



*appendix a*

## ***Essential Information for Athletes, Parents, and Coaches***

This appendix provides a brief summary of the previous chapters, primarily designed to provide an overview of sport concussion for coaches, athletes, and family members. Clinicians can use this appendix as a useful communication tool when working with these individuals.

A concussion is an alteration in mental status or brain functioning resulting from a direct or indirect blow to the head. A person does not have to lose consciousness in order to sustain a concussion. Most sport concussions are mild and cause a transient disruption of the brain's normal electrical and chemical processes, leading to various signs and symptoms. Structural injury to the brain is relatively rare in sport concussion, but it can occur. Approximately 822 sport-related concussions occur in the United States every day. Your family doctor and the team athletic trainer are key players in the evaluation and treatment of sport concussion. A neuropsychologist may also be consulted to assess the effects of concussion on brain functioning; she will administer a battery of paper-and-pencil or computer-based tests to evaluate the cognitive effects of the concussion. The athletic trainer may also test balance (postural stability) because balance can be affected adversely after a concussion.

From *The Heads-Up on Sport Concussion* by Gary S. Solomon, Karen M. Johnston, and Mark R. Lovell, 2006, Champaign, IL: Human Kinetics.

**neurotransmitter**—A naturally occurring substance in the brain that serves as a chemical messenger from one nerve cell to the next. Neurotransmitters allow neurons to communicate and serve as the biological basis for cognitive functioning.

During a concussion the brain undergoes a series of chemical events and changes that can last for a week or even longer. These chemical changes involve alterations in numerous substances, including calcium, potassium, and **neurotransmitters** in the brain. Blood flow to the brain also tends to be reduced after a concussion. In most cases, the brain heals the chemical and blood-flow abnormalities on its own. The U.S. Food and Drug Administration has not approved any medications for the treatment of concussion, and at present there is no proven way to speed up the process of healing the brain after a concussion. Rest, avoiding exertion (physical and mental exertion can worsen the symptoms of a concussion), and the prevention of a premature return to play (which can cause the athlete to run the risk of incurring another concussion) are the only known effective treatment strategies.

Concussion in sport has become a major problem. Disability and death have occurred as a result of concussive head injuries, especially at the high school level. Second-impact syndrome (SIS) is a condition that occurs when an athlete who sustains an initial head injury (usually a concussion) experiences a second head injury before symptoms associated with the first injury have cleared. Although quite rare, SIS can be life threatening for young athletes. It is important to realize, however, that although the rate of concussion incidents in sport has grown, in the United States an adolescent has a greater chance of being killed while riding a bicycle than while playing organized sports.

Awareness of sport concussion peaked in the United States at the turn of the 21st century. It is now a commonly discussed topic in the media and in professional journals and textbooks. According to published data, the odds of a contact sport athlete sustaining a concussion while playing organized sports are roughly 5% per season. This percentage may be an underestimation, however, given that athletes often fail to recognize symptoms or report concussions to trainers or doctors.

## Signs and Symptoms

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Some of the immediate signs that an athlete has sustained a concussion include the following:

- Appears dazed
- Is confused about the play, score, or opponent
- Exhibits decreased playing ability
- Displays poor balance, lack of coordination
- Answers questions slowly
- Exhibits personality or behavioral changes
- Is unaware of time, date, and place
- Runs in the wrong direction
- Has a vacant stare; looks glassy eyed
- Forgets plays or events that occurred before the impact (retrograde amnesia)
- Forgets plays or events that occurred after the impact (anterograde amnesia)
- Loses consciousness
- Experiences a seizure (rare)

Some of the more common symptoms of concussion include the following:

- Headache
- Nausea and vomiting
- Balance problems
- Double or blurred vision
- Sensitivity to light (photosensitivity)
- Sensitivity to noise (phonosensitivity)
- Feeling sluggish, "foggy," or "just not right"
- Feeling "dinged" or "dazed," having "bell rung"
- Seeing stars or flashing lights
- Ringing in the ears
- Changes in sleep patterns
- Poor concentration

- Memory problems
- Drowsiness
- Low energy, feeling slowed down
- Irritability
- Sadness
- Anxiety and nervousness
- More emotional than usual
- Feeling “pressure in the head”

These symptoms are usually self-limiting and clear up within a week.

## Assessment, Evaluation, and Treatment

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The clinical assessment of concussion can be performed on the sideline with mental-status questions and structured cognitive tests. Examples of mental-status questions for the assessment of sport-related concussion include asking the athlete the score of the game, which quarter or period it is, and who won the previous game. Neuropsychological testing is a more thorough strategy in the evaluation of the cognitive symptoms of concussion. These are paper-and-pencil or computer-based tests that measure brain functions such as memory, concentration, and speed of information processing. Neuropsychological testing and other sideline mental-status tests are most useful when a preseason baseline score on the test has been obtained on each athlete. The athlete’s postconcussion test scores, in tandem with an assessment of clinical signs and symptoms, can then be compared with baseline scores to assess the severity of the concussion and to monitor recovery. Cost- and time-effective baseline neuropsychological testing is now available through sports neuropsychologists; we strongly urge parents of contact- and collision-sport athletes to have their children undergo baseline neuropsychological testing.

Structural **neuroimaging** (brain) scans, such as **computed axial tomography (CT)** or **magnetic resonance imaging (MRI)**, are not always required after sport-related concussion. In fact, these tests are found to be normal more than 90% of the time after mild sport concussions. The presence of specific neurological signs (detected by a physician, athletic trainer, or nurse) or the prolonged presence of postconcussion symptoms would warrant the consideration of a

CT or MRI of the brain. Newer functional brain-imaging technologies (such as positron emission tomography [PET] scans and functional MRI [fMRI]) measure oxygen, glucose, and blood-flow patterns in the brain and show a great deal of promise for the future. Balance testing may be a useful adjunctive strategy in assessing the postural-stability effects of concussion.

More than 25 grading scales for concussion have been published, and two in particular are used commonly to assess sport concussion. Most of these scales were not derived from scientific study but have been based on expert and consensus opinion. The true values of a grading scale are in its ability to accurately classify concussion severity and to predict recovery and outcome. No grading scale has yet to meet these criteria from a scientific viewpoint. The Concussion in Sport (CIS) Group (2002) did not endorse any particular grading scale and emphasized the need for each concussion to be assessed and treated individually.

Since the late-1990s, structured programs for the evaluation and assessment of concussion have occurred in the NFL, NHL, and NCAA. Greater effort has been made at all levels of competition to increase awareness of concussion and to better evaluate and treat this common brain injury. Professional organizations have also been busy delineating guidelines for the assessment and management of concussion in athletes. Neurologists, neurosurgeons, orthopedic surgeons, and multidisciplinary groups have published concussion guidelines. The Concussion in Sport Group (CIS), an international group of sport concussion experts, has presented the most recent guidelines (2002, 2005). We consider these guidelines to be the gold standard for concussion assessment and management.

The CIS guidelines emphasize a multistep rehabilitation program under the direction of a qualified professional. The first step postconcussion is complete rest until all symptoms resolve. If baseline neuropsychological testing has been done, the test scores should have returned to the athlete's baseline. If neuroimaging has been performed, the results should be normal. The next step

**neuroimaging**—The application of various types of X-ray and nuclear methods to produce radiographs (images) of the central nervous system. Computed tomography (CT) and magnetic resonance imaging (MRI) are the most common neuroimaging methods.

**computed axial tomography (CAT, or CT)**—A specialized X-ray technique that allows visualization of detailed areas of the body in a specific plane.

**magnetic resonance imaging (MRI)**—A specialized diagnostic technique that utilizes magnetic, X-ray, and nuclear methods to provide a detailed image of specific body areas.

after symptom resolution is light aerobic activity such as walking or stationary cycling. Sport-specific training follows and might include running in soccer or skating in hockey. The next step is noncontact training drills, followed by full-contact training (after medical clearance, including a normal neurological exam). Return to game play is the final step. The CIS group emphasized that each step in the rehabilitation program may take a day to complete and that the recurrence of symptoms at any point necessitates stepping back to the prior level of rehabilitation.

At present, there are no medications approved in the United States (or anywhere else in the world) specifically for concussion. Some doctors are using various medications for the treatment of specific, prolonged concussion symptoms (for example, migraine-type headache), and the off-label use of various drugs has been noted in many (nonsport-related) concussive injuries. Rest (and the prevention of another concussion) is the primary treatment at present. The athlete should not engage in exertional activities (physical or mental) before beginning the structured and supervised rehabilitation program because these activities can worsen the symptoms of concussion and prolong the rehabilitation period. It is important to recognize (as Dr. Mark Lovell has said), that the brain is not a muscle; exercise will not help an athlete recover from a concussion initially. Design changes have been made by football-helmet manufacturers in an attempt to improve protection against concussion. A concussion-proof helmet, however, does not yet exist.

## Sport-Specific Concerns

**arachnoid cyst**—A closed cavity or sac containing a liquid or semisolid material found in the spiderlike covering between the brain and the skull.

**subdural hematoma**—A localized collection of blood (and spinal fluid) in the space underneath the outer covering of the brain (the dura) usually resulting from a laceration in the brain and/or a tear in a blood vessel.

Although clear evidence proves that concussions occur in soccer and that brain function can be affected adversely by them, there is no convincing evidence to indicate that heading the ball in soccer causes cognitive deficits in the vast majority of athletes. Soccer athletes with **arachnoid cysts** of the brain may be at greater risk for the development of a **subdural hematoma** after repeated heading of the ball or concussion.

Boxing is the only sport where one of the stated purposes is to inflict a concussion on one's opponent. Available studies suggest a significant risk for cognitive difficulties later in life for professional boxers who have prolonged careers. A specific genetic risk factor (the Apolipoprotein E4 allele, or ApoE e4) has been proposed. Less convincing evidence for significant long-term cognitive impairment has been reported in amateur boxers. Limiting one's exposure to boxing is perhaps the safest alternative.

The risk for concussion in cycling is evident; more cycling deaths occur in the United States annually than in any other recreational sport. Everyone should wear a helmet while cycling. The same can be said for equestrian sports, although studies indicate that some equestrian athletes do not wear helmets due to cosmetic (personal appearance) reasons (Broshek et al. 2004).

The introduction of better-designed football helmets may offer athletes improved protection against the effects of concussion; we eagerly await the results of studies in progress designed to test this possibility. We await further studies of the role of ApoE e4 in short- and long-term studies of sport concussion. A preliminary study, which reported on professional football athletes (Kutner et al. 2000), suggested that older athletes who were positive for the ApoE e4 allele had lower cognitive test scores and merits further formal investigation. It should be emphasized that at the present time there is no scientific evidence to support a specific magic number of concussions that would mandate retirement or cessation of competition.

We are not aware of any current attempts to modify helmets in professional hockey but believe that the severity of concussions experienced in hockey could be truncated (at least in part) with better padding and improved helmet design. Regular helmet inspection and replacement of worn parts, along with appropriate enforcement of the rules for wearing helmets (that is, tightened chinstraps), could also result in lessened effects of concussion.

## Long-Term Effects

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No answer has yet been found to the question of how many concussions are too many. Preliminary studies have linked concussion to an increased risk of Alzheimer's disease and major depression in the *general population*. A survey study of retired NFL athletes

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has not shown a strong relationship between concussion and Alzheimer's disease but did indicate a higher incidence of major depression later in life in athletes who experienced multiple concussions. Preliminary studies (Collins et al. 2002; Iverson et al. 2004a) are suggesting that the effects of multiple concussions may be cumulative in high school and collegiate athletes, evidenced by worse on-the-field indicators of concussion (for example, confusion, disorientation, amnesia), worse scores on neuropsychological tests, and a protracted resolution of concussion symptoms.

## Return to Play

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Consideration of all aspects of the game and its risks should be considered when deciding whether an athlete should return to play. If it is decided that the athlete will return to play, it is recommended that every athlete follow the guidelines outlined in the CIS Group's (2002, 2005) documents to maximize safety. This includes completing a preseason concussion-symptom checklist, taking baseline sport-concussion neuropsychological tests, and having routine medical examinations. In the end, return to play is a medical decision that should not be made by a parent or an athlete. Each case is handled individually, but in general, an athlete should not be returned to play until all symptoms have cleared, both at rest and with exertion. If done, neuropsychological test scores should have returned to baseline. Finally, the athlete should have completed a graduated, sport-specific rehabilitation program under the supervision of an athletic trainer and physician.

## Educating Athletes About Concussion

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First and foremost, we hope that this book fills a needed information gap for physicians, athletic trainers, psychologists, coaches, therapists, and other sports professionals in the understanding of concussion. Surprisingly, few formal programs are available to educate athletes about concussions. For example, Dr. Kevin Kaut and colleagues (2003) surveyed collegiate athletes during the 1995 to 2001 athletic seasons. The results indicated that nearly one-third of the athletes had sustained a blow to the head causing dizziness (or other physical symptoms). Less than 20% of the athletes were

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aware that these symptoms represented a probable concussion, and over half continued to play despite the presence of these symptoms. More than half of the athletes were deemed as having knowledge deficits about concussion.

These results in *collegiate* athletes mirror McCrea's findings of underreported concussions in nearly half of *high school* football players (2004). Delaney and colleagues (2000) found that 80% of *professional* football players were unaware that they had sustained a concussion despite being symptomatic. Taken together, these studies are worrisome and indicate a lack of awareness about concussion symptoms and consequences among athletes at all levels of competition. We believe the time has come to include concussion education, including symptom recognition and appropriate medical management, for all athletes. Sports medicine professionals are in an excellent position to take the lead in this endeavor. In its Position Statement on sport-related concussion, the National Athletic Trainers' Association (NATA) called for athletic trainers to play an active role in educating athletes, coaches, and parents about concussion and the potential risks of playing while still symptomatic (Guskiewicz et al. 2004).

Doctors Janet Jankowiak and Elizabeth Roaf (2004), writing in the "Patient Page" section of the journal *Neurology*, present a brief but concise educational overview of sport concussion for athletes and their parents, coaches, and medical personnel. At the professional sports level, the National Hockey League Players Association has developed an educational video (addressing the roles of helmets and padding, chinstraps, visors, mouthguards, and playing "heads up") that is shown to all players during training camp. This video was first introduced to all NHL teams during training camp in the 2002-2003 season. It is a sensible, factual documentary hosted by Brett Lindros (an ex-NHL player whose career was cut short by concussions) that emphasizes prevention. We are not aware of any formal directives by the NFL or NCAA regarding player education about concussion. What we have observed in the NHL and NFL is an informal mentoring process whereby athletes who have dealt with concussions provide information to their peers who are now dealing with the problem. The grassroots approach is a powerful one.

Neurosurgeons and neuroscience nurses across Canada and the United States began the ThinkFirst Foundation, an organization devoted to the prevention of traumatic injuries in children. Safety

education is a primary focus, and many of ThinkFirst's programs are geared toward young athletes. For more information, go to [www.thinkfirst.ca](http://www.thinkfirst.ca). The Pashby Sports Safety Fund of Canada previously had a Web site specific to hockey and concussion, but it has been merged with the ThinkFirst Web site. A number of other educational tools and resources for the community are available and are listed in appendix B.