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An Introduction to Sports Concussion for the Sport Psychology Consultant

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This paper was designed to introduce the sport psychology consultant (SPC) to the relevant practical and theoretical information pertaining to sports concussion. The paper discusses four key areas related to sports concussion: 1) recognition, 2) management, 3) psychological issues following a concussion, and 4) prevention and education. Throughout the paper, the authors emphasize the role of the SPC in each of these four areas. An integrated review of the sport concussion literature and current research and guidelines regarding the definition, pathophysiology, symptoms, neuropsychological testing, and risk factors for concussion is presented. The SPC's roles in educating and helping athletes deal with post-concussion issues such as the pressure to return to play and fear of reinjury are examined. The authors highlight the need for baseline neuropsychological testing of athletes; and advocate a multidimensional team approach to sport concussion, involving the SPC as a key member of that team.

"I am Batman!" claims the disoriented American football player seated on the sideline after having his "bell rung" during a game, as depicted in a television commercial for a popular U.S. candy bar. This humorous commercial makes light of concussion, a relatively common and potentially fatal injury that affects nearly 300,000 athletes in the U.S. each year (Centers for Disease Control and Prevention, 1997).

Now, imagine that you are the SPC on the sideline when the disoriented American football player referred to earlier leaves the field with a potential (well, in this case, obvious) concussion. What is your role as the SPC in relation to this injury? As part of the sport medicine staff, it may be advantageous for SPCs to be able to recognize, communicate, and provide education regarding the athlete's condition from a neurocognitive and behavioral perspective. SPCs are in a unique position to be active participants, from a psychological

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perspective, in the athlete's recovery from concussion. However, few SPCs receive formal training in areas related to concussion during their graduate programs or through professional workshops.

This paper is designed to introduce SPCs to relevant practical and theoretical information pertaining to sport concussion. In particular, the authors will review the SPC's role in sports concussion recognition, management, psychological issues following a concussion, and prevention and education. A review of sports concussion recognition issues is presented first.

RECOGNITION

What is a Concussion?

To date, researchers and practitioners have struggled to operationalize a clear definition of a concussion. Currently, the most widely accepted definition of a concussion is "a traumatically-induced alteration in mental status that may or may not involve a loss of consciousness." (Kelly & Rosenberg, 1998, p. 56). This definition emphasizes a change in mental status, which is typically manifested as confusion or memory loss, as the hallmark symptom of a concussion. However, the initial signs or symptoms of a concussion are largely determined by the biomechanics of the injury and the locally affected brain structures.

The brain is contained within the cranium where it is surrounded by cerebral spinal fluid. In this position, the brain is free to move about the cranium, however, the cranium is filled with bony protuberances. Hence, high velocity movement of the brain inside the cranium typically results in focal axonal damage that, depending upon the sites of injury, will present in the common signs or symptoms of concussion (Bailes & Cantu, 2001). More severe trauma and biomechanical forces may also result in contusions or lesions on the brain's surface (Bailes, 2001). These outcomes are the result of the action of one of two types of biomechanical forces on the head: (a) acceleration–deceleration forces, or (b) rotational forces (Bailes, 2001). Acceleration–deceleration forces occur when an object, such as a baseball, traveling at a high velocity, strikes the head. These forces also occur when the body and head are in motion and collide with a stationary object such as basketball player striking the occipital region of his or her cranium on the hardwood floor. Rotational forces occur when the cranium is rotated along its axis in an angular motion, while the brain remains in a relatively fixated position (Bailes & Cantu, 2001). This type of shearing force is common in a quarterback sack where the quarterback's head rotates from the impact of the tackle (Bailes & Cantu, 2001). Occasionally, concussions are a result of the combination of both acceleration–deceleration and rotational forces. Because many SPCs attend sport competitions, they can help identify potential concussive episodes and bring them to the attention of ATCs or physicians by watching athletes and looking for impacts involving high velocity acceleration-deceleration or rotational forces.

Pathophysiology of Concussion

From a pathophysiological standpoint, symptoms of sports concussion are related to acute metabolic dysfunction (Giza & Hovda, 2001). Immediately after a concussion is sustained, significant potassium efflux from the affected neurons occurs. Such action results in subsequent depolarization of the affected cells, which leads to the release of glutamate, further exacerbating the efflux of potassium. This cycle continues until there is a resultant hyperglycolysis and increased energy demand within the brain (Bailes & Cantu, 2001). At the same time, however, there is also reduced cerebral blood flow, which is likely caused by increased extracellular

Table 1
Postconcussion Symptoms

Headache	Nausea	Confusion/disorientation
Difficulty recalling incident	Emesis	Balance problems
Fatigue	Trouble falling asleep	Sleeping more than usual
Drowsiness	Sensitivity to light/noise	Irritability
Increased sadness	Nervousness	Numbness or tingling
Feeling slowed down	Difficulty with memory	Difficulty with concentration
Sensation of being "in a fog"		

Note: Adapted from "Neuropsychological Assessment of the College Football Player," by M. R. Lovell & M. W. Collins, 1999, *Journal of Head Trauma and Rehabilitation, 9,* 20. Used with permission of the author.

calcium and resultant vasoconstriction (Katayama, Becker, Tamura, & Hovda, 1990). This pathophysiology leads to an energy crisis in the brain that may not be seen until 2–3 days post-injury and may last for several weeks. Such metabolic dysfunction, until fully resolved, leads to significantly increased neurologic vulnerability for consequences such as second impact (SIS) and post-concussion syndromes (PCS), if a subsequent trauma (even minor) is sustained (Collins & Hawn, 2002).

SIS occurs when an athlete sustains a second, often minor head injury before symptoms associated with the first head injury have completely abated (Saunders & Harbaugh, 1984). The result of this second impact is a rapid (i.e., <2 minutes) dysautoregulation of the brain involving increased intracranial pressure, brain stem failure, coma and frequently (>50% of cases) death (Saunders & Harbaugh, 1984). PCS refers to any potentially permanent symptoms (see Table 1) from a single episode or chronic history of head injury, which linger beyond a few weeks post-injury (Collins & Hawn, 2002). Although PCS is less severe than SIS, it has potential long-term consequences including increased likelihood for neurological diseases such as Alzheimer's disease and Parkinson's syndrome. Moreover, PCS may increase the vulnerability of affected athletes to subsequent concussions (Collins & Hawn, 2002).

Though long-term deficits in the form of PCS have been observed from a single concussion (Collins, 2002), a consensus agreement exists that proper management of injury should lead to good prognosis and few long-term harmful effects (Aubry et al., 2002). Conversely, returning an athlete to participation prior to complete recovery may increase the risk of lingering, long-term, or catastrophic neurologic sequelae (Collins, Lovell, & McKeag, 1999; Collins et al., 2002) As such, assessment of symptoms is critical in recognizing a concussed athlete.

Concussion Symptoms

The initial symptom presentation of a concussed athlete is dependent upon the aforementioned biomechanical aspects of the injury, as well as the specifically affected brain structures (Collins & Hawn, 2002). For example, a blow to the frontal portion of the cranium (i.e., frontal lobes) may result in subtle changes in personality or mood, difficulty in executing sport assignments, and overt confusion, though it will not likely result in loss of consciousness (LOC). Similarly, a blow to either side of the cranium (right or left temporal lobe) is more likely to result in confusion and memory disturbance (i.e., amnesia), rather than LOC. A blow to the back of the head may result in slowed processing, dizziness, sensitivity to light/noise, and visual disturbance. Moreover, a blow to the back of the head is more likely to result in LOC given the proximity of this area to deeper brain structures (e.g., brainstem) responsible for consciousness.

The point of emphasis in this discussion is that the brain is a highly complicated organ and an athlete may present with a myriad of symptoms dependent upon a host of factors, including, but not limited to, the location of the injury. SPCs should refer to Collins and Hawn (2002) for additional information on the localization of brain functions and concomitant concussion symptoms.

SPCs dealing with a potentially concussed athlete should be aware of the severity and varied presentation of the signs and symptoms of a concussion. This is particularly important when the initial impact appears relatively innocuous or is not witnessed by any members of the coaching or sports medicine staffs. Consequently, SPCs should observe athletes for the sometimes subtle behavioral and cognitive signs of a concussion. Some of the more common immediate signs of a concussion include: (a) appearing dazed or stunned; (b) being confused about a play; (c) forgetting plays; (d) clumsy movements; (e) slow responses to questions; and (f) uncertainty about the score or opponent. In addition to these behavioral and cognitive signs, athletes may also report other symptoms of a concussion. The most common post-concussion symptoms are presented in Table 1. The severity of these symptoms should be assessed in athletes with a suspected concussion via a verbal or written self-report scale ranging from 1 (mild) to 6 (severe). Athletes not suffering from a symptom would report a score of 0 for that symptom. Use of such a scale augments the neuropsychological testing (see Neuropsychological Testing section) used to manage a concussed athlete. The symptom severity rating scale is not a concussion grading scale (see 'Current Concussion Management Guidelines' under Management), and should not be used alone to determine the presence or severity of a concussion. SPCs should assess each of the symptoms presented in Table 1 and their level of severity in each athlete's presentation of a potential concussion immediately after a suspected concussion and during follow-up sessions with the athlete (even if the athlete claims to be symptom free). Because symptoms often linger 6–8 weeks post injury and have been documented as long as 6 months after a concussion (Bohen, Jolles, & Twinjstra, 1992), SPCs should utilize their sessions with athletes to evaluate and document symptoms until an athlete is no longer symptomatic.

Although no acute concussion symptoms have been shown to explicitly correlate with concussion severity (Bailes & Cantu, 2001), some researchers have suggested that (a) anterograde and retrograde amnesia; and (b) confusion or disorientation as to person, place, time or event are as important to the detection of concussion as LOC (Collins & Hawn, 2002). Whereas anterograde amnesia is the inability to store and retrieve information subsequent to a concussion, retrograde amnesia is the inability to recall information preceding the concussion. LOC is also useful in recognizing a concussion, but appears to be related less to neuropsychological impairment than amnesia or confusion (Lovell, Iverson, Collins, McKeag, & Maroon, 1999). Presence of one or more of the post-concussive symptoms, particularly 'confusion/disorientation,' 'difficulty remembering the incident,' and 'difficulty with memory' presented in Table 1, should be brought to the attention of the sports medicine team. Although it is not the professional domain of the SPC to medically diagnose an athlete's condition, it is important for SPCs to recognize and discuss these symptoms with the sports medicine team. To this end, the cognitive section of the 'concussion card' developed by the University of Pittsburgh Medical Center's Sports Concussion Program is a useful and easily accessible reference for an initial and immediate evaluation of a potentially concussed athlete (see Table 2). The card, which focuses on factors such as orientation to time and place, working memory, concentration, and anterograde and retrograde amnesia, provides a template for a brief, on-field assessment of cognitive symptoms of a concussion. The interview probes in the 'concussion card' should only be used for acute, on-field evaluations (in conjunction with the evaluations of the signs and symptoms of a concussion discussed previously), and should not replace neuropsychological testing or other clinical evaluation.

Table 2
Cognitive Testing Section of the 'Concussion Card'

Orientation	
Ask the athlete the following questions:	
What stadium (court, competition) is this?	What month is it?
What city is this?	What day is it?
Who is the opposing team?	
Anterograde amnesia	
Ask the athlete to repeat the following words: Girl, dog, green	
Retrograde amnesia	
Ask the athlete to repeat the following questions:	
What happened in the prior quarter/period/event?	Do you remember the impact?
What was the score of the game (competition) prior to the impact?	What do you remember just prior to the impact?
Concentration	
Ask the athlete to do the following:	
Repeat the days of the week backward (starting with today).	
Repeat these numbers backward: 63 (*36 is correct*), 419 (*914 is correct*)	
Word list memory	
Ask the athlete to repeat the three words from earlier: Girl, dog, green	
Any failure should be considered abnormal.	
Consult a physician if the athlete exhibits any signs or symptoms.	
From the "Concussion Signs and Symptoms Evaluation," by the University of Pittsburgh	

Note: *Medical Center Sports Concussion Program*. Used with permission of the institution.

MANAGEMENT

Current Concussion Management Guidelines

Reviews of the sports concussion literature highlight the availability of several concussion management grading scales that assign a numeric value (e.g., Grades 1, 2, 3) to severity of injury and make corresponding return-to-play recommendations based upon this diagnosis (Bailes & Cantu, 2001; Collins et al., 1999). It should be noted that the development of these grading systems is anecdotal in nature and based upon expert consensus rather than on prospective empirical data (Collins et al., 1999). Such an arbitrary delineation speaks to the fact that 17 disparate concussion grading systems currently exist. Most current grading systems predicate severity of injury based upon the absence of presentation of mental status change, amnesia, and LOC (Collins & Hawn, 2002; Collins et al., 1999; Maroon et al., 2000). LOC is the most commonly used method for on-field recognition of a concussion, however, recent research suggests that LOC alone is not a reliable indicator of a concussion's severity (Collins et al., 1999; Lovell et al., 1999). Moreover, an individual athlete's response to a concussion is distinctly variable and may be related to multiple moderating factors, such as the presence of learning disability (LD; e.g., Collins et al., 1999), presence of the apolipoprotein E ϵ4 gene (APOE-4; Kutner, Erlanger, Tsai, Jordan, & Relkin, 2000), and age (Collins & Hawn, 2002). Due to the variability of concussion responses, and unreliability of traditional

LOC-based grading scales, experts at the First International Symposium on Concussion in Sport have recommended the use of neuropsychological testing to assess concussion (Aubry et al., 2002).

Neuropsychological Testing

The management of sports-related concussion is currently one of the most hotly debated topics in sport medicine. Much of this debate centers on the safe determination of return to participation once a concussion has been diagnosed. The determination of return to participation and lingering difficulties associated with concussion have traditionally proven problematic for a variety of reasons. First, mainstream neurodiagnostic techniques, such as CT scan and MRI, though invaluable in discerning more serious intracranial pathology (e.g., skull fracture, hematoma, parenchymal lesion), are generally insensitive in measuring the subtle effects of concussion (Aubry et al., 2002). Further, relying on the self-report of the athlete may also prove ineffective because athletes may minimize symptoms for a quicker return to play or generally be unaware of the subtle symptoms of concussive injury (Bailes & Cantu, 2001). Consequently, although symptoms, behaviors and mechanisms related to a concussion provide a good initial assessment of the injured athlete, they do not reveal the whole picture. Given these issues, ancillary neuropsychological assessment has proven critical to the safe management of the concussed athlete.

The utility of neuropsychological testing in assessing a concussion was proposed as early as the 1880s (Walton, 1883), and has been documented empirically since the early 1980s (Rimel, Giordani, Barth, Boll, & Jane, 1981). Early studies focused primarily on memory retention and retrograde amnesia to assess neuropsychological functioning (Yarnell & Lynch, 1970). The results indicated that athletes developed progressive retrograde amnesia and memory difficulties approximately 3–20 minutes after a concussion. However, measuring only memory related performance was insufficient to assess the multidimensional effects of a concussion. As mentioned earlier, from a mechanistic perspective, the decrements in neuropsychological performance seen in athletes with concussion are directly linked to both the localization of the injury (Collins & Hawn, 2002) and subsequent pathophysiological events. Hence, the early focus on memory was expanded in subsequent studies to include multiple neuropsychological measures including attention/concentration, reaction time (RT), processing speed, and complex problem solving (Barth et al., 1989; Rimel et al., 1981). Results of studies using these multidimensional neuropsychological assessments indicated that concussed athletes consistently performed poorly on these tests (Barth et al., 1989; Macciochi, Barth, Alves, Rimel, & Jane, 1996). However, most concussed athletes returned to normal functioning levels within 10 days of a concussion. These initial findings concerning the neurocognitive decrements related to concussion have been confirmed in subsequent studies (e.g., Collins & Hawn, 2002; Lovell & Collins, 2001).

Initially, neuropsychological testing was conducted using paper-and-pencil measures (e.g., Barth et al., 1989; Collins et al., 1999; Wilberger, 1993). Since the late 1990s, paper and pencil neuropsychological testing protocols have been used by the entire National Hockey League (NHL) and are implemented by the majority of National Football League (NFL) franchises. Such data are used extensively to determine more objective and individualized return to play parameters in athletes sustaining a concussion. The most effective use of neuropsychological test data to help determine post-injury return to play is obtaining a 'baseline' level of function prior to concussive injury (Lovell & Collins, 2001). This testing is typically conducted at pre-season training camps and incorporated into the routine physical for the athlete. Athletes are tested again within 24–72 hours of a suspected concussion. Thereafter, follow-up tests are

Table 3
ImPACT Neurocognitive Test Modules

Test*	Cognitive domain measured
Word discrimination	Attention, verbal recognition
Symbol memory	Visual working memory, visual processing speed
Sequential digit tracking	Sustained attention, reaction time
Visual span	Visual attention, immediate memory
Symbol-matching	Visual processing speed, learning and memory
Color track	Concentration, response inhibition, reaction time
Three letters	Working memory, visual-motor response speed

*Results from above tests are computed into overall Memory, Reaction Time, and Processing Speed composite scores.

administered 5 and 10 days post injury, or until the concussed athlete returns to 100% of their original overall baseline neuropsychological performance, and reports no lingering symptoms above baseline levels at both rest and exertion (Lovell & Collins, 2001). Traditional paper and pencil methods, however, are time consuming and require trained, on-call clinical personnel to be properly administered (Collins & Hawn, 2002). Though this type of testing is feasible at the professional level, very few collegiate and high school programs have implemented this approach given the constraints of time, money, and personnel.

Recently, however, researchers have developed computerized neuropsychological testing and symptom evaluations that enable quick (i.e., <30 minutes) and efficient baseline evaluations of large groups of athletes (Lovell & Collins, 2001). In addition, the use of computerized neuropsychological testing (e.g., Immediate Post-concussion Assessment and Cognitive Testing [ImPACT], Headminders, and CogSport) increases reliability by minimizing subject practice effects, and provides greater sensitivity in measuring outcomes (Collins, 2001). A review of the test modules and respective cognitive domains assessed in the ImPACT test is presented in Table 3. In essence, a computerized approach appears to be more sensitive, reliable, practical, and certainly more cost-effective than traditional paper and pencil approaches.

Because computerized neuropsychological testing is self-paced and self-directed, trained SPCs, athletic trainers and other properly trained sports medicine staff members can administer baseline and follow-up tests. Currently available computerized neuropsychological testing modules cost $500 (high school) to $1,500 (professional team) for a software site license, which offers unlimited use of the testing software with an entire high school or college campus or club sport team. Software upgrades are also offered for $100–$500 and are usually released every 2 years. Several computerized neuropsychological testing companies offer single use software licenses accessible on-line for as little as $15 per test administration. See Collie, Darby and Maruff (2001) for a review of current neuropsychological testing modules. This, together with the minimal equipment requirements (i.e., PC laptop for field testing or student desktop computers for administrations to large groups), offers a cost-effective and accessible concussion management system for scholastic sports. Consequently, this technology is now being utilized at approximately 250 colleges and high schools across the country. Clinical neuropsychologists, however, must be consulted to interpret test results, diagnose individual cases, and make a determination regarding subsequent treatment, return to play decisions, and follow-ups/referrals. SPCs are also in an ideal position to advocate for and initiate the use and administration of computerized neuropsychological testing, as well as educate team medical staff regarding the utility of these tests to concussion management.

PSYCHOLOGICAL ISSUES FOLLOWING A CONCUSSION

Post-Concussion Behaviors

Just as many sport psychology intakes are susceptible to a self-reporting bias, post-concussion symptom assessments may not accurately reflect the presence of a concussion (Maroon, 2001). Following a concussion, some athletes may attempt to minimize their symptoms to avoid being withdrawn from competition (Bailes & Cantu, 2001). Other athletes may be relatively symptom-free, or inadvertently underreport symptoms. In either case, the athletes' behaviors will often reflect the presence of a concussion. Some of the post-concussion behaviors that may result from a concussion include (a) sleep deficits (hypersomnia, insomnia), (b) subtle changes in personality and mood (e.g., increased irritability, lassitude), (c) hyperdistractibility and an overall feeling of "fogginess," (d) increased fatigue and somnolence, and (e) academic difficulties (Lovell et al., 1999). Regarding the latter, it is important to note that the cognitive effects of concussion often manifest in the classroom (e.g., concentration, memory, processing speed deficits; Collins & Hawn, 2002). Such symptoms are also common to other problems including mood, adjustment, and anxiety disorders, and substance abuse (American Psychiatric Association, 1997); as well as LD. While an acute onset of these symptoms may indicate that an athlete has suffered a concussion, it is important to discern the presence of these symptoms through mental status exams and clinical intakes prior to a concussion to eliminate differential diagnoses. This further highlights the need for the baseline testing of athletes discussed previously (Maroon et al., 2000). The potential differential diagnoses mentioned above also underline the need for SPCs to assess, document, and when appropriate, communicate to other members of the sports medicine team any confounding diagnoses or factors. It is also important for SPCs to observe, document and communicate the athlete's nonverbal behaviors, academic difficulties, and changes in mood. Moreover, SPCs should corroborate any athlete-reported information with teachers, coaches, parents and teammates who have contact with the athlete.

Pressure to Return and Malingering

As with any sports injury, concussed athletes may feel pressure to resume their sport participation. This pressure may be self-imposed, determined by the situation (e.g., playoffs) or a result of organizational/team (i.e., coach, players) dynamics. Within this context, relying solely on the athlete's self-report of concussion-related symptoms may be misleading, misrepresentative, and potentially problematic (Bailes & Cantu, 2001). Given most athletes' desire to play, neuropsychological data is extremely advantageous to help uncover sometimes subtle sequelae of injury that represent lingering deficits of injury. Researchers have found that athletes generally under-report concussion symptoms even when continuing to suffer from cognitive deficits (Maroon, 2001). Thus, neuropsychological testing data and behavioral assessments may be the most reliable measure for determining return to play. SPCs can provide useful information regarding an athlete's post-concussion behaviors that coaches, physicians, and athletic trainers, who rarely watch a single athlete for a long period of time, might otherwise miss. In particular, SPCs should observe and assess athletes' behavioral symptoms (e.g., mood/personality changes, lethargy, confusion, slowed RT and processing) after physical exertion because symptoms may return or become more magnified during and immediately following exertion. Arranging a brief sport psychology session with an athlete immediately following a practice would offer the SPC a chance to observe the athlete following exertion and assess cognitive functioning using simple probes and discussion about the day's events, practice, coaches' comments, and performance. For instance, asking the athlete to "review

what happened at practice that day," or to "explain a complicated skill sequence or strategy from practice," may reveal subtle evidence of slowed processing speed, confusion or memory difficulties. This would allow for an informal assessment of the athlete's post-concussive condition without the appearance of an overt clinical evaluation, which may arouse suspicion and guarded responses from the athlete.

Regardless of its source, the pressure to return to sport before making a complete recovery can have dire consequences for the concussed athlete (Cantu, 2001; Collins & Hawn, 2002; Maroon et al., 2000). Even the most 'mild' concussion can have a tremendous impact on a player's neurocognitive and neurobehavioral functioning. Thus, SPCs should be cautious about an athlete returning to the field too quickly. Not only does this put an athlete at risk for SIS and other serious neurological impairments, but because concussion affects attention, concentration, information processing, and decision making, an athlete's ability to recognize and avoid dangerous situations on the field may be significantly impaired when they attempt to "play through" a concussion (Collins & Hawn, 2002). Consequently, concussed athletes who return to sport too soon, may also run the risk of sustaining additional injuries.

Occasionally, as with any potential sports injury, some athletes might fabricate or exaggerate symptoms and behaviors related to a concussion as a means of escape from sport or to gain the attention of others (Rotella, Ogilvie, & Perrin, 1999). Given their close working relationship with athletes, SPCs can be invaluable in detecting potential malingerers. However, detecting malingering athletes is difficult, and one can never be certain that an athlete is in fact malingering (Rotella et al., 1999). Due to the potentially catastrophic consequences of returning an athlete to sport with a symptomatic concussion and that most concussion malingers would report vague and difficult to confirm symptoms, SPCs should exercise caution when determining the presence of malingering. When there is any doubt, the SPC and other concussion team members should defer to the athlete's self-reported symptoms and neuropsychological testing data.

Fear of Re-Injury and Other Emotional Responses to Concussion

Emotional reactions to injury (e.g., fear of re-injury, reduced confidence, emotionality) can have a negative impact on performance in that athletes alter their typical style of play or approach their sport differently than they did before they were injured (Petitpas & Danish, 1995). Although it is common (and sometimes expected) for athletes to play with minor injuries, the dangers of playing with a concussion are potentially more serious, and may have a wide range of implications for performance and future injuries. Athletes returning too early from any injury might play with less confidence, comfort, and intensity (Williams & Roepke, 1993). Tentative play or frustration over performance difficulties can create a mindset that places athletes at greater risk for a variety of other injuries and limits their ability to focus on their performance (Williams & Roepke, 1993). Consequently, SPCs should assess athletes' post-concussion state anxiety, self-efficacy, and perceptions of subsequent risk using a combination of self-report measures and observations of athletes in practice or competition.

Relatively infrequently, athletes with lingering post-concussion sequelae may exhibit concomitant emotional distress that is both a function of, and response to, the lingering effects of concussive injury (Gasquoine, 1997). Though few formal epidemiological studies have been conducted in this regard, mood disturbance (e.g., depression, anxiety) is certainly not unprecedented in this population. Emotional reactions to injuries such as concussion are well documented among athletes (Evans & Hardy, 1995; Larson, Starkey, & Zaichkowsky, 1996). Anxiety, mood disturbances, irritability, and other emotional symptoms can be as much a part of the post-concussive symptom pattern as concentration problems and memory deficits

(Gasquoine, 1997; Mittenberg, Tremont, Zielinski, Fichera, & Rayls, 1996). In fact, King and his colleagues (King, Crawford, Wenden, Caldwell, & Wade, 1999) found that they could predict the incidence of post concussion symptoms in patients by examining a combination of emotional and neuropsychological deficits during the days immediately following their injury.

Although emotional distress and anxiety have been cited as concomitant factors in PCS (Gasquoine, 1997), other researchers have found that education, normalizing symptoms, stress reduction, and the amelioration of emotional difficulties can reduce the incidence and length of post concussion reactions (Groveman, Reba, Pollack, & Lehrer, 1987; Mittenberg et al., 1996). In this capacity, SPCs can help prevent protracted post-concussive complications or reduce the magnitude of these reactions. Supplying athletes with information about their symptoms and providing an outlet for their concerns can be large components of an SPC's involvement. In addition, SPCs with appropriate training can help athletes utilize stress management skills such as progressive relaxation, healing imagery, and cognitive restructuring; and intervene before psychological symptoms have a negative impact on their recovery. However, SPCs without the requisite clinical skills should be quick to refer athletes with these symptoms to qualified treatment providers.

PREVENTION AND EDUCATION

Who is at Risk for Concussion?

Athletes in collision sports such as American football, hockey, and rugby have the highest risk of concussion. In American football, which has the highest rate of concussion among sports, data suggest that between 4% (Powell & Barber-Foss, 1999) and 6% (McCrea et al., 1998) of athletes incur a concussion during an average year of exposure. This is an inevitable consequence of the purposeful collisions (e.g., tackles, checks) that occur in these sports. Although the aforementioned collision sports have the highest incidence of concussion, other sports are not immune from its effects. Sports including race-car driving, skiing/snowboarding, equestrian events, soccer, and basketball also have significant incidences of concussion (Bailes & Cantu, 2001). Soccer, the only sport in which athletes use their heads to propel the ball, has the added concern of athletes being exposed to potentially detrimental cumulative effects to the brain from repetitive heading. Initial research, however, has provided inconsistent support for these effects (Green & Jordan, 1998; Kontos, 2002). Based on the results of a study on adolescent soccer players, Kontos (2002) suggests that any proposed cumulative effects related to heading are most likely a product of the types of headers (e.g., defensive clearing headers, goal scoring headers), the biomechanics of the heading motion, and the length of exposure to heading.

A related concern involves the cumulative effects of repetitive blows to the head incurred in the sport of boxing. The effect of these impacts, which are considerably greater in force than those experienced in soccer heading, may result in dementia pugilistica or 'punch drunk' syndrome. Initial symptoms of dementia pugilistica include slowed or slurred speech, motor difficulties, memory disturbances, and subtle personality and behavior changes (Jordan, 1998). More severe symptoms including pyramidal and cerebellar dysfunction, significant personality and mood disturbances, and Parkinsonian-like symptoms such as tremors and severe gait ataxia may manifest during later stages of the injury (Bailes & Cantu, 2001). Boxers with long-term exposure to the sport and poor defensive skills (Jordan, Matser, & Zimmerman, 1996), and those who possess the APOE-4 gene (Jordan et al., 1997) appear to be at increased risk for developing demenitia pugilistica.

In addition to sport type, the way in which athletes participate in their given sport is also a potential risk factor for concussion. These behaviors are influenced by both age and gender. During adolescence, levels of self-efficacy over-inflate as perceptions of risk decrease (Bandura, 1997; Kontos, in press), thus leading to more frequent and risky behaviors (Gonzalez et al., 1994; Harre, 2000). In regard to gender, males tend to perceive less risk and take more risks in sport than females (Kontos, 2002; Kontos, in press). These relationships suggest that males may be more susceptible than females to potential injuries from risk taking in sport. In a recent study of concussion in soccer players, low self-efficacy, low perceived risk, and high risk taking were significant predictors of concussion and concussion related symptoms (Kontos, 2002). This supports the proposed relationship between low self-efficacy and injury among athletes (Bandura, 1997). However, females reported more symptoms related to heading, and more concussions from soccer than males, suggesting that gender differences in risk taking may not be reflective of increased likelihood of concussion (Kontos, 2002). Researchers have also suggested that the developing brains of younger athletes might be at particular risk for concussion and other head trauma (Field, 2002; Tysvaer & Storli, 1981), highlighting the importance of risk behavior management among youth and adolescent athletes.

The SPC's Role in Prevention and Education

Obviously, SPCs cannot influence an athlete's sport selection, age, gender or physical attributes, all of which may contribute to the occurrence of concussion. However, the SPC is in a unique position to assess athletes' behaviors and provide accurate information to athletes who place themselves at greater risk for concussions and other injuries. Realistic appraisals of risks associated with difficult skills, such as diving headers in a crowd in soccer, and aggressive play, such as late hits in hockey, are useful in providing athletes with a better understanding of the consequences of risk taking in sport. Although it is not in athletes' best interest to become fearful of performing, it is beneficial for athletes to accurately assess risk and make appropriate and informed decisions regarding it. SPCs can also help less confident athletes to enhance their self-efficacy and overconfident athletes to develop an accurate self-efficacy, which may limit exposure to injuries such as concussion (Bandura, 1997).

One of the most important preventive roles an SPC can fulfill is that of an educator. Although empirical knowledge about concussion is increasing within the sports community and population in general, this information can be confusing and misleading (Sturmi, Smith, & Lombardi, 1998). Consequently, athletes may be ill prepared for optimal recovery due to a lack of knowledge or awareness. Several authors have identified the importance of educating athletes about the effects of head injury, providing information about what to expect during recovery, and normalizing an athlete's symptoms following their injury (Feler & Watridge, 1992; Mittenberg & Burton, 1994; Mittenberg et al., 1996). SPCs can be a consistent source of information, and can provide an outlet for an athlete's questions, concerns, and apprehensions (Gasquoine, 1997). Athletes armed with basic information about concussion may be more inclined to follow the medical advice of their treatment providers and this new knowledge may circumvent the worry and apprehension that can accompany prolonged concussion symptoms (Gasquoine, 1997). The educational information provided by SPCs at the outset of treatment may also serve to protect athletes from re-entering the sporting environment too early, experiencing setbacks, and extending their recovery time.

One of the primary goals of concussion prevention is the prevention of further injury and/or cognitive decline (Bailes, 2001; Cantu, 2001; Collins et al., 1999). It is important for athletes to understand the significance of their symptoms and to be warned about the seriousness of sustaining additional head injuries during the recovery process. Although researchers and

treatment providers in the field are aware that athletes need complete resolution of symptoms and a gradual return to athletic participation (Bailes, 2001; Cantu, 1998; Collins & Hawn, 2002), athletes may be unaware that ongoing symptoms are indicative of continued neurological risk. More definitive research is still needed, but researchers are beginning to understand the additive effects of concussion and the importance of preventing repeated neurological insults (Bailes, 2001; Collins et al., 2002; Gronwell, 1989; Maroon et al., 2000). With each additional concussion, an athlete's risk of subsequent concussions increases, as does the severity of symptoms and neuropsychological sequelae (Collins & Hawn, 2002). SPCs working with concussed athletes should continue to provide accurate information and reassure athletes that the lingering effects of a concussion are part of the normal healing process (Erlanger, Kutner, Barth, & Barnes, 1999; Mittenberg & Burton, 1994).

A SUMMARY OF THE SPC ROLES RELATED TO SPORTS CONCUSSION

Today's sports medicine team relies on a multidisciplinary approach to managing sports concussion. Members of this team traditionally have included neurologists, clinical neuropsychologists, and athletic trainers. More recently, SPCs have been gaining support and acceptance as key members of many sport medicine teams. This trend is evidenced in the Sport Psychology Registry of the United States Olympic Committee and similar programs in Australia and Europe that recognize the importance of SPCs in the sports medicine team. Concussion is an injury to the mind that involves a multitude of interrelated diagnostic, management, referral and preventive processes and roles. Consequently, a multidisciplinary team approach is most effective to properly manage a sport concussion. Hence, the SPC should be an integral member of any sports concussion management team. The specific roles of the SPC as discussed throughout this paper are summarized below.

With proper training, the SPC can provide athletes, coaches and sport medicine teams with the appropriate education, recognition, and preventive information regarding sports-related concussion. In particular, the SPC is ideally positioned to promote and initiate systematic approaches to concussion management involving neuropsychological baseline testing, consistent symptom evaluation, and appropriate referrals in the case of a suspected concussion. Moreover, with the advent of computerized neuropsychological testing, properly trained SPCs are in an ideal position to administer initial and follow-up neuropsychological testing to athletes and subsequently communicate the results to a licensed clinical neuropsychologist. The traditional role of the SPC in delivering performance enhancement services to athletes affords them the opportunity to provide post-concussion consultation regarding issues such as fear of injury, confidence, anxiety, and other psychological issues related to return to play. Evaluating the concussed athlete's academic performance and day-to-day cognitive and emotional changes may also be included among the SPC's concussion management duties. In extreme concussion cases that involve retirement or restricted participation, the SPC may also consult with the athlete regarding adjustment and other issues related to withdrawal from sport. Given the intimate nature of the relationship between the SPC and the athlete, the SPC might become aware of post-concussive symptoms, behaviors and emotional disturbances that would warrant referral to a clinical psychologist or counselor. From a preventive perspective, the SPC can assist athletes in recognizing and managing risky in and out of sport behaviors. As is the case with all concussion management team members, the SPC will also communicate relevant information concerning the concussed athlete's condition to appropriate team members.

Lastly, it is important to briefly discuss the follow-up procedures an SPC should conduct to insure the proper management of a concussion. First and foremost, the SPC should

communicate any changes in an athlete's condition with other members of the sports medicine team. Both formal (e.g., clinical neuropsychologist) and informal (e.g., during sport psychology sessions) follow-up evaluations of signs and symptoms should be conducted until an athlete is symptom free. However, additional evaluations may be needed as symptoms may recur after initially subsiding. Because concussed athletes often require more time to complete academic and other cognitive tasks, SPCs should assist athletes in restructuring their schedules to allow more time to complete tasks. Athletes should also be given the opportunity to discuss their concussion and symptoms during sport psychology sessions. In some cases, it may be useful to involve other members of the sports medicine team in a session to address an athlete's concerns and questions. One of the most important follow-up issues pertains to the potential for catastrophic head injuries to be misdiagnosed, and subsequently mismanaged. Hence, anytime an athlete reports chronic or recurrent symptoms, or an acute onset of symptoms he or she should be immediately referred to a neurologist for appropriate diagnostic and clinical follow-up. Given the seriousness of SIS, a quick referral is particularly salient in instances when an athlete may have incurred another concussion or sub-concussive impact to the head.

CONCLUSION

The purpose of this paper was to introduce SPCs to the most relevant issues regarding concussion in sport. The role of the SPC on the sports medicine team in concussion recognition, management, psychological issues following a concussion, and prevention and education is a significant one. This role is dependent upon the SPC's training, education and overall experience with concussion management. It is strongly recommended that all SPCs participate in an introductory course, workshop or other continuing education experience on concussion in sport. In addition, the authors encourage the use of neuropsychological testing as an integral component for any concussion management program. In summary, SPCs are in a unique position to assist the sports medicine team and athletes in dealing with specific aspects of sport concussions.

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