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It's Just a Game: Preconcussion Baseline Assessment and Return-to-Play Guidelines for Sports-Related Concussions

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Every year, millions of athletes of all ages participate in recreational activities, putting many at risk for sports-related concussions. This topic has gained national attention and placed pressure on governing bodies to hold the healthcare industry responsible for identifying, managing, and clearing athletes. As we gather more information about the mechanism and pathophysiological process of concussions, it is clear that no single factor plays a role in prevention. Preconcussion clinical assessment and education are paramount to identify risk factors and reduce the risk of long-term complications. Some experts consider computerized baseline neuropsychological testing as the "cornerstone" in the evaluation and management of sports-related concussions and may be a valuable future tool. To ensure the safety of athletes, individualized graduated return-to-play protocols have been developed. This article provides an overview of the newest guidelines and education regarding preconcussion baseline assessments and provides consistency in the evaluation and management of return-to-play recommendations.

Introduction

Recently, sports-related concussions have been placed on the front lines by national media exposure in popular sports like football, baseball, hockey, and men's/women's soccer. Recent research regarding the long-term effects of concussions has led to a groundswell of public support for legislation, which has thus far been passed in 42 states. This legislation holds coaches, referees, and healthcare providers responsible for identifying, assessing, and clearing athletes to return to play after sports-related concussions. In a complex acute injury process, healthcare personnel will now be held to a higher standard in the assessment, management, and clearance of these athletes.

Concussed athletes will have to deal with a wide range of medical professionals who vary greatly in their knowledge of evaluation and management of sports-related concussions. This has brought into question the consistency in which these injuries are identified and managed (Giza et al., 2013). This article intends to provide licensed healthcare providers an overview of the literature and newest guidelines on sports-related concussions and preconcussion baseline assessments and provide consistency in the evaluation and management of return-to-play recommendations.

Prevalence

With healthcare professionals and society placing a greater emphasis on physical activity and a healthier lifestyle, people are engaging in more recreational and organized activities. Approximately 44 million adolescents and 170 million adults in the United States make up this group, which places many participants at risk for sports-related concussions (Ma et al., 2012).

Figures from 2013 estimate that approximately 1.6 million to 3.8 million traumatic brain injuries related to competitive sports and recreational activities occur in the United States, resulting in 275,000 hospitalizations and 52,000 deaths annually. Unfortunately, the astonishing figures do not tell the entire story as it is suspected that as many as 50% of traumatic head injuries are still unreported (Harman et al., 2013).

According to the National Electronic Injury Surveillance System, from 2001 to 2009 an estimated 2.6 million individuals younger than 19 years were treated annually for sports- and recreation-related injuries, with 173,285 of these being traumatic brain injuries. A majority of these were males (122,970), with the highest incidence in the 10–19 age range. Most of these groups were participating in football, bicycling, and basketball activities (Centers for Disease Control and Prevention, 2011).

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Concussion Defined

The definition of a concussion has evolved because of better knowledge and research into the understanding of the pathophysiology behind the mechanism of injury. The medical community has agreed that a concussion is a type of traumatic brain injury. We have heard terms such as "dazed," "knocked-out," or "bell-rung" used to describe concussions, but all these different nomenclatures make it difficult for the public to understand the severity of the injury. Because of this confusion, the Fourth International Conference on Concussions in 2013 wanted to establish a universally accepted definition of a concussion. This conference established a committee, which defined a concussion as:

> Complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces. Several common features and constructs that incorporate clinical, pathological, and biomechanical injury have been utilized in defining the nature of a concussive head injury. Concussion may be caused either by a direct blow or "impulsive" force to the head, face, neck, or even a blow elsewhere on the body. This typically results in the rapid onset of a short-lived neurological impairment that resolves spontaneously. These neuropathological changes only resemble the acute clinical symptoms of the functional neurologic disturbance rather than the structural injury. Concussions result in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course. With a small percentage of cases the prolongation of postconcussive symptoms may occur. No abnormality on standard structural neuroimaging studies is seen in concussion. (McCrory et al., 2013)

Mechanism of Injury

Athletes today are performing at the highest levels in history. They are bigger, stronger, and faster, which result in more violent impacts and contribute to the increase in sports-related concussions (Barth, Freeman, Broshek, & Varney, 2001).

The biokinetics of a concussion consists of a single event causing acceleration–deceleration of direct forces resulting in rotational and angular energy to the brain (see Figure 1). A concussion may be caused by a direct blow to anywhere on the body causing a transient force to the brain. A direct impact to the head is not needed to sustain a concussion (Scorze, Raleigh, & O'Conner, 2012). Like other traumatic brain injuries, these stresses may result in damaging axons or cell death, or even cause intracranial bleeding (Duff, 2009).

The pathophysiological process is much more debatable and unclear. There are multiple theories on the exact process, but the consensus is that there is disturbance in the brain's metabolic equilibrium from the small focal brain contusion causing a cascade of events. Concussion injuries can be considered a two-part process: a primary insult and a secondary inflammation period (Grady, 2010). The initial assault of the neural membranes results in channel alterations of potassium,

Figure 1. Biokinetics of a concussion. (Courtesy of *Headzone Concussion Care by Physicians*, Karen L. Laugel, MD, 2014. Retrieved June 20, 2014, from http://head-zone.com/about-concussions.)

calcium, and glutamate into the extracellular space, resulting in suppression of neuron activity. The cells rapidly try to restore the brain's homeostasis by the demanding energy requirements by increasing adenosine triphosphate and glucose, leading to an energy crisis and subsequently decreasing cerebral blood flow (Scorze et al., 2012). This complex process may persist for up to 4 weeks (Halstead & Walter, 2010). As the injured cells are repaired or die, there is a release of cytokine, which is responsible for the inflammation response. This cascade of cell injury is thought to explain why concussive symptoms may not appear or worsen over a 72-hour period (Grady, 2010). Thus, incidents of sports-related concussions to the immature brains of young athletes exacerbate this multifaceted metabolic process, possibly prolonging repair and recovery (Harman et al., 2013).

Signs and Symptoms of a Concussion

Being able to recognize a concussion can be an intimidating and challenging task. An athlete's signs and symptoms may be profound, subtle, begin immediately, or develop several hours, days, or even weeks later. According to the Centers for Disease Control and Prevention (2014) and the most recent international consensus of concussion, experts found four main areas that may be affected by a concussion. These are physical, cognitive, emotional, and sleep (McCrory, Davis, & Makdissi, 2012; see Table 1).

Most athletes who experience postconcussion syndrome may exhibit any one or more of these different symptoms with headaches, nausea, light sensitivity, dizziness, and difficulty concentrating being the most common (Marar, McIlvain, Fields, & Cornstock, 2012). It is important to reiterate that loss of consciousness does not always occur with a concussion, but is the single most imperative indication that possibly a severe underlying pathologic process may be occurring.

Table 1. Signs and Symptoms of a Concussion

Physical	Cognitive	Emotional	Sleep
Headache	Feeling "foggy" or a sense of "slow motion"	Irritability	Drowsiness
Nausea	Difficulty concentrating	Depressed	Sleeping less or more than usual
Vomiting	Forgetful	Overly emotional	Trouble initiating sleep
Balance problems	Confused about recent events	Nervousness	
Dizziness	Answer questions slowly or repeat themselves		
Visual disturbances			
Fatigue			
Sensitivity to light or noise			
Numbness/tingling			
Dazed or stunned			

Note. From *Heads Up: Facts for Physicians About Mild Traumatic Brain Injury* by Centers for Disease Control and Prevention, 2014. Retrieved June 17, 2014, from http://www.cdc.gov/concussion/headsup/pdf/facts_for_physicians_booklet-a.pdf

Preconcussion Baseline Assessment

Athletes across the United States are required to have an annual sports physical examination. During these examinations, it is essential that healthcare providers screen athletes for risk factors and past concussion injuries, no matter their age or sports activity they are involved in. In assessing the risk of sports-related concussions, multiple studies have tried to isolate a specific or individual factor associated with the increased risk of athletes sustaining a traumatic brain injury. Age, gender, sport played, level of competition, and protective equipment utilized have all been shown to have some degree of influence on the risk for concussions. This adds to mounting evidence, suggesting that concussions are a multifactorial process (Giza et al., 2013). With all the marketing campaigns provided by helmet and mouth guard companies claiming to have a "concussion proof" helmet or mouth guard, there is currently no strong evidence supporting this claim (Harman et al., 2013). Other studies have tried to link genetic factors associated with the increased risk of concussion, so far these studies have shown little to no significant correlation (Terrel, Bostick, & Bartch, 2012).

Athletes with a previous history of neck or head injuries, including loss of consciousness, amnesia, or concussion, should undergo a detailed neurological history and examination (Peaker & Jones, 2008). A history of concussions is associated with a two to six times higher risk of sustaining another concussion (Harman et al., 2013). Other factors such as mood, learning disabilities, attention-deficits, and migraine disorders should also be documented because they can play a role in complicating or masking the injury.

In addition to a clinical assessment, baseline concussion testing or neuropsychological testing has shown promise to be a valuable tool and is considered by some to be the "cornerstone" in the evaluation and management of sports-related concussions (McCrory et al., 2012). Neuropsychological tests are designed to provide objective data identifying cognitive and brain function; they also analyze and measure selected brain processes including balance and somatic and neurobehavioral symptoms such as attention span, working memory, and reaction time (Stewart, Mcqueen-Borden, Bell, Barr, & Juengling, 2012).

The use of neuropsychological testing prevents the primary care provider from solely relying on subjective symptoms, which tend to vary and can be poorly recognized (Makdissi, 2010). These baseline tests are obtained during preseason or when the athlete is asymptomatic to provide a preinjury baseline. The results can then be used in postconcussion management and compared with the national average database.

There is a wide variety of different baseline tests available ranging from written to computerized. With the advancement of technology, computerized testing seems to be more practical than previous written methods. Simple paper-and-pencil tests are time-consuming and require extensive resources and a trained medical professional to interpret the results. Computerized testing can be performed in large groups and on an outpatient basis. Currently, there are a number of different commercially available programs being used, including Automated Neuropsychological Assessment Metrics (ANAM), CogState, HeadMinder, and Immediate Post-concussion Assessment and Cognitive Testing (ImPACT). There are no current recommendations on which type of test is superior; therefore, it will be determined solely by the provider. The consensus statement at the Fourth International Conference on Concussion recommends that all athletes should have a clinical neurological baseline physical and cognitive assessment to foster better interpretation of postinjury scores; however, they do not feel that it should be mandatory. Guidelines established in 2013 by the American Academy of Neurology on baseline scores state:

> Licensed health care providers caring for athletes might utilize individual baseline scores on concussion assessment tools, especially in younger athletes, those with prior concussions, or those with preexisting learning disabilities/attention-deficit/hyperactivity

disorder, as doing so fosters better interpretation of post-injury scores. —Level C recommendation.

Clinical licensed health care providers might use supplemental information, such as neurocognitive testing or other tools, to assist in determining concussion resolution. This may include but is not limited to resolution of symptoms as determined by standardized checklists and return to age-matched normative values or an individual's preinjury baseline performance on validated neurocognitive testing. —Level C Recommendation.

Even with strong support and recommendations, baseline testing is still not available to every athlete. The only state mandating cognitive baseline testing is Rhode Island. Other states such as Texas and Hawaii have tried unsuccessfully to pass laws mandating baseline testing (Fjordbak, 2011). Not performing baseline testing could be the result of financial burdens or lack of educational resources. Even without legislation mandating baseline testing, several organizations and programs at different levels of competition require baseline testing before participation. There is no research that shows whether athletes with baseline neuropsychological testing recover faster; however, the testing does aid clinicians in making return-to-play decisions and might be the key for researchers to understand the recovery process.

Like all tools used in medicine, neuropsychological testing does not come without limitations. Even though there are multiple tests available to evaluate athletes suspected of suffering a concussion, no single test score can definitively diagnose a concussion (Giza et al., 2013). Neuropsychological testing is not to be used to diagnose or grade the severity of concussions. It is simply one of many types of resources used to analyze these athletes during the recovery period. There is much debate on the reliability and prognostic value of neuropsychological testing. Many of these programs have performed multiple self-report studies, but limited outside research has been completed. There is no question that neuropsychological programs uphold clinical judgment as the primary determination of severity and management, but the companies still feel their programs can detect dysfunctions that at times may be missed. Presently, there is no set of evidence-based guidelines on when to retest these concussed athletes or how often the testing should be repeated. Some clinicians administer testing immediately after the concussion regardless of symptoms to give a baseline of postconcussion result, while others prefer to wait 72 hours or when the athlete is asymptomatic (McCrory et al., 2012). Majerske et al. (2008) performed a study on high school athletes and the effects of activity on recovery that showed that athletes had the worst symptoms and poorest cognition during the highest and lowest levels of postconcussion activity.

Return-to-Play Guidelines

Under legal and medical guidelines, no athlete suspected of a concussion shall return to play in a 24-hour period before being cleared by a licensed medical provider. Implementation of these regulations is meant to protect these athletes. Even if the symptoms appear to be mild, the individual's ability to function physically, cognitively, and psychosocially may be significantly impacted (Stewart et al., 2012).

There are multiple grading systems used for concussions, but overall the medical community sees no need for grading the severity of the injury because grading's role in management is obsolete. Similar to all biological healing processes, time and rest play a vital role in a concussed athlete. Currently, there is no evidence suggesting interventions that may enhance recovery (Giza et al., 2013).

Each athlete's treatment plan will be as unique as the injury itself. It is important to emphasize that not all concussed athletes will present in the same manner, and the patient's clinical presentation and clinician's judgment ultimately hold the vital interpretation of the injury.

Primary care providers are encouraged to develop individualized graded recovery plans for return to physical and cognitive activity. These care plans must be carefully monitored with a clinical approach to minimize the possibility of early postconcussive impairments or complicating the initial injury (Giza et al., 2013).

Most athletes who have sustained a concussion will have a resolution of symptoms after 2 weeks and a return of neuropsychological testing to baseline in 7–10 days (Waryasz & Tambone, 2013). There are three main components that need to exist before an athlete shall be allowed to return to play: subjective symptoms, a neuropsychological assessment, and balance testing (McCrory et al., 2012).

Only after being symptom-free while at rest is the concussed athlete permitted to begin return-to-play rehabilitation. This rehabilitation structure consists of six different stages that are followed in a systematic approach. Each stage should be evaluated for a 24-hour period while assessing the patient for symptoms. Table 2 provides an outline on the different stages, along with physical objectives and functional exercises to incorporate into the plan of care.

All athletes, regardless of the level of participation, should be managed using the same treatment and return-to-play treatment guidelines. There is no proof that complete rest is beneficial and it may also have deleterious effects. Some evidence suggests that moderate amounts of activity may help recovery (McCrory et al., 2012). Younger age appears to be associated with a more prolonged recovery time from concussions and should be taken into account when determining return-to-play (McGuire & McCambridge, 2011).

Education is also important during the recovery process. Athletes and their guardians should fully understand the rehabilitation process. The guidelines provided enhance the communication and expectations of the injury. A study performed by Ponsford et al. (2002) clearly illustrates the importance of education. When athletes and guardians were supplied with educational materials on the expected course of recovery and ways to cope, they fared better in terms of residual symptoms at 3 months compared with noninterventional groups.

Table 2. Graduated Return-to-Play Protocol

Rehabilitation Stage	Physical Objectives	Functional Exercise
Stage 1	Rest until asymptomatic	Physical and cognitive
Stage 2	Light aerobic activity	Walking, swimming, or stationary biking
	Increase heart rate and blood pressure	
Stage 3	Sport-specific exercises	Skating, running, or shooting drills
	Sport drills with no head impact or physical contact. No resistance training	
Stage 4	Noncontact training drill	Game-like situations with no contact, agility workouts, and endurance
	More complex drills with light resistance	
Stage 5	Full-contact practice	Normal training or practice
	After being cleared by physician	
Stage 6	Return to play	Game time!

There are multiple resources available, such as the "Get a Heads Up on Concussion in Sports Concussion Sports," provided by the Centers for Disease Control and Prevention and nonprofit organizations such as Sports Legacy Institute Community Educators (SLICE), which provides concussion workshops. Increasing concussion awareness among athletes, parents, coaches, and healthcare providers will improve the safety of these athletes. An understanding of the risks, detection and assessment techniques, and management guidelines should help expand concussion safety and promote favorable outcomes.

Second Impact Syndrome

An athlete recovering from a concussion who returns to play before complete resolution of postconcussive symptoms could suffer a rare, but devastating, and often fatal injury called second impact syndrome (SIS). This phenomenon is a catastrophic reaction to a second exposure head injury or blow that causes a loss of autoregulation system of cerebral vasculature and rapid, irreversible swelling and herniation that occurs to the brain stem, leading to increased intracranial pressure and most likely resulting in a coma or death (Cantu & Gean, 2010).

Second impact syndrome, first identified in 1984, is a very controversial term. (Bey & Ostick, 2009). To date, there is insufficient scientific evidence and all events of SIS are based on the interpretation of subjective case reports with insufficient details to definitively identify SIS as the cause of death. The key question that remains elusive is whether SIS is caused by the cumulative effect of multiple hits or blows is required or whether the brain swelling is the result of a single blow to the head, which is a well-recognized consequence of head injury (McCrory, Davis, & Makdissi, 2012).

The National Center for Catastrophic Sports Injury Research in Chapel Hill, NC, identified 172 cases of catastrophic cerebral injury from 1984 to 2012 with only one case suggesting "possible" SIS. Of these 172 cases, 155 of the injuries occurred at the high school level (Mueller & Cantu, 2012). A different study by Thomas et al. (2011) analyzed data from the 30-year U.S. National Registry of Sudden Death in Young Athletes and found that the most frequent cause of death was trauma-related usually involving the head and/or neck. They also found that 17 high school football players with a prior history of a concussion and with residual postconcussion symptoms still present suggesting that SIS was the cause of their deaths.

Although the chances are very low, any athlete recovering from a concussion is at risk for SIS. The risk factors for SIS are currently not understood, but current research does suggest that young athletes are at a higher risk for an unpredictable death. Increasing recognition and stressing the importance of return-to-play guidelines give healthcare workers a better chance to prevent SIS from developing in a concussed athlete.

Conclusion

The role of athletic competitions and recreational activities is an essential part of our society and a positive influence in the growth of our youth. With these activities comes the risk of injuries. Given the complex nature of the mechanical and pathological processes and multiple up-to-date studies showing the detrimental effects involved in sports-related concussions, stress has been placed on the importance of proper evaluation and management that will give healthcare providers a true appreciation of the injury.

This is a multifactorial injury that requires a multidisciplinary approach for appropriate evaluation and treatment of the concussed athlete. Because no two athletes are the same, the utilization of various resources in the assessment and rehabilitation period is required. Although neuropsychological baseline testing is not mandatory, with further research, this "cornerstone" tool may 1 day be used diagnostically. With further research on sports-related concussions, we may someday find the key to the many unanswered questions that remain. In hindsight, with all the media attention and social pressures overshadowing sports-related concussions, we as healthcare providers have to remember one thing, "It's Just a Game."

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