With students returning to school this fall and practices for football and other sports in full swing, the topic of sports-related concussion and head injury will soon be back in the news. Indeed, in recent years there has been increased attention (popular and scientific) given to sports-related concussion in both student and professional athletes and across the full range of sport and recreational activities—not just football.

With nearly 60% of high school students in the United States participating in organized sports and with the number of younger children involved increasing annually (CDC, 2003), the identification and management of concussion is a growing public health issue. Considered to be the fastest-growing sub-discipline in neuropsychology, concussion management also poses unique challenges and opportunities for speech-language pathologists working with school-aged children.

**Definition and Demographics**

A concussion is a mild traumatic brain injury (TBI) caused by direct or indirect impact to the head. The American Academy of Neurology (1997) defines concussion as any alteration of mental status due to a biomechanical force affecting the brain with or without loss of consciousness.

Sport and recreational activities are the third-leading cause of TBI for children and adolescents. The U.S. Centers for Disease Control and Prevention (CDC) estimates that 300,000 sports-related traumatic brain injuries, most of which can be classified as concussion, occur annually in the United States (CDC, 1997). Team and contact sports such as football and ice hockey have the highest incidence of concussion, followed by soccer, wrestling, basketball, field hockey, baseball, softball, and volleyball (Koh et al., 2003), but concussion can also occur in individual sports such as gymnastics or diving.

The risk of concussion is highest in the 15– to 19-year-old age group; in addition, males are at higher risk than females (CDC, 2002).

**Symptoms and Mechanisms**

Concussion symptoms can include immediate memory disturbance, confusion, clumsiness, dizziness, and vomiting. The majority of children will make a complete recovery from a single concussion but it is important to remember that recovery can take days, weeks, and even months and that a number of
cognitive and physical symptoms are possible. These post-concussive neurobehavioral symptoms are typically divided into three domains—somatic, cognitive, and emotional/behavioral—and can include any combination of symptoms (see Table 1 [PDF]).

Like other TBIs, a concussion involves rotational acceleration/deceleration forces to the brain that can stress and tear axons and the vasculature, causing diffuse injury, cell death, and intracranial bleeding. In addition to understanding these biomechanical forces, considerable progress has been made in understanding the brain’s chemical response to concussion through animal models. Whereas the healthy brain is constantly working to achieve chemical equilibrium, concussion can cause a “cascade” of significant metabolic disturbances in the brain including decreased cerebral blood flow, increased production of glucose and glutamate, and abnormal cellular ionic fluxes that can take minutes, hours, or days to return to equilibrium (Giza & Hovda, 2001).

**Effects of Multiple Concussions**

Not only is metabolic dysfunction thought to underlie concussion symptoms, but some researchers believe that until equilibrium is achieved again, the brain may be more vulnerable to a second injury. This second injury, regardless of severity, can produce catastrophic outcomes from severe neurological dysfunction to death. The term “second-impact syndrome” refers to an individual who sustains an initial head injury and then sustains a second head injury before the symptoms associated with the first injury have resolved (Cantu, 1998). The second injury can be minor (e.g., a blow to the chest that jerks the head) but potentially can be fatal for the athlete (e.g., 17 deaths in individuals under age 30 related to second-impact syndrome were reported between 1984 and 1995 across a range of contact sports including football, hockey, and boxing, (Cantu & Voy, 1995)).

The concussion literature includes a long-held assumption that multiple concussions are predictive of a lower threshold for subsequent injury and a worse outcome afterward (Collins et al., 2002). Yet the data are equivocal: Studies (Collins et al., 1999; Collins et al., 2002) have shown that multiple concussions are associated with poorer performance on neurological tests, prolonged learning difficulties, and increased vulnerability to subsequent concussion than in individuals with a single or no concussion; other studies (Iverson et al., 2006; Macciocchi et al., 2001) have shown no significant differences on cognitive testing or in on-field presentation of symptoms between athletes with one or two concussions.

**Age Effects**

The Kennard principle (Kennard, 1936) states that due to neuroplasticity, a young brain is more adaptive and protective against damage than an older, adult brain. Recent studies (e.g., Levin et al., 2001), however, suggest that the developing brain is actually more vulnerable to the effects of widespread damage associated with TBI. To date only one study has directly compared concussion recovery rates by age (high school vs. college athletes); although the college sample had a greater prior incidence of concussion in that study, the
high school students took longer to recover (Field et al., 2003). More research is needed to replicate and extend this finding to younger developmental samples, but there are neurobiological (e.g., cerebral blood volume, level of myelination) and biomechanical (e.g., less well-developed neck and shoulder musculature) differences between children and adults that may make young children more vulnerable to the effects of concussion and account for more protracted recovery rates (Lovell et al., 2004; McCrory et al., 2004). The age of the athlete who has experienced a concussion, therefore, may affect outcome and clinical decision-making regarding return to play and academic life. Efforts are underway to obtain incidence data and to conduct empirical studies examining recovery rates and long-term outcomes in elementary and middle-school populations.

**Concussion Management**

There is no consensus on the best course of action for concussion management. In fact, there are as many as 22 different published guidelines for grading concussion severity and determining return to play. The most commonly used concussion grading system is that of the American Academy of Neurology (Kelly & Rosenberg, 1997), which includes three levels. In a Grade 1 concussion—considered the most common yet most difficult to recognize form of concussion—the athlete does not lose consciousness and has only transient or momentary confusion for less than 15 minutes. In a Grade 2 concussion, the athlete also does not lose consciousness but exhibits signs of confusion or other mental status abnormalities for longer than 15 minutes. Grade 3 concussions are the most easily recognized as the athlete loses consciousness, either briefly (seconds) or for more prolonged periods of time (minutes).

The most widely cited return-to-play guidelines—those by Cantu (1988), the amended Colorado Guidelines (Colorado Medical Society, 1991), and those of the American Academy of Neurology (1997)—make recommendations based on the grade of concussion (1, 2, or 3) and number of concussions (first, second, or third). The publication of these guidelines has been instrumental in increasing awareness of concussion symptoms and promoting the use of common terminology. However, in addition to their tremendous variability, these sets of guidelines are criticized for lacking empirical evidence on which to base the recommendations and for assuming a “one-size-fits-all” approach that ignores individual factors such as age, gender, and the unique circumstances of a given injury (Collins & Hawn, 2002).

In recognition that concussion management guidelines were inadequate to assure proper management of every concussion, a group of experts convened at the International Conference on Concussion in Sport, first in Vienna in 2001 and then in Prague in 2004, and made recommendations regarding the importance of individualized and graduated return-to-play protocols (Aubry et al., 2002; McCrory et al., 2005). The recommendations include immediate removal from and no return to play in the current game following any signs or symptoms of concussion, a medical evaluation to rule out serious intracranial pathology, and post-injury neuropsychological testing. The key to the graduated return to play is that the athlete be symptom-free throughout each step before progressing to
the next step or returning to play (i.e., if athlete is asymptomatic at rest and develops a headache following light aerobic exercise, athlete returns to complete rest).

The steps in the graduated return to play are:

1. No activity and rest until asymptomatic
2. Light aerobic exercise (e.g., walking)
3. Sport-specific training
4. Non-contact drills
5. Full-contact drills
6. Game play

**Baseline Neuropsychological Testing**

Under the new recommendations, pre- and post-injury neuropsychological testing is considered the cornerstone of concussion management, return-to-play decision-making, and diagnosis and management of the athlete who has experienced concussion. Pre-injury or baseline neuropsychological testing (which can be completed in about 30 minutes) is followed by post-injury testing; the pre- and post-testing allows comparison between the individual's performance pre-injury and after a concussion. The goal is to individualize the decision-making process for return to play, and this testing is considered a more sensitive and objective measure than observation of symptoms and self-report.

The three most widely used computerized, baseline-testing programs—**ImPACT** (Immediate Postconcussion Assessment and Cognitive Testing), **Concussion Resolution Index**, and **CogSport**—are used by the military, national and international professional teams (e.g., Major League Baseball), college and high school athletic departments, and neuropsychological centers and clinics. All of these programs collect baseline data from athletes across various neuropsychological domains (e.g., memory, attention, processing speed) and on concussion symptoms and provide a detailed clinical report documenting changes from baseline performance that can be used to make decisions regarding return to play (i.e., when the athlete is symptom-free and cognitive performance returns to baseline levels).

Although the paradigm shift towards individualized baseline neuropsychological testing represents an important and exciting advancement in concussion management, it is important to remember that these tools are new and are still being validated. Developers are working to collect data regarding reliability, validity, and clinical utility of these tools; independent replication is still forthcoming. Some have even called the implementation of baseline testing premature (e.g., Randolph et al., 2005), but this direction in concussion management has tremendous momentum. As more research becomes available on the incidence and effects of concussion in younger children, we will likely see the use of these programs in elementary and junior high schools.

**Concussion Management in the Schools: A Role for SLPs**

The confluence of increased research directed toward understanding the effects
of concussion in younger populations, the creation of prevention campaigns aimed at preschool and school-aged children, and the anticipation that individualized computer baseline assessment will be common in the schools makes now an opportune time for SLPs to get involved in concussion management. SLPs have not traditionally had a central role in working with student athletes in the return-to-play/school decision-making process, but SLPs are particularly well-suited and qualified to take a leading role in many of the issues of concussion management in the schools, including administering and interpreting cognitive and behavioral assessments and working with other personnel to maximize academic success and social functioning of student athletes who have experienced concussion. Below are some ideas and suggestions for establishing a role for SLPs in concussion management in the schools.

**Promote awareness and prevention.** The first line of defense in managing concussion and sports-related head injury is prevention. Student athletes, teachers, and coaches should be familiar with frequent causes of injury, necessary protective equipment and its fit (e.g., helmets), and a common vocabulary to discuss and report cognitive and behavioral concussion symptoms. A number of Web sites provide information on the incidence, causes, symptoms, outcomes, and prevention of concussion and organizations have created freely available prevention and educational materials for children of different ages in English and Spanish ([see sidebar](#)).

A team approach that includes teachers, coaches, SLPs, and school administrators yields the best results for school-wide awareness campaigns. Ideas for prevention awareness include fundraisers for helmets or other protective equipment, coloring contests, essay-writing contests, or letter-writing campaigns to policy-makers and local newspapers for older students. These activities can be planned around already-established awareness campaigns throughout the year:

- Brain Injury Awareness Week (second week in March)
- National Playground Safety Week (fourth week in April)
- National Youth Sports Safety Month (April)
- National Bicycle Safety Month (May)
- Brain Injury Awareness Month (October)

**Identify affected students and support transition back to school.** Within communication sciences and disorders there is recognition of the role SLPs play in the assessment and treatment of cognitive and behavioral deficits following brain injury, but other school officials may not fully understand or recognize this role. Indeed, in a survey of 78 Illinois school-based SLPs, 94% of respondents indicated that they are not informed when a student sustains a sports-related head injury ([Duff et al., 2003](#)).

There are several important benefits to promoting communication among school personnel and creating a team approach in the identification and management of student athletes who have experienced concussion. First, these athletes may be more symptomatic under conditions of exertion (physical and cognitive) and fatigue that fluctuate with the demands of the day. The more
individuals monitoring a student, including SLPs, the more opportunities there are to document symptoms at different times during the day and at various levels of cognitive and physical exertion and to make appropriate decisions regarding SLP services, classroom management, and resumption of full academic and athletic activities.

Second, although rare, some students may present with chronic and severe cognitive and neurobehavioral deficits following a concussion and require specialized educational services provided by an SLP. For the majority of athletes, however, a complete recovery can be expected with close monitoring and an appropriate transition back to school. Working with teachers, SLPs can make significant contributions to a timely and gradual transition back to a full academic schedule to ensure maximum academic success and social functioning. The transition should also follow a graduated protocol monitored closely for symptoms during fatigue and exertion.

Consistent with modifications and accommodations for students with TBI in general, Kirkwood and colleagues (2006) have found the following strategies useful in supporting the student athletes' return to school following a concussion:

**Initial transition back to school**

- School personnel are alerted to injury.
- School reintegration occurs gradually.
- Student is not expected to do all work completed in absence.
- Extra assistance is provided to facilitate completion of makeup work.

**School-based support**

- Monitor student closely for two to three months.
- Provide rest time and breaks as needed.
- Reduce homework and class load.
- Reduce cognitively demanding in-school tasks (e.g., no more than one test daily).

**Classroom-based support**

- Delay tests.
- Waive time constraints for tests.
- Increase flexibility for assignment due dates.
- Provide preferential seating for close monitoring and decreased distractions.
- Be a part of individualized baseline testing.

Coaches, athletic trainers, and school nurses usually administer the individualized baseline testing conducted in high schools. In many ways, SLPs are a better choice for this role. SLPs are familiar with administering standardized tests, have extensive clinical decision-making expertise, and most importantly, are trained in various areas of cognition and cognitive disorders. In addition, athletes may under-report any concussion symptoms to a coach or teammates for fear of exclusion or letting down the team. If SLPs participate in
baseline and post-injury testing, student athletes may feel more comfortable reporting symptoms to clinicians. This role also offers SLPs the opportunity to serve as an advocate and a referral source; as an advocate for the student, the SLP also could assist the student in the referral process to special education providers.

The science of concussion research and the clinical management of children and adolescents who have experienced concussion is rapidly evolving, presenting many challenges and opportunities for those serving this population. Although SLPs are not routinely involved in concussion management, they have a unique skill set that is particularly well-suited to help athletes who have experienced a concussion make the transition back to school and to work with them to promote their cognitive, communicative, academic, and social success.

SLPs are encouraged to review the online educational and prevention resources to increase their own awareness of concussion in children and adolescents and to consider taking a leading role in concussion management in their practices.

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**Concussion: Online Resources**

**Centers for Disease Control and Prevention**. The CDC created the "Heads Up" program that offers a free toolkit containing fact sheets for coaches, athletes, and parents; videos; posters; and educational materials.

**The Brain Injury Association**. This association's 2003 campaign, "I.M. Brainy," provides educational activities for preschoolers, fact sheets, prevention information, and materials for increasing community awareness. The Brain Injury Association's Web site also has sample letters to the editor, news release templates, and radio public service announcements that can be used to increase community awareness.

**ThinkFirst National Injury Prevention Foundation**. This group has educational materials geared for young children and teens/adults that address issues of risk-taking and personal vulnerability.

**Students With TBI: The 504 Agreements and RTI**

Students experiencing traumatic brain injury (TBI) may be covered by Section 504 of the Rehabilitation Act, and clinicians often use a response-to-intervention (RTI) model to ensure the students' needs are being met in the least
restrictive environment. Section 504 protects individuals with disabilities from discrimination and ensures that children with disabilities have equal access to an education. Typically students who need only an accommodation—but not specialized direct instruction—are provided those accommodations under a 504 plan. To qualify for this protection, students must have a physical or mental impairment that substantially limits at least one major life activity: walking, seeing, hearing, speaking, breathing, learning, reading, writing, doing math calculations, working, caring for oneself, or performing manual tasks.

If there is a question regarding the need for specialized instruction, students with TBI could also be monitored under an RTI model. Initially the RTI team could plan the student's return to school. The SLP and/or health care providers should provide the team with information about signs that may indicate more long-term effects of TBI. If issues arise, other levels of the RTI model could be used to modify instruction and provide accommodations; if that approach does not provide the necessary support, consideration could be made to do a full multidisciplinary assessment.

This assessment would determine if the student requires special education services, which would include direct speech/language support as well as any other services, such as learning support, occupational therapy, or other supports.

—Deborah Adamczyk, MA, CCC–SLP, ASHA director of school services

Online-Exclusive References


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