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Masterclass

Interprofessional management of concussion in sport

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ABSTRACT

Due to the high incidence of sports concussion, various health and medical providers are likely to encounter athletes who have sustained such an injury. Management of concussion necessitates coordinated care by the members of the sports medicine team due to its pathophysiology and complexity of management during recovery. All members of the sports medicine team must possess contemporary knowledge of concussion management as well as strong interprofessional communication skills to ensure effective care and safe return to sports participation. Therefore, the aim of this manuscript is to review the current best practices in interdisciplinary management of sports concussion with a special emphasis on the required interprofessional communication among the sports medicine team.

1. Introduction & background

Concussion and mild traumatic brain injury in sport has been gaining such significant attention in both the media and literature that the issue of concussion is being classified as an epidemic that needs immediate action (Carroll & Rosner, 2012; Murray, Murray, & Robson, 2015). Estimates of concussion in sports and recreational activities have ranged from 1.6 to 3.8 million per year in the United States (Langlois, Rutland-Brown, & Wald, 2006). Recent epidemiological studies have reported concussion diagnosis increases due to both increased athletic participation in all levels of sports (Daneshvar, Nowinski, McKee, & Cantu, 2011; Marar, McIlvain, Fields, & Comstock, 2012) as well as enhanced awareness and knowledge on the topic resulting in fewer missed diagnoses (Macpherson, Fridman, Scolnik, Corallo, & Guttmann, 2014). This growth has been corroborated by the United States Centers for Disease Control and Prevention (CDC), who has reported a 62% increase in emergency room visits per year are due to concussion in adolescents (CDC, 2011).

Concussions occur in athletes of various levels of competition and sport. Epidemiological studies often find a distribution among numerous sports, with contact sports typically being most involved, followed by women's sports at the collegiate level (Hootman, Dick, & Agel, 2007; Meehan, d'Hemecourt, & Comstock, 2010). Many athletes who suffer sports-related concussions do not go to the emergency room or visit their physician for care (Gerberich, Priest, Boen, Straub, & Maxwell, 1983; McCrea, Hammeke, Olsen, Leo, & Guskiewicz, 2004; Tommasone & McLeod, 2006). In fact, these athletes often never report their injuries. McCrea and colleagues found that only 47.3% of high school football players will report their injuries (McCrea et al., 2004). An additional study found that only 22% of high school American football players who suffered concussions were examined by medical personnel and 29% received no examination (Gerberich et al., 1983).

Concussion management guidelines have been adopted and openly distributed by international experts from the International Conference on Concussion in Sport (McCrory et al., 2013). These guidelines propose a multifaceted approach to comprehensive concussion management. Interestingly, recent studies suggest that these guidelines are not being followed to their full intent (Carson et al., 2014; Haran et al., 2015; Stoller et al., 2014). This is likely due to the notion that meeting the established international guidelines is resource dependent. All athletic organizations and teams are unlikely to possess a comprehensive array of sports medicine providers who are trained in the contemporary management of concussion. A comprehensive team of interdisciplinary professionals working collaboratively may be best suited to substantiate the aim of these comprehensive procedures. Therefore the purpose of this manuscript is to review concussion management in

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sport with special consideration to the interdisciplinary teamwork necessary for best practice and safe return of all athletes to sport participation.

1.1. Definition of concussion

Concussion is defined as a brain injury involving "a complex physiological process … induced by traumatic biomechanical forces" (McCrory et al., 2013, p. 250). In addition, there are a number of common features incorporated into defining the nature of concussive head injury. These include the following (McCrory et al., 2013):

1. Caused by a blow to the head, neck, face or somewhere else on the body.
2. Results in rapid onset of short lived neurological impairment that resolves spontaneously.
3. May result in neuropathological changes but the acute clinical symptoms largely reflect functional disturbances rather than structural injury.
4. Results in a graded set of symptoms that may or may not include loss of consciousness.
5. Resolution of clinical and cognitive symptoms generally follows a sequential course.
6. Post concussive symptoms may be prolonged in a small percentage of people.
7. No abnormality is seen on standard structural neuroimaging.

1.2. Signs & symptoms

When an athlete sustains a concussion, he or she can present with numerous signs and symptoms across a broad spectrum (Table 1). The CDC breaks down the signs and symptoms of concussion into four categories: cognitive, physical, emotional, and sleep (CDC, 2015a,b); additionally, typical signs and symptoms of concussion were developed and distributed after the last International Conference for Concussion in Sport (McCrory et al., 2013).

1.3. Pathophysiology

The most common cause of concussion is direct blow, impulse, or sudden movement of the head that causes an impact with resultant neurologic injury. The linear and/or rotational acceleration in the brain results in a biomechanic trauma, with translational forces producing focal lesions and rotational forces produce more diffuse lesions (Almasi & Wilson, 2012). Shortly after this neuronal disruption, these translational or rotational forces initiate a complex neurometabolic cascade (Barkhoudarian, Hovda, & Giza, 2011; Giza & Hovda, 2014; Meaney & Smith, 2011; Post et al., 2014). Shearing forces damage neuronal cellular membranes releasing potassium to the extracellular space causing depolarization. Depolarization causes the release of glutamate which in turn binds ionic channels causing the influx of sodium and calcium. To restore ionic imbalance, the sodium-potassium pump is activated which utilizes increased amount of ATP and requires high glucose metabolism that depletes intracellular energy stores. This ionic flux has been associated with migraine headache and photophobia. Extracellular accumulation of lactate increases membrane permeability, acidosis and cerebral edema (Barkhoudarian et al., 2011; Seifert & Shipman, 2015).

Table 1
Signs & symptoms of concussion.

Category	Signs & symptoms	
Cognitive	Slow reaction time	Lack of concentration
	Disorientation	Amnesia
Physical	Headache	Visual disturbances
	Loss of consciousness	Nausea/vomiting
	Dizziness	Loss of balance
Emotional	Irritability	Depressed mood
	Lability	Anxiety
Sleep	Drowsiness	Sleep disturbances

The increase in cellular metabolism happens at the same time as a decrease in cerebral blood flow resulting in an energy crisis of discrepancy in glucose supply and demand (McKee, Daneshvar, Alvarez, & Stein, 2014). The energy imbalance increases the susceptibility of the brain cells to a second insult or injury (Giza & Hovda, 2014; Herring et al., 2011). Calcium is sequestered into the mitochondria which causes disruption in oxidative metabolism. In healthy people, an increase in cerebral blood flow matches an increase in neural activity and metabolism. The opposite happens in patients with traumatic brain injury. There is a decrease in cerebral blood flow instead of hyper perfusion resulting in a secondary injury (Adelson et al., 1997; Ellis, Leddy, & Willer, 2015).

The biomechanical forces in a concussion damage dendrites and axons. Axonal stretch causes microtubule disruption which diminishes neural transmission and increase the potential for disconnection resulting in impaired cognitive function and slower reaction time (Giza & Hovda, 2014). This is sometimes referred to as traumatic axonal injury as opposed to the term diffuse axonal injury (Büki & Povlishock, 2006). In a single concussion, the neurometabolic changes are usually temporary and self-limiting (Barkhoudarian et al., 2011). The most common injuries in concussion are caused by lateral or side-to-side forces. Injuries resulting from front-to-back or sagittal forces have better outcomes than injuries from lateral forces (McKee et al., 2009).

2. Principles of interprofessional management

Due to its complex pathophysiology, concussion management is multifaceted, involving an array of assessment and continuous monitoring. After a concussive event, symptoms continue as the brain attempts to restore a normal physiological state and return to a premorbid state of homeostasis. During this time, activities that are stressful to the system can exacerbate symptoms and interfere with recovery. Thus, symptom tracking on a continuous basis throughout the recovery cycle is necessary and involves optimal communication among all members of the sports medicine team to allow for informed decision-making.

2.1. Interdisciplinary team building

Effective concussion management requires an array of professionals working collaboratively throughout the spectrum of the disease process. The management spans prevention, early identification and acute management, continuous assessment and reassessment, and return to play (RTP). Thus, there is an interdependency of all health and medical professionals to appropriately guide an athlete through recovery. This management requires a variety of sports medicine professionals performing as a high-functioning team.

Clinicians trained in interprofessional care more effectively optimize the skillsets of all team members, which ultimately improves patient care and clinical outcomes (Institute of Medicine [IOM], 2015; World Health Organization [WHO], 2010). Thus, the focus on collaborative practice of the sports medicine team is necessary in order to achieve optimal health outcomes. Continuous development of team-based care should include values and ethics

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