

CONCUSSION: NOT JUST A BUMP ON THE HEAD

Assessment and Management of a Complex Population

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Case: A 14-year-old girl presents to your office for initial evaluation with complaints of increased anxiety and that her grades have fallen within the past semester. She describes difficulty focusing and concentrating during classes. When you question her further, she reveals that while she was spotting a stunt during cheerleading practice, one of the fliers hit her in the head with her elbow as she caught her. The incident occurred two months ago. After the injury she was slightly confused and did not remember what had occurred, but she did not lose consciousness. She went to the emergency room, had a negative CT scan, and was told to follow up with her pediatrician, which she has not done yet.

Emergency room visits for recreation-related traumatic brain injury (TBI) in children and adolescents has increased by 60% during the last decades.¹ A myriad of research has been published about the impact of concussion and the potential for long-term health consequences, but there continue to be areas of confusion regarding diagnosis and treatment. Studies suggest that concussion accounts for 8.9% of high school sports injuries;² however, many school athletes are unaware of the symptoms of concussion and continue playing despite post-concussive symptoms. Most patients recover from concussion within 10 days, but lingering symptoms such as depression and anxiety are oftentimes overlooked. Nearly all athletic sports pose a risk of concussive injury, but football and ice hockey have the greatest incidence, followed by soccer, wrestling, basketball, field hockey, baseball, softball, and volleyball.³

Underlying Mechanisms

Concussions involve an impact force of the head coming into contact with an object with resultant rotational acceleration and/or deceleration forces, which damage the brain by stressing or straining the tissue, vasculature, and other neural elements.⁴ Since the brain is composed largely of water, it deforms easily when shearing forces are applied. After injury, a cascade of neurotransmitters are released, related to an injury-induced ionic flux across the cell membrane.⁵ There is subsequently an initiation of uncontrolled metabolic cascades, cell damage via lipases, proteases, and endonucleases. Secondary neural damage then occurs, resulting in cell death and transneural degeneration.⁶

Children and young adults between the ages of 0-24 years old are at highest risk for head injury, along with the elderly (aged 75 or older).⁷ Research suggests that early injuries can have a detrimental impact on later development.⁸ Identification and treatment is therefore critical. Secondary consequences of concussion include altered educational, social, and emotional development.

Symptoms Following Concussion

Presentation of symptoms is individual and varied. Somatic symptoms, such as headache, fatigue, and dizziness, typically occur shortly after the concussion. Generally, patients and their family note changes in cognitive functioning, emotional difficulties, sleep dysregulation, and a range of somatic complaints.

Emotional symptoms such as irritability and frustration may develop later. However, in practice, patients may present with emotional symptoms at any time in the period following their injury. Cognitive complaints present throughout recovery.⁹ Posttraumatic headaches are the most commonly reported symptom following a sport-related concussion and are reported to be as high as 86%.¹⁰ See Table 1 for further information regarding the most typical signs and symptoms following a concussion.

The most common symptom associated with persistent disability following a concussion is cognitive impairment, usually presenting with changes in attention, executive function, memory, language, visuospatial and constructional abilities, and sensory-perceptual-motor skills.¹¹ As a result of these impairments, patients can experience falling grades and irritability. They are also at greater risk for subsequent concussions.

Table 1: Signs and Symptoms of Concussion²⁸

Physical: Nausea, headache, vomiting, balance changes, dizziness, visual changes, fatigue, sensitivity to light and noise, numbness/tingling, dazed or stunned

Cognitive: Fogginess, feeling slowed down, difficulty concentrating, difficulty remembering, forgetful of recent information/conversation, confused about recent events, answering questions slowly, repeating questions

Emotional: Irritability, sadness, more emotional, nervousness

Sleep: Drowsiness, sleeping less, sleeping more, trouble falling asleep

Post-Concussion Syndrome

The majority of children who experience a concussion will recover within a few weeks.⁸ A minority experience post-concussion syndrome (PCS). The term PCS is sometimes used to describe the persistence of concussion symptoms for three months following the injury.¹² It is difficult to predict which patients will be most likely to develop PCS. The presence of prior mental health problems and being young and female increase risk, whereas initial presentation is not associated with risk of developing PCS.¹³

The signs and symptoms following a concussion are vague, nonspecific, common in the general population, and may mimic other psychiatric disorders such as post-traumatic stress disorder (PTSD), attention-deficit/hyperactivity disorder (ADHD), depression, and anxiety. The presence and severity of symptoms following a concussion are influenced by the presence of co-occurring psychiatric disorders,¹⁴ further complicating the diagnosis. Studies have shown that children are capable of exaggerating symptoms (tested through validity measures) due to potential for secondary gain. Examples of secondary gain include getting out of school, work, or sports.

Second Impact Syndrome

In second impact syndrome, a second injury occurs while the youth is still symptomatic from a previous concussion (in the absence of a space-occupying hematoma) and results in rapid and profound brain swelling.¹⁵ Disruption to auto-regulation of the brain's blood supply is thought to be the underlying mechanism.¹⁶ Prevalence and incidence rates are unknown and the existence of second impact syndrome is controversial amongst head injury experts. A history of headache has been found in players that return to play shortly following an initial injury and later suffer from second impact syndrome.¹⁷ See Table 2 for a summary of concussion, PCS, and second impact syndrome.

Assessment Following a Concussion

Assessment following a concussion should be systematic, as signs and symptoms will guide management and inform recommendations that can result in reduced morbidity. If a patient presents later following the injury, it is important to obtain a history and make an initial assessment. Table 3 illustrates the method of determining the severity of a concussion based on the Glasgow Coma Scale, loss of consciousness duration, and the presence of posttraumatic amnesia. Evidence-based methods to interview patients and their parents after concussions are available through the Centers for Disease Control and Prevention (<http://www.cdc.gov/headsup/providers/tools.html>). If a patient presents a significant period of time after the injury, assessment should still include an understanding of the patient's current cognitive function-

Table 2: Concussion and Sequelae

Concussion: A mild traumatic brain injury that alters the way in which the brain functions

Post-concussion syndrome (PCS): Symptoms following a concussion persist for weeks or months after the initial concussion

Second impact syndrome: A second blow to the head while a youth is still symptomatic from a previous concussion with resulting effects, which may include vascular engorgement, diffuse cerebral swelling, increased intracranial pressure, brain herniation, coma, and death.¹⁶

ing, visual changes, pain, dizziness, headache, psychiatric complaints, sleep, attention, and motor skills.

Neuropsychological testing involves objective assessment of social, cognitive, and emotional functioning. Following a concussion, patients can experience deficits in executive functioning, attention, memory, and information processing,¹⁷ and may benefit from neuropsychological testing. There are several computerized tests currently on the market including the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT), Axon Sports, Concussion Resolution Index, and Automated Neurocognitive Assessment Metrics. The National Athletics Trainers Association (NATA) recommends that players get tested prior to the initiation of the season so a baseline measure can be obtained. The use of computerized testing is somewhat controversial, as studies have shown that up to 50% of variance seen on these tests can be attributed to effort and cooperation, as opposed to brain injury.¹⁸ Athletes also can attempt to do poorly on the initial testing with the hopes that if they ever require a subsequent test that their performance will improve. There are also secondary gain considerations in neuropsychological testing such as academic accommodations in school and time off from school or sports. Neurocognitive testing is generally not validated below age 12; however, efforts are being made to address this limitation.

Assessing risk factors associated with a complicated recovery should be part of the post-concussion evaluation. Complicated recovery is generally found when patients have suffered from previous concussions (especially within the immediate past). Athletes with a prior history of concussion are more susceptible to the acute symptoms of concussion following subsequent injuries, including loss of consciousness, amnesia, confusion, and mental status changes.¹⁹ Patients who report posttraumatic migraines are more likely to have a decline in neurocognitive performance following a sport-related concussion.¹⁰ Patients with new-onset psychiatric symptoms following concussion are more likely to have persistent symptoms of PCS.

Neuroimaging

Fewer than 10% of patients have intracranial bleeding after a concussion and fewer than 2% require neurosurgery.²⁰ Significant neurological signs such as vomiting, persistent anterograde amnesia, seizure, and suspected skull fracture indicate a need for neurological imaging, but determining when it is appropriate to get neuroimaging has proven controversial. Clinical decision rules, such as the New Orleans Criteria²¹ and the Canadian CT Head Rule²² have been developed, but the studies used to develop these rules excluded patients that were under 16 years of age, and thus the applicability of these rules is uncertain in the pediatric population. Partnering with other providers can be beneficial to psychiatrists in determining appropriateness of neuroimaging.

Non-Pharmacological Management: When in Doubt, Sit Them Out

Initially, brain and body rest is the most important intervention. This includes limiting physical and mental activity that increases heart rate, blood pressure, or cognitive stress. It is best to involve the school early so that accommodations can be made if needed (e.g. a 504 educational plan to address disability <http://www2.ed.gov/about/offices/list/ocr/504faq.html>). A school plan may involve modifications to the environment, attendance expectations, and testing and homework expectations. Patients should also make sure to get adequate sleep following a concussion.

A recent study looking at patients with sports-related concussion found that 39% reportedly returned to play on the day of their injury.²³ Education of parents, athletes, and coaches is essential regarding concussion. A conservative and individualized approach is appropriate when physicians evaluate patients to decide when it is safe for them to return to play. The recommendation is that patients should not return to play on the same day their injury occurred and that they wait until symptoms have resolved and they have completed a return-to-play protocol before returning. There are also growing developments in “return-to-learn” protocols as well.

Returning to Sports

Patients should not return to play until they are asymptomatic

at rest, asymptomatic with exertion, are cognitively back at their baseline, and have progressed in a stepwise fashion to return to play. This usually equates to an initial period of rest followed by increasing levels of activity after the patient is asymptomatic. Medical clearance is the standard of care: it is currently the law in 41 states that medical evaluation and clearance is required following a concussion and prior to return to play.

Psychotherapy

Therapy should follow a biopsychosocial approach, which will invariably involve consulting and collaborating with other professionals. Education should be provided for the patient, family, and teachers. Treatment is generally symptomatic, targeting specific complaints. Cognitive exercise and compensatory training, which can assist in teaching patients strategies to cope with deficits, may help to improve a patient’s cognitive deficits and also can be important in restoring patients’ sense of control over their illness. Cognitive-behavioral therapy (CBT) is recommended as a first-line treatment for anxiety and depression in patients with PCS. Treatment with relaxation techniques has also been shown to be effective.²⁴ Biofeedback is an option to consider and has a long and efficacious history in the behavioral medicine literature.²⁵ Biofeedback is used to treat chronic headaches, depression, and pain. Vestibular therapy is also an option to consider, although randomized-control trials are lacking. It is common practice for PCS patients to be referred to a physical therapist specializing in vestibular training. However, it is interesting to note that vestibular symptoms are known to be influenced by depression and anxiety,²⁶ further underscoring the importance of evaluating for and treating psychiatric symptoms.

Pharmacologic Management

Pharmacologic intervention may be helpful for the symptoms of post-concussive symptoms. The following medications are all off-label, as there are currently no FDA-approved medications for the treatment of the neuropsychiatric consequences following a concussion. Time should first be given for symptoms to go away because post-concussive symptoms resolve in the majority of concussion cases. The age-old adage of “start low and go

Table 3: Traumatic Brain Injury Severity Rating Scale

Severity	Glasgow Coma Score (GCS)	Loss of Consciousness (LOC) Duration	Posttraumatic Amnesia
Mild	13-15	<30 minutes	<1 hour
Moderate	9-12	1 to 24 hours	1 to 24 hours
Severe	<8	>24 hours	>24 hours

slow” especially applies to concussion patients, also with the knowledge that patients may be more sensitive to side effects. Studies have indicated a role for all the medications listed in Table 4, although no randomized controlled trials have been completed. Treatment of pre-morbid psychiatric conditions should be considered as well. Table 4 refers to off-label medication choices for various persistent post-concussive symptoms.²⁷

Conclusion

Physicians should inquire about sports-related concussions to determine if post-concussion symptoms are relat-

ed to a patient’s psychiatric presentation. Post-concussive syndrome (PCS) can be challenging and complex to diagnose and treat. However, child and adolescent psychiatrists are in a unique position to advocate for youth with PCS and educate others regarding diagnosis and available treatment modalities.

Take Home Summary

Concussion can have significant and long-lasting effects on children and is oftentimes underdiagnosed. Management is multifactorial, involving rest, non-pharmacologic, and pharmacologic measures.

Table 4: Off-Label Medications Used in Post-Concussion Syndrome (PCS)

Post-Concussive Symptoms	Medications Used
Cognitive Deficits	• Methylphenidate • Amantadine • Donepezil
Depression	• Sertraline • Methylphenidate • (Avoid tricyclic antidepressants due to anticholinergic effects)
Disordered Sleep	• Melatonin • Trazodone • Mirtazapine • (Avoid anticholinergics)
Mania	• Valproate • Lithium (second line; lowers seizure threshold) • Carbamazepine
Aggression	• Propranolol • Pindolol • Ziprasidone • Olanzapine • Risperidone
Psychosis	• Atypical antipsychotics

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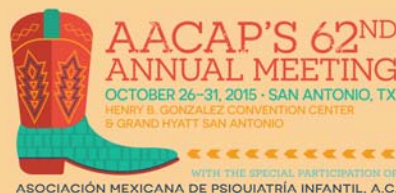
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