be taken seriously and the patient should be carefully monitored.)

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D. Identify Risk Factors that may Complicate the Recovery Process

Each of the factors below have been identified through empirical research to be associated with a longer period of recovery from an MTBI. Identifying any of these factors is helpful for understanding the nature and extent of the patient's injury and for monitoring their recovery.

1. Concussion (or MTBI) History. Assess the number and date(s) of prior concussions and the duration of symptoms for each injury. The effects of multiple MTBIs may be cumulative, especially if there is minimal duration of time between injuries and less biomechanical force results in subsequent MTBI (which may indicate incomplete recovery from the initial trauma).[10,21-26]
2. Headache History. Assess prior personal and/or family history of diagnosis and treatment for headaches. Headaches (migraines in particular) can result in protracted recovery from MTBI.[27-29]
3. Developmental History. Assess for a history of learning disabilities, Attention-Deficit/Hyperactivity Disorder or other developmental disorders. Recovery may take longer in patients with these conditions.30
4. Psychiatric History. Assess for history of depression/mood disorder, anxiety, and/or sleep disorder.[31-33]

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E. Establishing the Diagnosis.

Following the above assessment, the diagnosis of concussion or MTBI using the following

1. **850.0 (Concussion, with no loss of consciousness)** - Positive injury description with evidence of a direct or indirect forcible blow to the head, plus evidence of active symptoms and/or signs of any type and number related to the trauma; no evidence of LOC, skull fracture, internal bleed (i.e., intracranial injury).
2. **850.1 (Concussion, with brief loss of consciousness < 1 hour)** - Positive injury description with evidence of a direct or indirect forcible blow to the head, plus evidence of active symptoms and/or signs of any type and number related to the trauma; positive evidence of LOC; no skull fracture, internal bleed.
3. **850.9 (Concussion, unspecified)** - Positive injury description with evidence of a direct or indirect forcible blow to the head, plus evidence of active symptoms and/or signs of any type and number related to the trauma; unclear or unknown injury details and unclear evidence of LOC; no skull fracture, internal bleed.

If there is evidence of prolonged LOC (>1 hour), skull fracture, and/or intracranial injury, the diagnosis of 854 should be considered (consult the ICD-9-CM manual for detailed codes). Use of **ICD-9-CM 959.01 Head injury, unspecified** is not recommended for concussion/MTBI, as it excludes the above concussion diagnoses and is non-specific.

Clinical Management

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The first step to improving outcomes for patients with MTBI is to determine a plan of action for follow-up. Based on the findings of an evaluation, such as that provided by the ACE, the physician may decide to:

1. Monitor the Patient in the Office.

Office monitoring is particularly appropriate if the number and severity of symptoms are steadily decreasing over time and/or fully resolve within 3 to 5 days. However, if symptoms have not fully abated in this time period, or remain steady or worsen, referral to an MTBI specialist may be warranted.

2. Make a Referral to an MTBI Specialist.

Referral to a specialist who cares for patients with MTBI is appropriate if symptom reduction is not evident within 3 to 5 days post injury, or sooner, and if the type or severity of symptoms is of concern. Referral to a specialist can be particularly valuable to further evaluate the patient's complex presentation and to help manage certain aspects of their condition (e.g., return to sports, school, and work). (Information about specific TBI specialists in a particular area is often available through state or national brain injury associations.)

3. Refer the Patient for Diagnostic Testing.

During the acute phase, diagnostic tests may include neuroimaging (such as a CT or MRI scan) or neuropsychological testing.[34] Neuropsychological tests, which involve performance of specific cognitive tasks, can be helpful for confirming self-reported symptoms and tracking recovery. They assess a range of abilities such as memory, concentration, information processing, executive function, and reaction time.[34] Brief (approx. 25 minutes) and recently validated computerized test batteries and/or abbreviated traditional (paper and pencil) test batteries may be most practical and informative during this early phase.

Neuropsychological tests may also be helpful for determining the appropriate timing for return to safe sports participation, school, or work. Any indication or suspicion of neurologic deterioration should prompt strong consideration for referral to emergency medical evaluation and/or neuroimaging to rule out intracranial bleed or other structural pathology. For patients with persisting symptoms, more extensive neuropsychological and neurobehavioral test batteries can be useful for identifying specific deficits and needed supports for return to daily activities, school, or work.

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Concussion Management Plan

It is critical for the physician to guide the patient in their recovery with an active management plan based on their current symptom presentation. Careful management can facilitate recovery and prevent further injury. The two ACE Care Plans (see Figure 3) included in this tool kit are based on current research and clinical experience and were developed to help physicians actively manage patients with known or suspected MTBI.

Returning to Daily Home/Community Activities | Returning to School | Returning to Play (Sports and Recreation) | Returning to Work

Acute Concussion Evaluation (ACE)
Care Plan

Gerard Gioia, PhD[1] & Micky Collins, PhD[2]
[1]Children's National Medical Center
[2]University of Pittsburgh Medical Center

Patient Name:_____
DOB: _____ Age:_____
Date:_____ ID/MR#_____
Date of Injury:_____

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). ____**No reported symptoms**

Physical		Thinking	Emotional	Sleep
Headaches	Sensitivity to light	Feeling mentally foggy	Irritability	Drowsiness
Nausea	Sensitivity to noise	Problems concentrating	Sadness	Sleeping more than usual
Fatigue	Numbness/Tingling	Problems remembering	Feeling more emotional	Sleeping less than usual
Visual problems	Vomiting	Feeling more slowed down	Nervousness	Trouble falling asleep
Balance Problems	Dizziness			

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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Figure 3. ACE Management Plan

Rest and Careful Management of Physical and Cognitive

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 postconcussion 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, 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.

When concussion symptoms are no longer reported or experienced, a patient may slowly, gradually and carefully return to their daily activities. Children and adolescents will need the help of their parents, teachers, coaches, athletic trainers, etc. to assist in their recovery. Concussion management plans should involve all aspects of the patient's life including home life, school, work, and social-recreational activities.

Returning to Daily Home/Community Activities

Increased rest and limited exertion are important to facilitate the patient's recovery. Physicians 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.

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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. Students with temporary yet prolonged symptoms (i.e. longer than several weeks) or permanent disability may benefit from referral for special accommodations and services, such as those provided under a Section 504 Plan.

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
- Increase in symptoms (e.g., headache, fatigue) during schoolwork
- Greater irritability, less tolerance for stressors

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

- Time off from school
- Shortened day
- Shortened classes (i.e., rest breaks during classes)
- Allowances for extended time to complete coursework/assignments and tests
- Reduced homework/class work load
- No significant classroom or standardized testing at this time
- Rest breaks during the day

Physicians 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.

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Returning to Play (Sports and Recreation)

Guiding the recovery of individuals of any age with MTBI who participate in competitive or recreational activities requires careful management to avoid re-injury or prolonged recovery. Athletes engaged in collision sports require special management and evaluation to ensure full recovery prior to their return to play.

An individual should never return to competitive sporting or recreational activities while experiencing any lingering or persisting MTBI symptoms. This includes PE class, sports practices and games, and other high-risk/high-exertion activities such as running, bike riding, skateboarding, climbing trees, jumping from heights, playful wrestling, etc. The individual should be completely symptom free at rest and with physical exertion (e.g., sprints, non-contact aerobic activity) and cognitive exertion (e.g., studying, schoolwork) prior to return to sports or recreational activities.

Along with parent and teacher observation for continuing signs or symptoms of concussion, objective data in the form of formal neuropsychological testing may provide valuable information to assist with return to play decisions in younger athletes, as their symptom reporting may be more limited and less reliable. Formal neuropsychological testing of competitive athletes may also help physicians with return to play decisions, as athletes may minimize their symptoms to facilitate return to play.[1]

It is important to inform the athlete's coach, PE teacher, and/or athletic trainer that the athlete should not return to play until they are symptom-free and their cognitive function has returned to normal, both at rest and with exertion.

Return to play should occur gradually. Individuals should be monitored for symptoms and cognitive function carefully during each stage of increased exertion. Patients should only progress to the next level of exertion if they are asymptomatic at the current level. In competitive sports, a specific return to play protocol outlining gradual increase in activity has been established by the Concussion in Sport Group:[1]

- Rest
- Aerobic exercise (.e.g., stationary bicycle)
- Sport Specific training (e.g., running, skating)
- Non-contact drills (includes cutting and other lateral movements)
- Full-contact *controlled* training
- Full-contact game play

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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

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

Schedule Considerations:

- Shortened work day (e.g. 8am-12 noon)
- 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

Improving Communication with Patients with MTBI

Heads Up CDC

Content Source: National Center for Injury Prevention and Control, Division of Injury Response Heads Up! Concussion Information for Physicians Centers for Disease Control and Prevention

Patients with MTBI, particularly during the early post-injury phase, may have difficulties communicating with a physician. 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 physicians can do to improve communication with their patients.

Problem Area	Problem Description	What Physicians Can Do
Expression	▸ May have trouble thinking of specific words (wordfinding problems) or expressing the specifics of their symptoms or functional difficulties	▸ Allow patients time to express themselves ▸ Ask questions about specific symptoms and problems (i.e., are you having headaches?)
Comprehension	**Spoken:** ▸ May become confused if too much information is presented at once or too quickly ▸ Need extra time to understand what others are saying ▸ Have trouble following complex multi-step directions. ▸ May take longer than expected to respond to a question	▸ Speak slowly and clearly ▸ Use short sentences ▸ Allow time for patients to comprehend ▸ Provide both spoken and written instructions and directions
	Written: ▸ Read slowly	▸ Allow patients extra time to read and complete forms

	▹ Have trouble reading material in complex formats or with small print ▹ Have trouble filling out forms	▹ Provide written material in simple formats and large print when possible ▹ For patients who have trouble filling out forms themselves, have someone read the items and fill out the forms for them

In addition to the communications problems listed above, it is also important note that patients may be sensitive to environmental stimuli. In particular, patients may become disoriented or confused when exposed to:

- Bright lights
- Complex visual stimuli such as busy carpet patterns
- Noise, including from radio or TV

To address this, physicians should consider offering patients access to a quiet, low-stimulation waiting area if needed.

References

Heads Up CDC

Content Source: National Center for Injury Prevention and Control, Division of Injury Response Heads Up! Concussion Information for Physicians Centers for Disease Control and Prevention

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ImPACT® Reliability and Validity

Measurement of Symptoms Following Sports-related Concussion: Reliability and Normative Data for the Post-Concussion Symptom Scale

- **Authors:** Lovell, Iverson, Collins, Podell, Johnston, Pardini, Pardini, Norwig, Maroon
- **Publication:** Applied Neuropsychology
- **Date:** 2006-05-15

Validity of ImPACT for Measuring Attention and Processing Speed Following Sports-Related Concussion

- **Authors:** Iverson, Lovell, Collins
- **Publication:** Journal of Clinical and Experimental Neuropsychology
- **Date:** 2006-05-15

Abstract:
The purpose of this study was to examine the validity of ImPACT, a computerized neuropsychological test battery, for measuring attention and processing speed in athletes with concussions. This was accomplished by comparing the computerized testing to a traditional neuropsychological measure, the Symbol Digit Modalities Test. Participants were 72 amateur athletes who were seen within 21 days of sustaining a sports-related concussion. As predicted, the SDMT correlated most highly with the Processing Speed and Reaction Time composites from ImPACT.

High School Concussions in the 2008-2009 Academic Year

- **Authors:** William P. Meehan III, MD, Pierre d'Hemecourt, MD, R. Dawn Comstock, PhD
- **Publication:** The American Journal of Sports Medicine
- **Date:** 2011-06-02

Abstract:
Background: An estimated 136 000 concussions occur per academic year in high schools alone. The effects of repetitive concussions and the potential for catastrophic injury have made concussion an injury of significant concern for young athletes. Purpose: The objective of this study was to describe the mechanism of injury, symptoms, and management of sport-related concussions using the High School Reporting Information Online (HS RIO) surveillance system. Study Design: Descriptive epidemiology study. Methods: All concussions recorded by HS RIO during the 2008-2009 academic year were included. Analyses were performed using SPSS software. Chi-square analysis was performed for all categorical variables. Statistical significance was considered for P.05. Results: A total of 544 concussions were recorded. The most common mechanism (76.2%) was contact with another player, usually a head-to-head collision (52.7%). Headache was experienced in 93.4%; 4.6% lost consciousness. Most (83.4%) had resolution of their symptoms within 1 week. Symptoms lasted longer than 1 month in 1.5%. Computerized neuropsychological testing was used in 25.7% of concussions. When neuropsychological testing was used, athletes were less likely to return to play within 1 week than those for whom it was not used (13.6% vs 32.9%; P.01). Athletes who had neuropsychological testing appeared less likely to return to play on the same day (0.8% vs 4.2%; P = .056). A greater proportion of injured, nonfootball athletes had computerized neuropsychological testing than injured football players (23% vs 32%; P = .02) Conclusion: When computerized neuropsychological testing is used, high school athletes are less likely to be returned to play within 1 week of their injury. Concussed football players are less likely to have computerized neuropsychological testing than those participating in other sports. Loss of consciousness is relatively uncommon among high school athletes who sustain a sport-related concussion. The most common mechanism is contact with another player. Some athletes (1.5%) report symptoms lasting longer than 1 month. Keywords: concussion; sport-related concussion; mild traumatic brain injury; athletic injury; sports

Identifying Neurocognitive Deficits

- **Authors:** Danny G. Thomas, MD, MPH, Michael W. Collins, PhD, Richard A. Saladino, MD, Virginia Frank,
- **Publication:** Academic Emergency Medicine 2011
- **Date:** 2011-06-02

Abstract:
Objectives: This study of concussed adolescents sought to determine if a computer-based neurocognitive assessment (Immediate Postconcussion Assessment and Cognitive Test [ImPACT]) performed on patients who present to the emergency department (ED) immediately following head

injury would correlate with assessments performed 3 to 10 days postinjury and if ED neurocognitive testing would detect differences in concussion severity that clinical grading scales could not. Methods: A prospective cohort sample of patients 11 to 17 years of age presenting to the ED within 12 hours of a head injury were evaluated using two traditional concussion grading scales and neurocognitive testing. ED neurocognitive scores were compared to follow-up scores obtained at least 3 days postinjury. Postconcussive symptoms, outcomes, and complications were assessed via telephone followup for all subjects. Results: Sixty patients completed phone follow-up. Thirty-six patients (60%) completed follow-up testing a median of 6 days postinjury. Traditional concussion grading did not correlate with neurocognitive deficits detected in the ED or at follow-up. For the neurocognitive domains of verbal memory, processing speed, and reaction time, there was a significant correlation between ED and follow-up scores trending toward clinical improvement. By 2 weeks postinjury, 23 patients (41%) had not returned to normal activity. At 6 weeks, six patients (10%) still had not returned to normal activity. Conclusions: Immediate assessment in the ED can predict neurocognitive deficits seen in follow-up and may be potentially useful to individualize management or test therapeutic interventions. Neurocognitive assessment in the ED detected deficits that clinical grading could not and correlated with deficits at follow-up.

Neurocognitive and Symptom Predictors of Recovery

- **Authors:** Brian Lau, BS, Mark R. Lovell, PhD, Michael W. Collins, PhD, Jamie Pardini, PhD
- **Publication:** Clin J Sport Med Volume 0, Number 0, Month 2009
- **Date:** 2011-06-02

Abstract:
Objectives: The purpose of this study was to identify specific symptom and neuropsychological test patterns that might serve as prognostic indicators of recovery in concussed high school football players. The recently proposed simple versus complex concussion classification was examined and specific symptom clusters were identified. Design: Case–control study. Setting: High school football. Participants: Subjects were 108 recently concussed male high school football athletes between the ages of 13 and 19 (mean = 16.01) years. Assessment of Risk Factors: Participants were evaluated by utilizing the Immediate Postconcussion Assessment and Cognitive Testing computer-based neurocognitive test battery at before injury and within an average of 2.23 days of injury. All athletes were followed until they met criteria for clinical recovery. Main Outcome Measures: Symptom ratings and neurocognitive test performance. Results: Both neurocognitive test results and self-reported symptom data had prognostic value in determining time to clinical recovery. Self-reported cognitive decline, Immediate Postconcussion Assessment and Cognitive Testing reaction time, and migraine headache symptoms were associated with longer time to clinical recovery. Overall, these difficulties were predictive of concussions that were retrospectively classified as complex. Conclusions: Specific symptom clusters and neurocognitive test results may have predictive value to classifying and managing concussions. Key Words: concussion, complex, neurocognitive, symptoms, simple

Sensitivity and Specificity of Subacute

- **Authors:** Brian C. Lau, BS, Michael W. Collins, PhD, Mark R. Lovell, PhD
- **Publication:** The American Journal of Sports Medicine
- **Date:** 2011-06-02

Abstract:
Background: Concussions affect an estimated 136 000 high school athletes yearly. Computerized neurocognitive testing has been shown to be appropriately sensitive and specific in diagnosing concussions, but no studies have assessed its utility to predict length of recovery. Determining prognosis during subacute recovery after sports concussion will help clinicians more confidently address return-to-play and academic decisions. Purpose: To quantify the prognostic ability of computerized neurocognitive testing in combination with symptoms during the subacute recovery phase from sports-related concussion. Study Design: Cohort study (prognosis); Level of evidence, 2. Methods: In sum, 108 male high school football athletes completed a computer-based neurocognitive

test battery within 2.23 days of injury and were followed until returned to play as set by international guidelines. Athletes were grouped into protracted recovery (.14 days; n, 50) or short-recovery (14 days; n, 58). Separate discriminant function analyses were performed using total symptom score on Post-Concussion Symptom Scale, symptom clusters (migraine, cognitive, sleep, neuropsychiatric), and Immediate Postconcussion Assessment and Cognitive Testing neurocognitive scores (verbal memory, visual memory, reaction time, processing speed). Results: Multiple discriminant function analyses revealed that the combination of 4 symptom clusters and 4 neurocognitive composite scores had the highest sensitivity (65.22%), specificity (80.36%), positive predictive value (73.17%), and negative predictive value (73.80%) in predicting protracted recovery. Discriminant function analyses of total symptoms on the Post-Concussion Symptom Scale alone had a sensitivity of 40.81%; specificity, 79.31%; positive predictive value, 62.50%; and negative predictive value, 61.33%. The 4 symptom clusters alone discriminant function analyses had a sensitivity of 46.94%; specificity, 77.20%; positive predictive value, 63.90%; and negative predictive value, 62.86%. Discriminant function analyses of the 4 computerized neurocognitive scores alone had a sensitivity of 53.20%; specificity, 75.44%; positive predictive value, 64.10%; and negative predictive value, 66.15%. Conclusion: The use of computerized neurocognitive testing in conjunction with symptom clusters results improves sensitivity, specificity, positive predictive value, and negative predictive value of predicting protracted recovery compared with each used alone. There is also a net increase in sensitivity of 24.41% when using neurocognitive testing and symptom clusters together compared with using total symptoms on Post-Concussion Symptom Scale alone. Keywords: concussion; prognosis; symptoms; neurocognitive testing

The Value Added of Neurocognitive Testing After Sports-Related Concussion

- **Authors:** Van Kampen, Lovell, Pardini, Collins, Fu
- **Publication:** The American Journal of Sports Medicine
- **Date:** 2006-06-01

Abstract:
Neurocogntive testing has been endorsed as a 'cornerstone' of concussion management by recent Vienna and Prague meetings of the Concussion In Sport Group. Neurocognitive testing is important given the potential unreliability of athlete self-report after injury. Relying only on athletes' reports of symptoms may result in premature return of athletes to contact sport, potentially exposing them to additional injury.

ImPACT Normative Data for Children (Ages 11-14)

- **Authors:** Lovell, Collins, Maroon
- **Publication:** The ImPACT Test
- **Date:** 2006-05-18

Abstract:
Normative Data for the ImPACT Composite Scores A sample of 205 elementary, junior high, and high school students was initially used for this project. Three of these subjects had incomplete test data and were subsequently dropped from the normative sample. The current normative sample consists of 102 boys and 100 girls between the ages of 11 and 14. Multiple analysis of variance (MANOVA) was performed to allow an analysis of performance differences between gender and age across multiple neuropsychological domains.

No Cumulative Effects for One or Two Previous Concussions

- **Authors:** Iverson, Brooks, Collins, Lovell
- **Publication:** British Journal of Sports Medicine

- **Date:** 2006-05-15

Recovery From Sports Concussion in High School and Collegiate Athletes

- **Authors:** McClincey, Lovell, Collins, Pardini
- **Publication:** Brain Injury
- **Date:** 2006-05-15

Abstract:
Neuropsychological testing is a variable tool in concussion diagnosis and management. ImPACT, a computerized neuropsychological testing program, consists of eight cognitive tasks and a 21-item symptom inventory. ImPACT was used to examine the cognitive performance of 104 concussed athletes at baseline, 2, 7, and 14 days post-injury. Dependent measures included composite scores from the ImPACT computerized test battery, as well as a total symptom score from the Post-Concussion Symptom Scale.

Tracking Neuropsychological Recory Following Concussion In Sportsve

- **Authors:** Iverson, Brooks, Collins, Lovell
- **Publication:** Brain Injury
- **Date:** 2006-05-15

Sensitivity and Specificity of the ImPACT Test Battery for Concussion in Athletes

- **Authors:** Schatz, Pardini, Lovell, Collins, Podell
- **Publication:** Archives of Clinical Neuropsychology
- **Date:** 2005-08-03

Abstract:
This study explored the diagnostic utility of the composite scores of Immediate Post-Concussion Assessment and Cognitive Testing and Post Concussion Symptom Scale scores. Recently concussed high school athletes were tested within 72h of sustaining a concussion, and data were compared to non-concussed high school athletes with no history of concussion.

Athlete Concussion Management Guidelines Using Functional Magnetic Resonance Imaging

- **Authors:** Lovell, Collins, Fu, Stump
- **Publication:** Orthopaedic Technology Review
- **Date:** 2004-01-01

Grade 1 or 'Ding' Concussions in High School Athletes

- **Authors:** Lovell, Collins, Iverson, Johnston, Bradley
- **Publication:** American Journal of Sports Medicine
- **Date:** 2004-01-01

Abstract:
Recent concussion management guidelines have suggested that athletes with mild (grade 1) concussions may be returned to play if asymptomatic for 15 minutes. The purpose of this study was to assess the utility of a current concussion management guideline in classifying and managing mild concussion. Forty-three high school athletes completed neuropsychological test performance and symptom ratings prior to the season and at two times during the 1st week following mild concussion.

New Developments in the Management of Sports Concussion

- **Authors:** Collins, Stump, Lovell
- **Publication:** Current Opinion in Orthopaedics
- **Date:** 2004-01-01

Interpreting Change on ImPACT Following Sports Concussion

- **Authors:** Iverson, Lovell, Collins
- **Publication:** The Clinical Neuropsychologist
- **Date:** 2003-05-01

Abstract:
The purpose of this study was to examine the psychometric characteristics of Version 2.0 of ImPACT. The focus was on the stability of the test scores and the calculation of reliable change confidence intervals for the test-retest difference scores. A sample of 56 nonconcussed adolescents and young adults completed the test battery on two occasions. Test-retest coefficients, reliable change difference scores, and confidence intervals for measurement error are provided. These reliable change parameters were applied to a second sample of 41 concussed amateur athletes who were tested preseason and within 72 hr of injury. Applying these confidence intervals allows more precise determinations of deterioration, improvement, and recovery in the initial days following concussion.

Construct Validity of ImPACT in Athletes with Concussion

- **Authors:** Iverson, Franzen, Lovell, Collins
- **Publication:** Presented at the National Academy of Neuropsychologist's Annual Meeting
- **Date:** 2003-01-01

Abstract:
The purpose of this study was to examine the convergenet and divergent validity of computerized neuropsychological testing in a sample of athletes with concussion.

Differential Sensitivity of Symptoms and Neuropsychological Testing Following Sports Related Concussion

- **Authors:** Lovell, Collins, Bradley, Van Kampen, Moritz, McClincey
- **Publication:** British Journal of Sports Medicine
- **Date:** 2003-01-01

Recovery From Mild Concussion in High School Athletes

- **Authors:** Lovell, Collins, Iverson, Field, Maroon, Cantu, Podell, Powell, Belza, Fu
- **Publication:** Journal of Neurosurgery
- **Date:** 2003-01-01

Abstract:
The objective of this study was to evaluate memory dysfunction and self-report of symptoms in a group of concussed high school athletes utilizing a computerized neuropsychological test battery. Neuropsychological performance prior to and following concussion is compared with the test performance and age-matched comparison group. Potentially important diagnostic markers of concussion severity are discussed and linked to recovery within the first week of injury.

Relationship Between Post-Concussion Headache and Neuropsychological Test Performance in High School Athletes?

- **Authors:** Collins, Field, Lovell, Iverson, Johnston, Maroon, Fu
- **Publication:** American Journal of Sports Medicine
- **Date:** 2003-01-01

Abstract:
The relevance of headache to outcome following sports concussion is poorly understood and no studies exist examining this issue. The current study was conducted to investigate whether post-concussion headaches are associated with neurocognitive deficits and/or presence of other post-concussion symptoms at approximately one-week post injury. Study participants included 110 high school athletes who sustained concussion. Concussed athletes were divided into two groups, those reporting no headache at approximately day 7 post-injury and those reporting headaches. Dependent measures included symptom and neurocognitive test results collected via ImPACT, a computerized neuropsychological test battery.

New Developments in the Management of Sports Concussion

- **Authors:** Lovell, Collins
- **Publication:** Current Sports Medicine Reports
- **Date:** 2002-01-01

Validity of ImPACT for Measuring the Effects of Sports-Related Concussion

- **Authors:** x
- **Publication:** Archives of Clinical Neuropsychology
- **Date:** 2002-01-01

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Published Abstracts

ImPACT of Sleep Deprivation on Symptoms and Neurocognitive Performance of Orthopaedic Residents

- **Authors:** Rohde, Collins, Lovell, Pardini, Fu
- **Publication:** Proceedings of the American Academy of Orthopaedic Surgeons
- **Date:** 2006-05-18

Cognitive Recovery Patterns Following Sports Related Concussion

- **Authors:** Collins, McClincey, Lovell, Stump, Lowe, Maroon, Fu
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

Concussion in Sports: Relationship of Activity Level After Concussion to Post-Concussive Symptoms and Neurocognitive Performance

- **Authors:** Majerske, Collins, Mihalik, Lovell, Wagner, Burke
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

Differential Sensitivity of Symptoms and Neuropsychological Testing Following Sports-Related Concussion

- **Authors:** Lovell, Collins, Bradley, Van Kampen, Moritz, McClincey
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

Functional Neuroimaging and Neurocognitive Recovery After Sports-Related Concussion

- **Authors:** Stump, Lovell, Eddy, Roush, Welling, Bakal, Becker, Collins, Lowe
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

No Cumulative Effects For One or Two Prior Concussions

- **Authors:** Iverson, Lange, Lovell, Collins
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

Posttraumatic Migraine Following Sports-Related Mild Traumatic Brain Injury

- **Authors:** Mihalik, Collins, Lovell, Lowe, Maroon
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

Sensitivity and Specificity of the ImPACT Test Battery in Athletes' Concussion Status

- **Authors:** Stump, Shatz, Lovell, Collins
- **Publication:** In International Neuropsychological Society: 32nd Annual Meeting Program and Abstracts
- **Date:** 2004-01-01

Sensitivity and Specificity of the ImPACT Test Battery in Athletes' Concussion Status

- **Authors:** Schatz, Lovell, Collins, Moritz, Bradley
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

Sex Differences in Acute Recovery Following Concussion in Athletes

- **Authors:** Mihalik, Stump, Lovell, Collins, Norwig, Hagan, Fu
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

Symptom Recovery Following Concussion: Implications for Return to Play

- **Authors:** Stump, Collins, Lovell, Norwig, Lowe, McClincy, Fu
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

The Post-Concussion Symptoms Scale (PCSS): A Factor Analysis

- **Authors:** Pardini, Stump, Lovell, Collins, Moritz, Fu
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

Tracking Neuropsychological Recovery Following Conccusion

- **Authors:** Iverson, Collins, Gaetz, Lovell
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

Validity of ImPACT For Measuring Attention & Processing Speed Following Sports-Related Concussion

- **Authors:** Iverson, Lovell, Collins
- **Publication:** British Journal of Sports Medicine
- **Date:** 2004-01-01

Computerized Neuropsychological Testing in Sports-Related Concussion: Reliability and Validity of ImPACT

- **Authors:** Iverson, Lovell, Podell, Collins
- **Publication:** Journal of International Neuropsychological Society
- **Date:** 2003-01-01

Outcome From Concussion in Amateur Soccer Players

- **Authors:** Iverson, Moseley, Collins, Lovell
- **Publication:** Journal of the International Neuropsychological Society
- **Date:** 2003-01-01

Reliable Change in ImPACT Version 2.0 Following Sports Concussion

- **Authors:** Iverson, Lovell, Collins
- **Publication:** Archives of Clinical Neuropsychology
- **Date:** 2003-01-01

Cumulative Effects of Concussion in Amateur Athletes

- **Authors:** Iverson, Gaetz, Collins, Lovell
- **Publication:** Archives of Clinical Neuropsychology
- **Date:** 2002-01-01

Inaccuracy of Symptom Reporting Following Concussion in Athletes

- **Authors:** Lovell, Collins, Maroon, Cantu, Hawn, Burke, Fu
- **Publication:** Medicine and Science in Sports Exercise
- **Date:** 2002-01-01

Memory Dysfunction Eight-Days Post Injury in High School Athletes

- **Authors:** Collins, Lovell, Maroon, Cantu, McKeag
- **Publication:** Medicine and Science in Sports and Exercise
- **Date:** 2002-01-01

Recovery Patterns Following Concussion: Implications for Return to Play

- **Authors:** Collins, Lovell, Hawn, Maroon, Norwig, Grove, White, Grollman
- **Publication:** Journal of Athletic Training
- **Date:** 2002-01-01

Relation Between Fogginess and Outcome Following Concussion

- **Authors:** Iverson, Gaetz, Lovell, Collins
- **Publication:** Archives of Clinical Neuropsychology
- **Date:** 2002-01-01

Tracking Recovery From Concussion Using ImPACT: Applying Reliable Change Methodology

- **Authors:** Iverson, Lovell, Collins, Norwig
- **Publication:** Archives of Clinical Neuropsychology
- **Date:** 2002-01-01

Validity of ImPACT for Measuring the Effects of Sports-Related Concussion

- **Authors:** Iverson, Lovell, Collins
- **Publication:** Archives of Clinical Neuropsychology
- **Date:** 2002-01-01

Neuropsychological Testing in Sports: Past, Present, and Future

- **Authors:** Lovell, Collins, Fu, Burke, Maroon, Podell, Powell
- **Publication:** British Journal of Sports Medicine
- **Date:** 2001-01-01

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Symptoms Following Concussion

Relationship Between Subjective Fogginess and Neuropsychological Testing Following Concussion

- **Authors:** Iverson, Gaetz, Lovell, Collins
- **Publication:** Journal of International Neuropsychological Society
- **Date:** 2002-10-01

Abstract:
The purpose of this study was to examine the relation between the subjective report of feeling foggy at one-week post concussion and acute neuropsychological outcome. The outcome variables were derived from a computerized neuropsychological screening battery (ImPACT). Participants were 110 high school students who sustained a sport-related concussion and were evaluated 5-10 days post injury...

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Neuropsychological Testing in Professional Sports.

- **Authors:** Lovell, Collins
- **Publication:** Sports Medicine and Neurosurgery
- **Date:** 1999-01-01

Abstract:
Sports Medicine and Neurosurgery

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Mild Traumatic Brain Injury in Sports: An International Perspective

- **Authors:** Lovell, Echemendia, Barth, Collins
- **Publication:** Swets-Zeitlinger
- **Date:** 2004-01-01

Sports-Related Concussion

- **Authors:** Bailes, Lovell, Maroon
- **Publication:** Quality Medical Publishers
- **Date:** 1999-01-01