UPMC Rehab Grand Rounds

Physiatric Approach to Sports Concussion

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Clinical Vignette

A healthy 18-year-old, right-handed male had his legs swept out from under him during a lacrosse game on a Saturday afternoon. Wearing a helmet, he struck the posterior aspect of his head swiftly against the ground. His teammates reported that he appeared dazed while lying on the ground but did not lose consciousness. One minute after the event, he was able to stand on his own and walk off the field with little assistance.

Sideline assessment by his trainer found him to be confused and unable to state the location, details of the game, or date. He could not remember three words given to him or recite a short list of numbers backwards. In the 15 minutes following his injury, his confusion resolved and repeat cognitive assessment was normal. He did not return to the contest, and sat on the bench for the remainder of the game. Over the next several hours, he reported worsening headache, light and sound sensitivity, "fogginess," and dizziness. He was evaluated in the emergency department after the game, where neurological examination and head CT were normal. He was diagnosed with a concussion and sent home without further instructions.

He returned to school on Monday despite a mild lingering headache. Over the next two days at school, he noted significant increase in symptoms including headache, light and sound sensitivity, dizziness, and poor concentration. His sleep became fragmented and he had significant daytime fatigue. He was evaluated by his pediatrician, who referred him to the UPMC Brain Injury Rehabilitation Clinic for further treatment.

Definition of Problem

It is estimated that more than 3 million sports and recreation-related head injuries occur annually in the United States, though actual rates of incidence are difficult to ascertain because many head injuries go unreported.[1] The management of sports-related concussion has evolved significantly over the last decade. Traditional grading scales, once the foundation of concussion assessment and management, have been replaced by evidence-based protocols that rely on individualized assessment. Physiatrists are uniquely equipped to manage this injury because concussion represents an intersection between sports medicine and brain injury rehabilitation.

On-field assessment of injury must begin with emergent first-aid protocols to identify acute spinal or more severe brain injury requiring immediate neuroimaging and intervention. When life-threatening and acute medical injuries have been excluded, symptoms of concussive injury should be assessed. Direct trauma to the head or loss of consciousness may not have occurred, and the athlete may be unaware that he or she has been injured. Diagnostic evaluation is often complicated by symptom minimization due to personal or outside pressure to continue playing.[2]

Amnesia, confusion, and loss of consciousness are recognized as the three key acute markers of injury. Amnesia is defined as loss of memory for events preceding or following the injury. Confusion is characterized by lack of awareness or abnormal orientation to questioning, and the athlete may appear glassy-eyed or dazed. Loss of consciousness, which is estimated to occur in less than 10 percent of sports-related head injuries, is a disorder of consciousness itself marked by an athlete's being unresponsive to external stimuli, typically with eyes closed. Amnesia is the acute marker most predictive of injury severity and duration; loss of consciousness, previously a key factor in concussion grading scales, has not been found to predict injury severity.[3]

Educational tools, such as the Standardized Assessment of Concussion (see Table 1), have been developed to aid athletic trainers and medical responders in recognizing these markers of injury. These screening tools should not be used to guide management, nor implemented as a replacement for comprehensive neuropsychological testing. When a sports-related head injury is identified, medical evaluation should be pursued.

1) ORIENTATION:

Month: _____ 0 1
Date: _____ 0 1
Day of week: _____ 0 1
Year: _____ 0 1
Time (within 1 hr): _____ 0 1
Orientation Total Score _____ / 5

2) IMMEDIATE MEMORY: (all 3 trials are completed regardless of score on trial 1 & 2; total score equals sum across all 3 trials)

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

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

NEUROLOGIC SCREENING:

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

3) CONCENTRATION:

Digits Backward (If correct, go to next string length. If incorrect, read trial 2. Stop after incorrect on both trials.)

4-9-3 6-2-9 _____ 0 1
3-8-1-4 3-2-7-9 _____ 0 1
6-2-9-7-1 1-5-2-8-6 _____ 0 1
7-1-8-4-6-2 5-3-9-1-4-8 _____ 0 1

Months in Reverse Order: (entire sequence correct for 1 point)

Dec-Nov-Oct-Sep-Aug-Jul
Jun-May-Apr-Mar-Feb-Jan _____ 0 1
Concentration Total Score _____ / 1

EXERTIONAL MANEUVERS
(when appropriate):

5 jumping jacks 5 push-ups
5 sit-ups 5 knee bends

4) DELAYED RECALL:

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

SUMMARY OF TOTAL SCORES:

Orientation _____ / 5
Immediate Memory _____ / 15
Concentration _____ / 5
Delayed Recall _____ / 5
Overall Total Score _____ / 30

Reproduced from standardized Mental Status Testing on the Sideline After Sports Related Concussion, Michael McCrea, *Journal of Athletic Training*, Jul-Sep; 36(3):

Table 1: Standardized Assessment of Concussion (SAC)

Medical Assessment

Initial medical assessment often will occur in an emergency department or primary care physician's office, and more rarely at a specialized concussion or brain injury clinic. Initial focus should exclude more severe brain trauma using neuroimaging to identify structural damage. Neuroimaging also should be used to investigate focal deficits or worsening symptoms in presentations of prolonged disorders of consciousness.[4] A comprehensive history and physical examination should include thorough investigation of post-concussive symptoms and complete neurological assessment with attention to gait and balance, as described in detail below.

Postconcussion Symptoms

The Centers for Disease Control and Prevention has noted in its recent definition of concussion four distinct symptom clusters that mark the clinical presentation of concussion: cognitive, somatic, emotional, and sleep-related (see Figure 1). The CDC definition further notes that these symptoms may be highly variable in severity and duration, lasting from minutes to days, weeks, months, or longer.[5]

Somatic Symptoms

Headache is the most common symptom to be reported after concussion, occurring in up to 86 percent of patients.[6] It is important to remember that post-traumatic headaches can occur for a variety of etiologies, including musculoskeletal, vascular, and neuropathic conditions. A comprehensive headache evaluation should be completed so that intervention may be directed appropriately. Headache assessment includes pre-injury headache history, location, duration, severity, aggravating and alleviating factors, medications used, associated symptoms (nausea, vomiting, dizziness, etc.) and presence of aura. Post-traumatic headaches may not manifest immediately though the quality, intensity, and location will tend to remain constant. Abrupt changes in headache severity or mental status changes require immediate evaluation.

Cervical musculoskeletal injuries, including myofascial pain and whiplash-related strain, may produce pain in the neck or skull base radiating forward in a typical cervicogenic headache pattern. Physical examination should include assessment of cervical range of motion, the presence of trigger points, and tenderness over the greater occipital nerve origins. Early intervention with physical therapy and massage can be particularly helpful for these symptoms. Trigger point injections with local anesthetic also can be beneficial in appropriate patients.

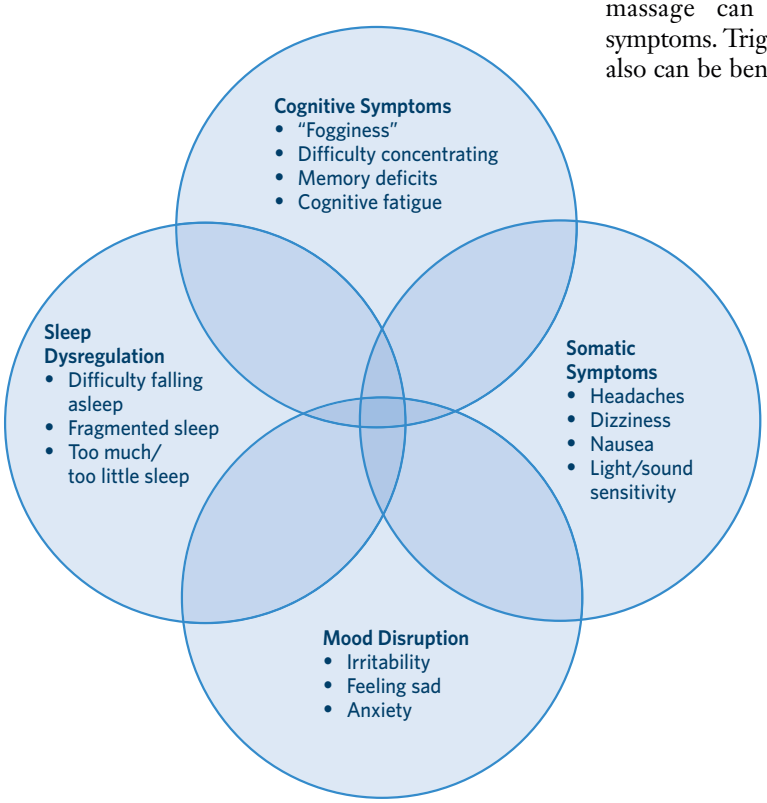

Figure 1: Postconcussion Symptoms

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Tension or migraine-like headaches may be treated with medications traditionally used for nontraumatic headache, including preventive medications such as antidepressants, anticonvulsants, beta blockers, calcium channel blocks, or abortive medications such as triptans.[7] In the adolescent population, amitriptyline has been well-studied for headache prevention with doses starting at 10 mg titrating to 30 to 50 mg nightly, though its use is often limited by its sedating side effects. Propranolol is also commonly used in this population with doses starting at 10 mg daily with an increase to 60 mg daily in one or divided doses. At this dose, changes in blood pressure are uncommon, but patients should be counseled about potential side effects. Topiramate, gabapentin, and valproic acid also have shown documented efficacy for management of headaches; however, cognitive side effects from these medications may exacerbate other postconcussive symptoms. Care should be taken to advise patients to minimize use of NSAIDs to prevent rebound headache.

Dizziness and vertigo have been reported as commonly as 78 percent following concussion.[8] A screening tool, such as the Dizziness Handicap Scale, and focused vestibular examination should be used to evaluate all patients with complaints of dizziness or vertigo.[9] In-office vestibular evaluation should include Romberg testing and tests of gaze stabilization.

Romberg testing should be performed with arms crossed across chest, with eyes open and closed, and with feet together and tandem stance for 30 seconds. Patients with mild vestibular dysfunction will sway with eyes closed; patients with more severe vestibular dysfunction or central lesions will sway with eyes open. Tests of the oculomotor/vestibulo-ocular system should include investigation for abnormal pursuits and saccades, abnormal convergence with near vision, and presence of nystagmus. The vestibulo-ocular reflex can be tested by having the patient focus on a stationary object while moving the head from side to side; this test is positive if it reproduces blurring and dizziness. Referral to an experienced vestibular therapist is encouraged when abnormalities are detected. Medications such as meclizine, which work by suppressing vestibular function, are discouraged as they tend to negatively impact CNS compensation for a unilaterally deranged vestibular apparatus.[10]

Emotional Symptoms

Mood disorders are common throughout the spectrum of brain injury and are thought to have some basis in physiologic changes of neurochemistry. In athletes, dramatic mood changes may be due to the inability to participate in sports or physical activity. In severe cases where postconcussive symptoms impair other life roles, such as school, work, or homemaking, this isolation can lead to anxiety or depression. Counseling is often recommended as an adjunct to antidepressants or anxiolytics for treatment of acute adjustment reaction.

Sleep Symptoms

Sleep dysregulation is common after traumatic brain injury, and includes symptoms such as fragmented sleep or hypersomnia.[11] Proper sleep hygiene should be the first step in regulating sleep disturbance after concussion. Appropriate measures include creating a sleep schedule, avoiding daytime napping, minimizing caffeine, and reducing cognitive stimulation prior to bed. Melatonin, available over the counter, has been efficacious for disorders of sleep initiation at doses from 1 to 3 mg nightly. Trazodone is also frequently used for sleep cycle regulation at doses ranging from 25 mg to 150 mg nightly. Non-benzodiazepine hypnotics or benzodiazepines should be used with caution and reserved for refractory cases of sleep cycle dysregulation.

Cognitive Symptoms

Subjective reports of cognitive symptoms, such as fogginess, difficulty concentrating, memory deficits, and cognitive fatigue, are also commonly reported after concussion.[12] These reports may be confirmed objectively by impairments noted on neuropsychological testing. In a study of athletes self-reporting feelings of "fogginess," foggy athletes were more likely to have other postconcussion symptoms than those who did not feel foggy.[13] Foggy patients were more impaired on neuropsychological testing, as evidenced by slower reaction times, poorer short-term memory performance, and slower processing speed compared to nonfoggy patients.

Neurostimulants may play a role in the treatment of impaired concentration, attention, and reaction time. More research is needed in this area, but clinical observation is promising. Unpublished data from our program has found significant improvement in symptoms and neuropsychological testing using amantadine at 200 mg in divided doses in adults, or with pediatric dosing for patients less than 40 kg. In our study, amantadine was initiated at least three weeks after injury and subjects were compared to age- and gender-matched controls.

Concussion Modifiers

The most recent consensus statement from the International Conference on Concussion in Sport (ICCS) identified concussion "modifiers" that may further influence return-to-play recommendations (Table 2). A comprehensive medical interview following concussive injury can identify these modifying factors. The presences of modifiers should make physicians more aware of athletes at risk for prolonged recovery, as well as those who would benefit from the expertise of a physician specializing in the management of concussion.[4]

Neuropsychological Assessment

The most significant advancement in the field of concussion management is the development and clinical implementation of neuropsychological testing programs. Neuropsychological testing measures domains such as verbal and visual memory, complex attention, reaction time, and processing speed. In athletics, this is particularly useful in the diagnosis and tracking of recovery when baseline (preseason) testing is performed and compared with post-injury scores.

Factors	Modifiers
Symptoms	Number Duration (> 10 days) Severity
Signs	Prolonged loss of consciousness (>1 min), amnesia
Sequelae	Concussion convulsions
Temporal	Frequency — repeated concussions over time Timing — injuries close together in time "Recency" — recent concussion or traumatic brain injury
Threshold	Repeated concussions occurring with progressively less impact force or slower recovery after each concussion.
Age	Child and adolescent (>18 years)
Co- and pre-morbidities	Migraine, depression or other mental health disorders, attention deficit hyperactivity disorder, learning disabilities, sleep disorders
Medication	Psychoactive drugs, anticoagulants
Behavior	Dangerous style of play
Sport	High risk activity, contact and collision sport, high sporting level

Reproduced from Consensus Statement of Concussion in Sport: the 3rd International Conference on Concussion in Sport held in Zurich, November 2008, P. McCrory, W. Meeuswisse, K. Johnston, J. Dvorak, M. Aubry, M. Molloy, R. Cantu; *Br. J Sports Med;* 43;i76-i84 with permission from BMJ Publishing Group, Ltd.

Table 2: Concussion modifiers which may further influence return to play indicators

Since 2001, the ICCS has underscored the importance of neuropsychological testing in the conference's published proceedings.[4,14,15] The group recommended that post-injury neurocognitive testing should be a "cornerstone" of proper management and return-to-play decision making, but should be used only in conjunction with medical evaluation and risk factor analysis. Cognitive instruments such as ImPACT® have been implemented by several professional sporting leagues, as well as college and high school athletic associations, for this purpose.

Management

In the initial days following injury, the patient should be instructed on the benefits of proper sleep hygiene, physical rest, and cognitive rest. A retrospective evaluation has shown delayed recovery in both visual memory and reaction time in athletes who excessively exerted themselves, either physically or cognitively.[16] This underscores the importance of early identification and patient education, especially for student athletes. For example, students should be kept out of school until symptoms are controlled, and upon returning to school, academic accommodations should be requested by the physician. Specifically, physician documentation should alert the school that the athlete may require untimed tests or open-note tests, reduced workload by 50 percent, and extra time for homework projects. These accommodations should be considered part of the medical management of the injury and should remain in place until the student athlete is completely asymptomatic during rest and exertion.

Return to Play

The standard of care now accepted for concussion management is that athletes meet three criteria before returning to sport:

- asymptomatic at rest
- asymptomatic with exertion
- return to baseline or normative values with neuropsychological testing[14]

In addition to these criteria, the athlete should be off any symptom-modifying medication before returning to activity.

Clinical Vignette Outcome and Treatment

One week after sustaining his concussion, the patient remained symptomatic upon evaluation at the UPMC Brain Injury Rehabilitation Clinic. He reported daily headaches, associated with light and sound sensitivity and difficulty concentrating. His physical examination was normal except for a grossly positive Romberg test with feet together and eyes closed at five seconds, and an increase in dizziness with tests of gaze stabilization. Compared to pre-injury baseline assessment, the patient's postinjury neurocognitive data suggested significant impairment in the domains of memory, processing speed, and reaction time. Given these findings, he was provided education regarding limitations on physical and cognitive exertion. He also was educated on sleep hygiene techniques, including limiting caffeine and adhering to a sleep schedule. Because he was reporting significant symptoms during school, he was held out of school for one week.

At his one-week follow-up, he reported modest improvement of his symptoms, including a decrease in the frequency and severity of headaches. He continued to have complaints of dizziness and he was noting more difficulty both falling and staying asleep. For these ongoing symptoms, he was referred to vestibular therapy and was prescribed low-dose trazodone 50 mg nightly for sleep cycle regulation.

In the following two weeks, the patient's sleep cycle significantly improved and his headaches dissipated when at rest. His concentration improved and he began catching up on schoolwork at home, though he reported easy fatigability. When he was able to tolerate limited cognitive exertion at home, he returned to half-days of school. He participated in vestibular therapy, with significant improvements in balance and dizziness. He was asymptomatic at rest within four weeks of injury and was started on very light aerobic activity gradually progressing to sport-specific drills. At six weeks postinjury, the patient was symptom free both at rest and with exertion and his neuropsychological tests returned to baseline. He was returned to school full-time and cleared for return to play.

Conclusions

Concussion is a functional injury that results in a constellation of somatic, emotional, cognitive, and sleep-related symptoms. An individualized approach integrating acute on-field markers of injury, patient-reported symptoms, physical examination, and objective neuropsychological data is vital in properly managing concussion. Though many patients will improve in the first three weeks after injury, the symptoms of concussion are variable and can last weeks, months, or longer. Management of this injury should be a multidisciplinary effort with physicians specializing in concussion working in conjunction with neuropsychologists, athletic trainers, and athletes to ensure a safe return to contact sports.

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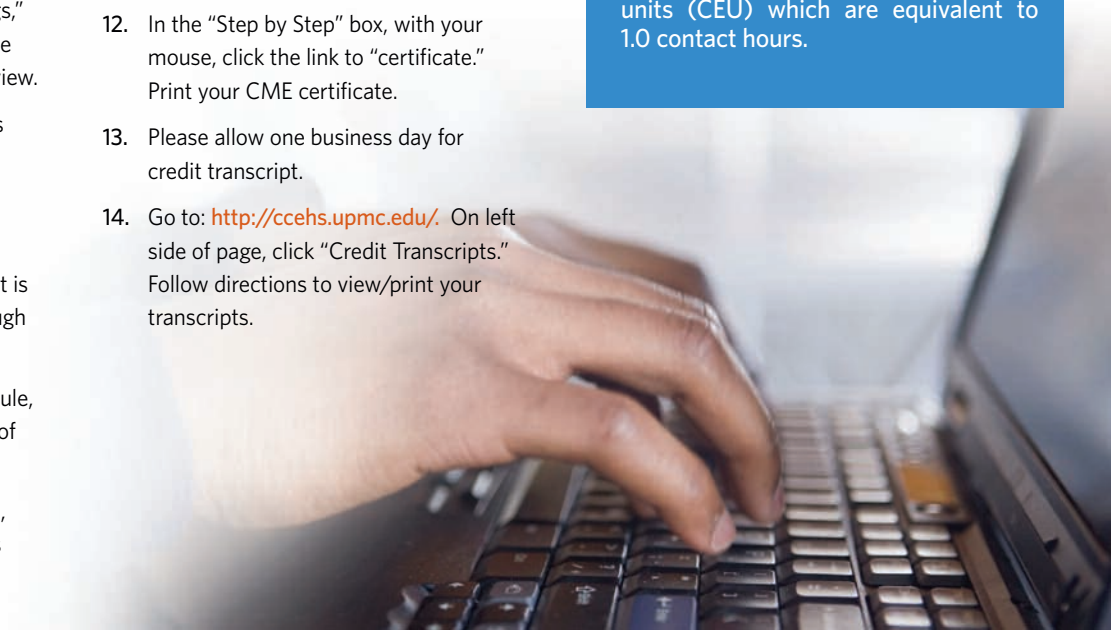

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