Dispelling the Fog on Post-concussion SYNDROME

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Academic performance is an area that is often adversely affected in students who have suffered a concussion (Moser, Schatz, & Jordan, 2005). This is especially true of individuals whose symptoms persist for an extended period of time. Post-concussion syndrome can have very detrimental side effects to these students who attempt to reintegrate into school too soon. Growing evidence also supports that nutritional factors could play a role in reducing inflammation in the brain after a traumatic injury (Maroon, LePere, Blaylock, & Bost, 2012). Recommendations for the management of these concussions in the pediatric and adolescent population are inspiring debate and may be creating a fog of confusion for the frontline caregivers — physical education (PE) teachers, athletic trainers, school nurses, athletic directors, coaches and non–physical education teachers. This article provides information on how to recognize students who may be experiencing post-concussion syndrome, as well as guidelines for a graduated return-to-learn plan.

Incidence and Urgency

According to the Centers of Disease Control and Prevention (CDC, 2011), an estimated 2,651,581 children ages 19 years old and younger were treated in emergency rooms annually for sports and recreational-type injuries between 2001 and 2009. During this timeframe about 6.5% of those injuries were traumatic brain injuries (TBI), and young males represented the most affected group. Activities with the greatest number of TBI-related emergency room visits included bicycling, football, playground activities, basketball and soccer. The number of children and adolescents who hurt themselves on the playground or in a game and did not report the injury to a supervising adult is unknown. The incidence of head-related injury in this population could be higher and underreported.

Since symptoms from post-concussion syndrome (PCS) are frequently not visible, mild TBIs are often described as the "silent epidemic" (Gerberding & Binder, 2003). Several PCS symptoms exist. Asking practical questions may help the PE and classroom teachers recognize PCS. These questions include: (1) Is there a "fogginess" to the student's thinking? (2) Does the student have trouble concentrating? (3) Is the student easily distracted? (4) Does the student have headaches or experience nausea or dizziness? (5) Is the student depressed, anxious or irritable? and (6) Does the student have trouble sleeping? For the young person, complications from PCS could be devastating to his or her school performance, and, more seriously, his or her future career and life decisions

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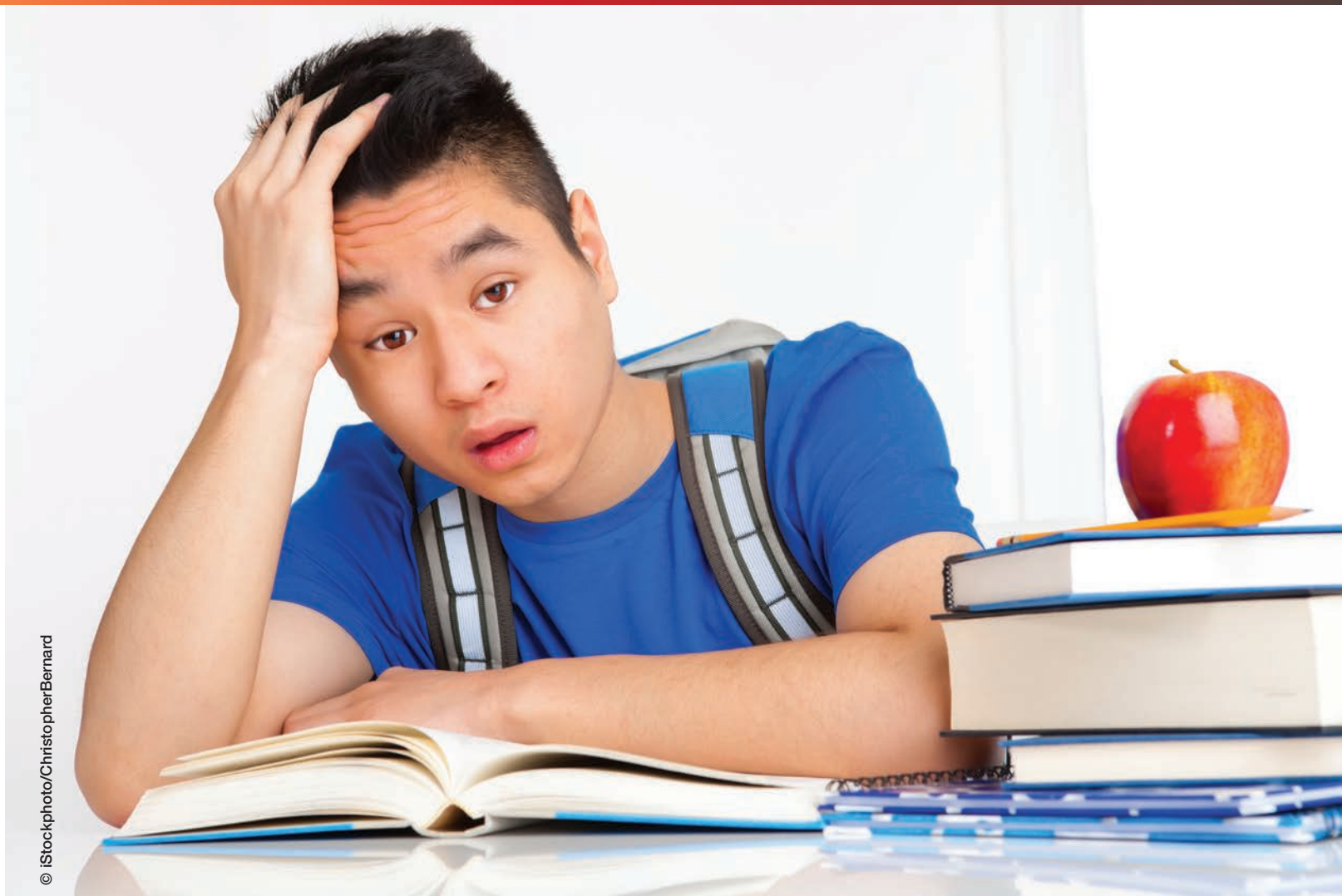

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could be ultimately affected. The seriousness of any type of brain injury in a young individual cannot be overstated and demands attention by all those associated with the lives of children and young adults.

Multiple concussions over time in young people can often lead to increased future risk of concussion. In a survey sent to high school and collegiate certified athletic trainers, Guskiewicz, Weaver, Padua and Garrett (2000) reported that of the 17,549 football players represented, 5.1% (n = 888) sustained at least one concussion. During the same season 14.7% (n = 131) of the 888 sustained a second injury. When compared to uninjured players, athletes who sustained one concussion in a season were *three times more likely* to sustain a second concussion in the same season. This is significant due to the cumulative effects of multiple concussions (Mannix et al., 2014). Recent discussion on multiple sport-related concussions has often led to the topic of chronic traumatic encephalopathy (CTE). This disease is a neurodegenerative condition that results in a constellation of symptoms ranging from behavioral and affective disorders, dementia, and other cognitive symptoms (McAllister & McCrea, 2017). Current research has not been able to establish a direct correlation between CTE and post-concussion syndrome. Further longitudinal studies are required to explore this relationship in greater detail.

Marar, McIlvain, Fields and Comstock (2012) used an Internet-based data-collection tool to gather injury data for 20 sports during the 2008–2010 academic years. High school–certified athletic trainers received this survey. Researchers concluded that concussions occurred across a wide variety of high school sports, not only full-contact sports such as football and ice hockey. In reporting the data, an "athlete exposure" represented one athlete participating in one athletic practice or competition. "Injury" was defined as one that (1) occurred as a result of participation in practice or competition; (2) required medical attention; (3) resulted in restriction of the athlete's sport activity for one day or more; or (4) resulted in any fracture, concussion or dental injury. An overall injury rate of 2.5 per 10,000 athlete exposures was reported. The sports with the highest concussion incidence rates included football (47%, n = 912), girls' soccer (8.2%, n = 159), boys' wrestling (5.8%, n = 112), and girls' basketball (5.5%, n = 107; Marar et al. 2012). There is limited evidence that has suggested that female athletes

may be at increased risk of sport-related concussion compared to male athletes (Dick, 2009). Further research is needed to conclusively identify reasons for this phenomenon. As more students are encouraged to participate in sports, frontline caregivers need to be aware of common post-concussion behaviors and need to be capable of supporting the student-athletes during recovery in the classroom, playground, gymnasium, and on the field.

Post-concussion Behaviors

Post-concussion syndrome can be defined as a complex neuropsychological disorder that persists for weeks or months following an initial brain trauma. Symptoms of this disorder include cognitive, behavioral and emotional disturbances that present without further trauma, except for the initial injury. Post-concussion syndrome presents a set of challenges to teachers, coaches and medical personnel to determine how much is related to the concussion and how much is caused by a pre-injury condition that has been exacerbated by the brain injury. Individuals with a pre-existing history of depression, anxiety or migraines often reported an increase in symptoms following a concussion and a prolonged recovery.

While it is encouraging that most concussed young athletes are able to successfully return to school and sport in a relatively short timeframe, students may continue to struggle with the effects of a concussion for weeks and months after the initial injury. Students who demonstrate post-concussive symptoms must be treated on a case-by-case basis, as resulting behaviors will be unique to each individual. Many of these symptoms occur as a result of physical exertion, so it is imperative for health and physical education professionals to be aware of these.

Support for Concussed Student-athletes during Active Recovery

Five years ago, complete rest was recommended until the individual was symptom free. Authors (McCrory et al., 2013) of the 2012 Zurich position statement suggested that 24 to 48 hours of acute rest could be beneficial. At that time current management involved rest and a reduction of any sensory stimuli from schoolwork and computers. Beyond that initial rest period, the statement was unclear about how much rest is enough and how much is too much. The answer likely depends on individual factors, such as age, gender and previous history of concussions. Younger individuals have longer recovery times, due to poorly understood factors with the developing brain. Females tend to have longer recovery times and higher rates of concussion than their male counterparts. Lastly, a history of one or more previous concussions results in two times greater risk of having concussion symptoms that persist for a week or longer (Chrisman, Rivara, Schiff, Zhou, & Comstock, 2013).

The pendulum has swung back to active recovery regarding the management of concussed individuals. After the acute stage of rest, low-intensity exercise has been shown to help improve neurocognitive function and minimize reported symptoms (Leddy, Sandhu, Sodhi, Baker, & Willer, 2012). Early exercise does not need

to be formal in nature. Activities such as walking, light jogging, and returning to school activities all provide enough exertion to maximize benefits. Dobney and colleagues (2017) reported that students who participated in an active recovery plan experienced significant improvements in physical, cognitive, emotional and sleep-related post-concussion symptoms. Even the 10%–15% of concussed individuals who experience post-concussive symptoms may benefit from early exertion and neurocognitive stimulation (McCrory et al., 2013). This physical activity can also help to minimize the associated affective and behavioral symptoms that often accompany sport-related concussion. Physical education teachers may be in a unique position to help facilitate better outcomes for students with PCS by incorporating early gradual immersion into physical activity. Students who are unable to physically participate in physical education class could possibly experience neurocognitive and psychosocial benefits by assisting the teacher in alternative manners.

Individuals engaged in various forms of active recovery therapies such as balance, cognitive, and light aerobic activities experience quicker recoveries with fewer symptoms (Leddy, Baker, & Willer, 2016). For those without access to these types of treatments, especially in rural populations, early reintroduction into activities of daily living may produce beneficial results in terms of symptom reduction and improved neuropsychological functioning.

Team Approach

The care and management of a student with post-concussion syndrome calls for a team approach. School administrators and faculty need a direct link of communication with athletics and medical personnel to ensure continuity of care and proper reintegration to school and activities. These key personnel can be assigned to one of three teams: medical, academic and family (Halstead et al., 2013). Potteiger and Wright (2016) also supported this multifaceted team approach to returning concussed students to the academic setting.

Medical Team. The combination of athletic trainers, physicians, school nurses, and, potentially, physician assistants and nurse practitioners make up this team, which is responsible for deciding when the student returns to the academic setting. Based on specific signs and symptoms exhibited by the patient, this decision is highly individualized. Special attention must be given to any activities that exacerbate symptoms. The medical team should communicate with the academic team regarding any limitations placed on the student.

Academic Team. This team's role is to ensure that the student is gradually integrated back into classes and that accommodations for testing and class assignments are provided. Students who present with post-concussive symptoms can often require significant accommodations for class participation and attendance, note-taking, assignments, and testing. Physical education teachers must make similar accommodations when gradually reintroducing students back into PE class. School personnel can develop and implement return-to-learn plans to provide a protocol for students to gradually participate in class again. Master, Gioia, Leddy and Grady (2012) described a return-to-learn plan as the gradual progression from initial introduction to full-time participation at school. Within six stages of activity, they suggested strategies to meet six related objectives:

1. For immediate recovery, they recommended no activity and complete cognitive rest. This means the student would not attend school and would also avoid reading, texting, video games, or the use of a computer.
2. To gradually increase cognitive and physical activities that do not aggravate symptoms, short periods of time (5–15 minutes at a time) for the previously listed activities in stage one can be introduced.
3. To increase cognitive stamina in stage three, homework of 20 to 30 minutes at a time is allowed at home.
4. For school re-entry, students are permitted to attend partial days at school after tolerating one to two cumulative hours of homework at home.
5. To integrate back into school, one can increase time at school to a full day in stage five.
6. When at the final stage, the student can fully return to school. A full cognitive workload is resumed, testing is allowed, and the student may attempt to catch up on homework.

Family Team. Parents, siblings, grandparents and other family and friends make up this critical team within the student's social and support network. In the early stages of recovery after a concussion it is critical to ensure that the concussed individual gets adequate rest and limits the amount of physical and cognitive exertion at home. This can be a delicate balancing act, because too much restriction from social contact can result in depression or other affective and behavioral symptoms. Students who suffer from post-concussion syndrome need the support and assurance at home to make a successful transition back to school.

The success of this team-oriented approach depends on effective communication between the different groups. Communication protocols should be defined and explained in each school or athletic department's policy and procedure manual. This information should also be made available to parents on the school's website and presented again to each group after a student sustains a concussion. Information should be presented in a way that is immediately comprehensible among all stakeholders.

Best practices for concussion management for all stakeholders need to be readily accessible in both the academic and athletic settings. Several resources are available online through the National Federation of State High School Associations, the CDC, the National Athletic Trainers Association (NATA), and other organizations that provide detailed information for various personnel to obtain optimal outcomes for students who have sustained concussions. The National Collegiate Athletic Association also has information on their website that outlines the requirements and best practices for concussion assessment, as well as management plans that are required for each member institution.

At home and school, caregivers also need to consider the nutritional support for the injured student. These considerations range from specific nutrients to a well-balanced nutritious diet to support recovery. Any nutritional recommendation should be specific to the individual and should be made by a qualified professional, such as a physician or dietician.

Nutritional Considerations

In a review of potential non-drug approaches to treat post-concussion syndrome, Maroon et al. (2012) suggested that natural anti-inflammatory agents be considered to reduce the inflammation of a concussion. Agents such as omega-3 fatty acids, vitamin D, resveratrol and magnesium have been identified as potential dietary components to reduce the inflammation in the brain.

Omega-3 Fatty Acids. Foods rich in omega-3 fatty acids include whole flaxseed, flaxseed oil, and chia seeds, with lower levels found in fatty fish (salmon, herring, mackerel) and canola oil (National Institutes of Health–Office of Dietary Supplements, 2016). Currently recommended daily allowances (RDA) for omega-3 fatty acids are not available due to insufficient data to establish a recommendation. In place of a recommended level the Institute of Medicine (IOM) established adequate intake (AI) levels to ensure nutritional adequacy. For AI levels of a young male from nine to 18 years old, 1.2 mg to 1.6 mg in the form of alpha-linolenic acid is suggested. The AI levels for females of the same age are slightly lower at 1.0 mg to 1.1 mg per day. According to the review by Maroon, et al. (2012), a total of 1.5 to 5.0 g of fish oil capsules can also be taken with meals; however, the U.S. Food and Drug Administration (2004) does not recommend exceeding 3 g per day of the omega-3 fatty acids (eicospentaenoic acid and docosahexaenoic acids combined), with up to 2 g per day from dietary supplements. For safety purposes an intake that includes omega-3 fatty acid–rich foods and no more than 2 g of an omega-3 supplement is advisable.

Vitamin D. The "sunshine vitamin" is synthesized by humans exposed to the sun; however, sunblock lotion, dark-colored skin, pollution and clouds can decrease vitamin D synthesis in the body. Vitamin D–rich foods include cod liver oil, swordfish, sockeye salmon, tuna fish, orange juice and milk fortified with vitamin D (Haytowitz et al., 2015). The current RDA is 600 IU (15 µg) for males and females (9–70 years old; Ross, Taylor, Yaktine, & Del Valle, 2011). A daily supplement, plus Vitamin D–rich food sources, would reasonably provide the student-athlete with adequate amounts.

Resveratrol. Uncontrolled inflammation following injury to the central nervous system is known to promote brain damage. Resveratrol, a plant component in red wine, was previously made popular to prevent heart disease. It is also known as an antioxidant. For those who have experienced a concussion resveratrol may reduce edema, alleviate inflammation, and provide neuroprotection following injury (Lopez, Dempsey, & Vemuganti, 2015). Common food sources of resveratrol include red grapes, peanuts and chocolate. Supplements are also commercially available. No RDA exists for resveratrol; however, in a systematic review, Vang, Ahmad, Baile, Baur and Brown (2011) concluded that published evidence was not strong enough to justify a recommendation for resveratrol supplementation, beyond that obtained from diet sources.

Magnesium. As a very common mineral in the body, magnesium is required in numerous metabolic processes and for many body functions. For young males and females (9 to 13 years old), the RDA for magnesium is 240 mg per day and increases to 360 mg per day for females 14 to 18 years of age. Legumes, nuts, whole grains, and most vegetables can provide food sources of magnesium (Volpe, 2013).

For practical purposes, student-athletes would benefit from adequate food intake to cover their energy needs, extra protein for healing needs (eggs, dairy or meat), and special attention to foods containing the anti-inflammatory agents described here (e.g., fish oil, vitamin D–fortified milk, fruits, legumes, vegetables, and whole grains). Position statements from NATA are used by certified athletic trainers to guide the treatment of sport concussions. In the NATA statement, Broglio and colleagues (2014) recommended that the student-athlete avoid alcohol and narcotics, while being instructed to eat a well-balanced, nutritious diet.

Future of Concussion Management

In 2013 the IOM and the National Research Council convened an expert committee to review the research literature addressing sport-related concussions in youth and military personnel (Graham, Rivara, Ford, & Spicer, 2014). They recommended the following, based on their findings:

1. A national surveillance system to determine the incidence of sport-related concussion in youth ages five to 21 years old;
2. Research to establish effective metrics and markers of concussion diagnosis, prognosis and recovery;
3. Research consisting of controlled, longitudinal, large-scale studies to assess the short- and long-term consequences of concussion and repetitive head impacts over the lifespan;
4. Research for the design of more effective safety equipment; and
5. Evaluation of the effectiveness of large-scale efforts to increase knowledge about concussions.

While agencies come forward to improve sport-related concussion diagnosis and management, every frontline caregiver can support the concussed student in the classroom, playground, gymnasium and outdoor facility with an informed and redirected focus on recovery. Using the team approach and return-to-learn plan, the student can potentially avoid long-term cognitive and motor deficits, plus possibly recover more quickly.

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