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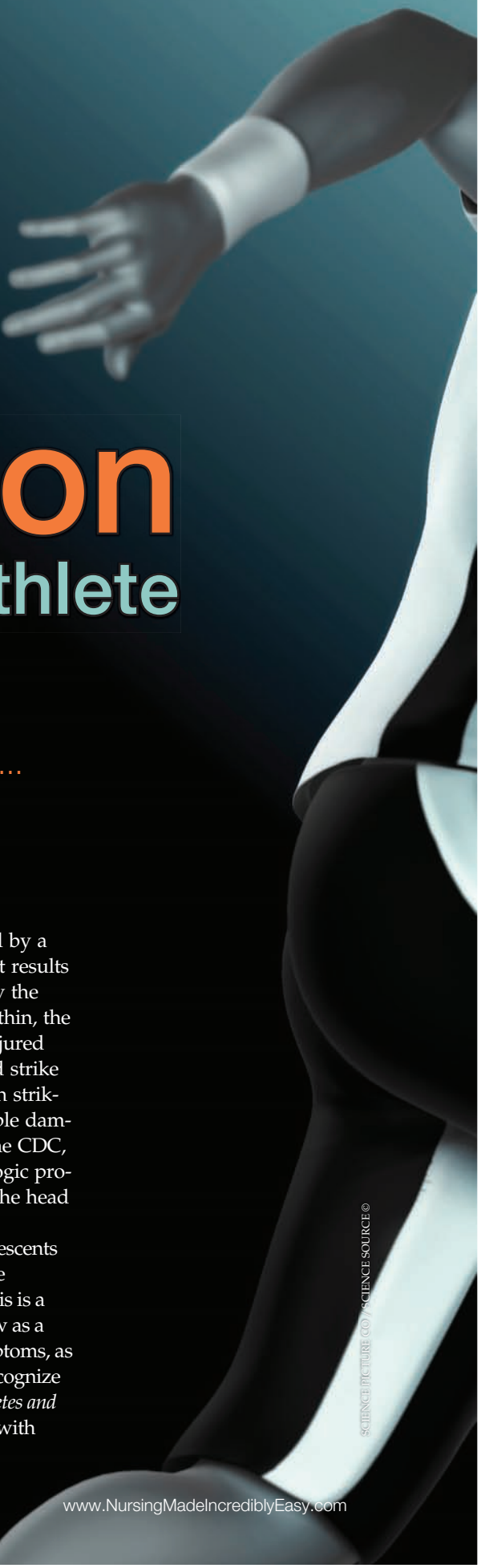
Concussion & the teenage athlete

It was just a little bump to the head... What's the big deal?

By Amanda Perkins, MSN, RN

A concussion is a mild traumatic brain injury caused by a blow to the head or an indirect force to the head that results in the brain striking the skull. Although protected by the skull and the cerebrospinal fluid (CSF) contained within, the brain is able to move in the skull and can become injured when forces acting on the body cause it to move and strike the inner surface of the skull. The impact of the brain striking the inner surface of the skull may not cause visible damage, but can cause invisible damage. According to the CDC, a concussion is defined as "a complex pathophysiologic process affecting the brain...caused by a blow or jolt to the head that disrupts the function of the brain."

Each year, approximately 173,285 children and adolescents are seen in the ED for traumatic brain injuries that have occurred as the result of athletic activities. Although this is a significant number, it's believed that the estimate is low as a result of adolescents failing to report injuries and symptoms, as well as the inability of many coaches and parents to recognize the signs and symptoms of concussion (see *Female athletes and concussion*). The sporting events most often associated with



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concussion include bicycling, football, basketball, and soccer. As would be expected, collision sports are associated with concussion at a much higher rate than noncollision sports. For example, football carries a higher concussion risk than does softball or baseball.

According to the CDC, teenagers are more prone to concussions than adults and their recovery time after a concussion is greater than that of an adult. An understanding of concussions in the adolescent is essential for nurses because education, prevention, and management after a concussion may lead to improved patient outcomes and a reduction in associated complications.

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Brain basics

The brain is the most vital and essential organ in the human body. Our brains are our control centers, responsible for every aspect of our bodies from breathing to holding our breath, sleeping to waking, and walking to running. Our brains control our heart rate, our immune response, how we learn, and so on.

The brain works in conjunction with the nervous system to send and receive messages. Each of us has billions of nerve cells known as neurons that reside in the brain and are responsible for the brain's ability to control the body. These nerve cells communicate information to other nerve cells, muscle cells, and gland cells. They're also responsible for receiving information, such as the drive to breathe or temperature regulation. Our brains are able to function as they do because of the communication that occurs between the brain and the body.

As powerful as our brains are, they're also fragile. Without the protection of the skull and CSF, the brain, which is the consistency of jelly with minimal structural strength, will quickly become deformed and lose its shape. Additionally, the brain is filled with tightly packed nerve cells that don't allow for significant pressure changes. As a result, the brain is prone to damage when the pressure inside the skull increases, which can occur when a concussion is sustained.

The teenage brain

Although much of the development of the brain occurs in the embryo, there are important changes that occur after birth and into adolescence. It was once believed that the brain completed development during childhood, but we now know that brain development continues throughout adolescence and into the 20s.

The areas of the brain to develop first are those responsible for our most basic senses, such as controlling movement and sleeping. The last area of the human brain to develop is the frontal lobe, which is responsible for our thinking, judgment, insight, planning, and impulse control (see *Picturing the brain*). Studies have shown that the frontal lobe undergoes dramatic development during

Female athletes and concussion

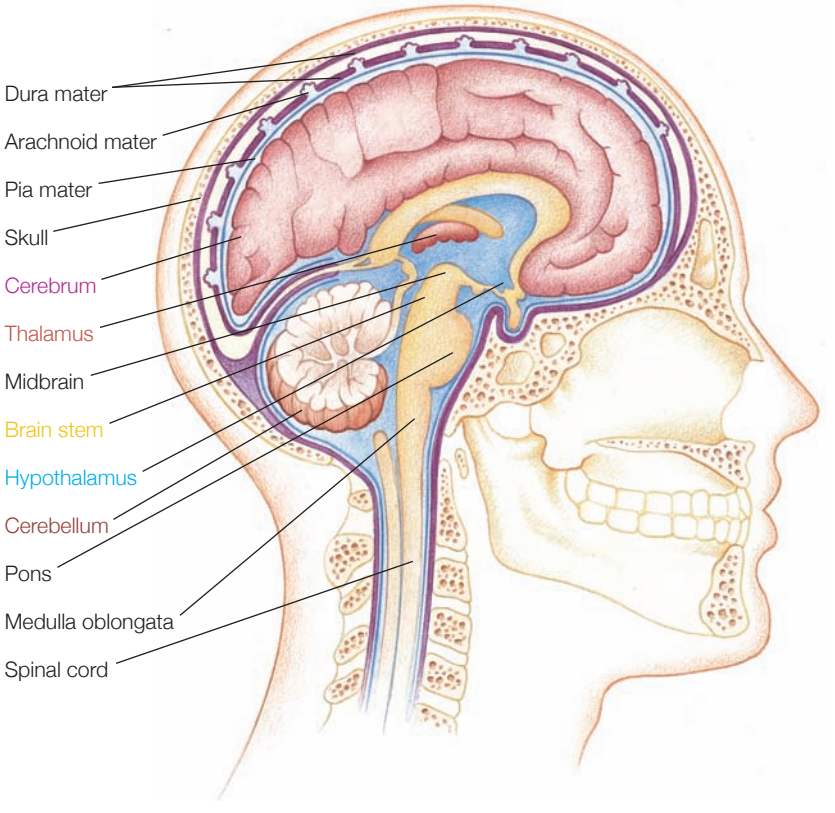
Much of the information available about concussion tends to focus on the male athlete, more specifically the male football player. Although male athletes do sustain a high number of concussions, the question has to be asked: What about the girls? Do they sustain concussions as frequently as males and are those concussions as severe? The answer to both of those questions is yes. Studies have shown that female athletes may sustain more concussions than males and these concussions are more severe, with a longer recovery period. Additionally, female athletes report more symptoms and have a higher incidence of repeat concussions.

Research indicates that females sustain concussions differently than males. It's believed that this is due to anatomical, as well as hormonal, differences. In general, female athletes have smaller necks and heads than male athletes. Larger, stronger necks protect the brain from sudden acceleration-deceleration forces. As a result of their smaller necks and heads, female athletes have more difficulty counteracting the forces that occur during head trauma. The inability to counteract these forces leads to an increased movement of the brain within the skull, which can result in concussion. The hormone estrogen is also believed to play a role in concussion in the female athlete. Although still being studied, it's believed that estrogen correlates with an increased number and severity of concussions.

The bottom line is that female athletes do sustain concussions and, in fact, may be more prone to them.

Sources: Hainline B. Do female athletes concuss differently than males? http://www.ncaa.org/health-and-safety/medical-conditions/do-female-athletes-concuss-differently-males.
Luo X, Curry E, Matzkin E. A heads-up on concussions: are there sex-related differences? http://www.aaos.org/news/aaosnow/may14/research5.asp.

Picturing the brain



Brain structures

Cerebrum

- Also known as *cerebral cortex*
- Controls ability to think and reason
- Enclosed by three meninges (dura mater, arachnoid mater, and pia mater)
- Contains the diencephalon, which consists of the thalamus and hypothalamus

Thalamus

- Relay station for sensory impulses

Hypothalamus

- Controls regulatory functions, including body temperature, pituitary hormone production, and water balance

Brain stem

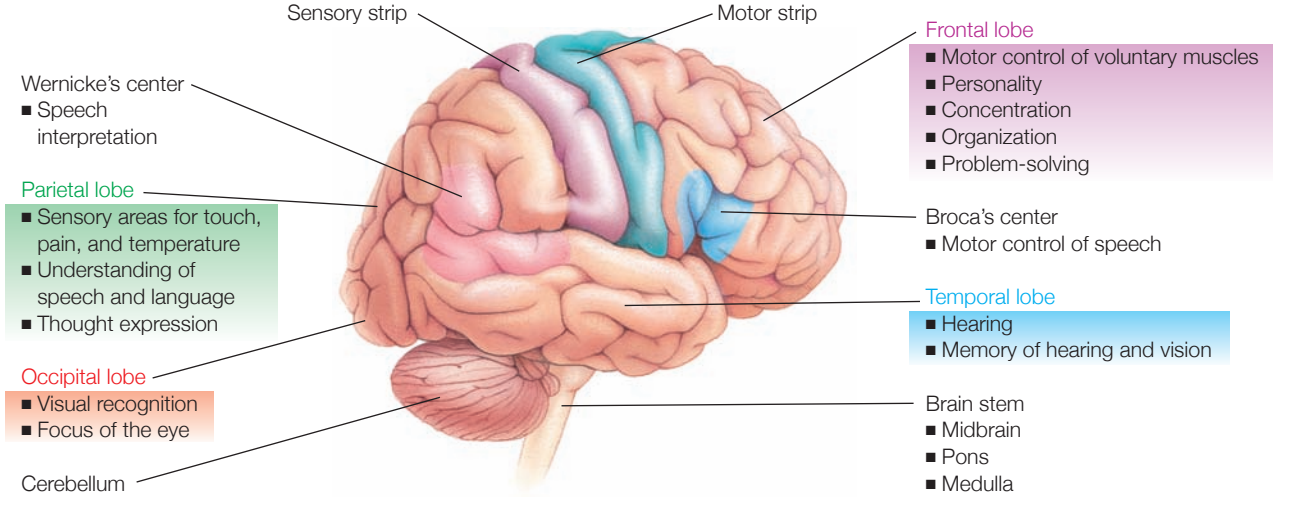
- Regulates autonomic body functions, such as heart rate, breathing, and swallowing
- Contains cranial nerves III through XII

Cerebellum

- Contains major motor and sensory pathways
- Helps maintain equilibrium
- Controls muscle coordination

Cerebral lobes

The cerebrum is divided into four lobes and two hemispheres.



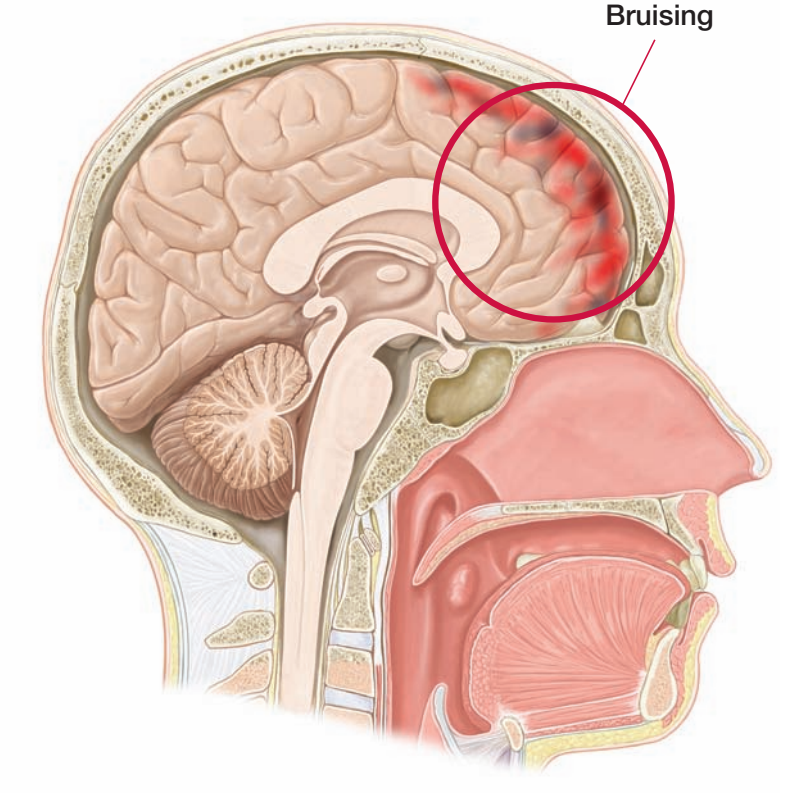
adolescence and doesn't completely develop until we're in our early 20s. That's why concussion in teenagers is particularly concerning—their brains aren't completely developed and, therefore, are more prone to injuries associated with concussion.

The cerebral cortex, commonly referred to as gray matter, is the outer surface of the brain in which the highest level of neural processing occurs. This includes language, memory, emotion, analysis of sensory information, planning, judgment, and organization. The parts of the brain within the cerebral cortex that are associated with high-level executive functions are the last to mature in the adolescent.

Gray matter increases during childhood, reaches a peak, and then begins to fall during adolescence. These changes are very important to the developmental process. The gray matter peak that occurs during adolescence is associated with the formation of synapses, also known as connections, between the cells in the brain. The gray matter decline that occurs in adolescence after the peak is associated with the pruning or removal of excess synapses. The cells and synapses within the brain that are unused or are weak are removed. The pruning of the unused and/or weak cells and their connections allows those synapses that are utilized to strengthen and work more efficiently. Basically, the brain tissue is being fine-tuned so that the remaining connections are more reliable and precise.

During adolescence, the amygdala typically increases in boys and the hippocampus tends to increase in girls. This is thought to occur as the result of hormonal changes during puberty, which can have complex effects on the brain, affecting behavior and the adolescent's response to stress.

Picturing concussion



A look at pathophysiology

The pathophysiology of a concussion is complex and is thought to occur at the cellular level as the result of both metabolic and physiologic changes. The cellular damage that occurs with a concussion is the result of the movement of the brain within the skull caused by a force, either direct or indirect. When the brain hits the skull, there's a temporary disruption in brain activity (see *Picturing concussion*).

When a concussion is sustained, the following occurs at the cellular level: neuronal depolarization, release of excitatory neurotransmitters, changes in cerebral blood flow, changes in glucose metabolism, axonal dysfunction and injury, impaired functioning of the mitochondria, and the production of lactic acid. The movement of the brain within the skull causes its cells to stretch and tear.

When brain cells are damaged, electrical and chemical balances are affected and the axons within the brain begin to swell, impacting cell function and communication. These changes are responsible for the symptoms that are present in the concussed patient.

Is it a concussion?

After a concussion has been sustained, patients may report or display a variety of acute signs and symptoms, including:

- confusion
- disorientation
- amnesia (The patient may complain of no memory of events before the concussion and/or no memory of the events that happened after the concussion was sustained.)
- balance and coordination problems
- headache
- drowsiness
- dizziness
- nausea
- vomiting
- vision changes
- ringing in the ears
- concentration problems
- mood and behavior changes
- fatigue
- sensitivity to noise and light
- sleep disturbances.

Making the diagnosis

Although the changes that occur at the cellular level are significant, as are the signs and symptoms, a concussion won't show up on standard imaging such as magnetic resonance imaging or computed tomography. In addition to the inability to view a concussion via standard imaging, the diagnosis of concussion can be difficult because the symptoms can mimic those of other conditions and they may not occur instantaneously after the injury, sometimes taking days to weeks to appear.

The diagnosis of concussion is based on a history and physical. The patient should be asked about the characteristics of the injury, symptoms, and risk factors that can affect recovery. When obtaining information about the characteristics of the injury, ask the patient about the following:

- mechanism of injury (biomechanics). Ask how the injury occurred and where the patient was injured (location on the head/area of the body that was hit).

Signs and symptoms

cheat sheet

- Confusion
- Disorientation
- Amnesia
- Balance and coordination problems
- Headache
- Drowsiness
- Dizziness
- Nausea
- Vomiting
- Vision changes
- Ringing in the ears
- Concentration problems
- Mood and behavior changes
- Fatigue
- Sensitivity to noise and light
- Sleep disturbances

- cause, including speed. Ask what caused the injury and about the speed and force of the injury.
- use of safety devices, such as helmets. Ask if any protective gear was worn. If protective gear was worn, ask if the protective gear fit properly.
- amnesia occurring before or after the injury. Ask the patient if he or she can recall what happened before the injury, including the hours before the injury, and what happened after the injury.
- loss of consciousness. Ask the patient if he or she remembers losing consciousness or if anyone observed him or her losing consciousness.
- confusion. Ask the patient questions to help determine his or her level of consciousness, such as name, date of birth, current date, and current location.
- seizures. Ask if anyone observed a seizure after the injury.

Assess for risk factors, including a history of concussion, headache, developmental disorders, or mental disorders. If the patient reports a history of concussion, you should ask about the number of concussions, how long ago they occurred, and the duration of symptoms after the concussions. It's important to ask the patient about previous concussions because the answers given will provide clues regarding risk factors for complications and recovery time.

It's complicated

Concussion complications may vary and increase with each additional concussion. Complications include:

- second impact syndrome
- postconcussion syndrome
- suicide
- chronic traumatic encephalopathy.

Second impact syndrome is a rare complication that occurs in adolescents who return to play and sustain a repeat concussion before the symptoms from a previous concussion have subsided. Seconds to minutes after the second hit the athlete may collapse and go into respiratory failure. It's believed that second impact syndrome occurs as the result of edema within the brain. When the athlete sustains the first concussion, there's resulting edema. A second concussion further increases the edema, causing an increase in intracranial pressure. As the intracranial pressure increases, so does the risk of permanent and potentially life-ending brain damage, such as brainstem herniation.

Individuals who survive second impact syndrome can have lifelong cognitive impairments. We can avoid this complication by not allowing our adolescent patients to return to play after concussion is suspected. Adolescents with suspected concussion shouldn't be allowed to return to play until they're symptom free and evaluated and cleared by a healthcare provider.

Postconcussion syndrome is a complex disorder that can present days to weeks after concussion. It can take up to 6 months to resolve in first-time cases and longer in individuals with a history of concussion. The following symptoms may be observed:

- somatic (physical)—headaches, neck pain, dizziness, nausea, motion sickness, photosensitivity, insomnia, and fatigue
- cognitive—poor concentration, action lapses, memory problems, poor recall, and mental fatigue
- emotional—anxiety, depression, and irritability.

The rate of suicide among individuals who've experienced traumatic brain injuries is increased, as are the reports of suicidal ideation. Adolescents who've sustained a concussion should be monitored for psychiatric changes, especially those patients with a history of mental disorders.

A long-term complication of repetitive concussions or other head injuries, chronic traumatic encephalopathy is a neurodegenerative process that includes the symptoms of early-onset cognitive decline and psychiatric disturbance. You may have heard about this condition recently in the news, as it has become a topic of interest in the professional football arena. It has been suggested that individuals with chronic traumatic encephalopathy tend to develop Alzheimer disease at an early age.

A1 management

After a concussion diagnosis, the patient should be instructed to rest and avoid returning to high-risk activities, such as sports, until all concussion symptoms have resolved. If a concussion or suspected concussion occurs during a sporting event, the adolescent should be sidelined for the remainder of the event and until evaluated by a healthcare professional. After the adolescent is symptom free, he or she may gradually return to daily activities.

The management of concussions can be difficult because healthcare providers must rely heavily on symptoms reported by the patient. Adolescents may underreport symptoms because they want to return to normal activities, such as school and/or sports. Research has shown that the adolescent brain must

key points

Nursing considerations

- Determine the characteristics of the injury, including the mechanism of injury, its cause, the use of safety devices, amnesia occurring before or after the injury, loss of consciousness, confusion, and seizures.
- Assess for risk factors, including a history of concussion, headache, developmental disorders, or mental disorders.
- Educate patients and their families about how to prevent concussion.
- Stress the importance of physical and cognitive rest during recovery and not returning to athletic play until medically cleared.
- Teach school-based professionals about concussion, including risks, complications, monitoring, and when to remove an athlete from play.

work harder than that of an adult when assessing and determining the risks associated with a situation. It's also known that adolescents tend to take risks—more so than adults—because their limbic system is underdeveloped. The increased risk-taking behavior combined with difficulty assessing dangerous situations may make adolescents less likely to report concussions or the persistence of symptoms associated with concussions.

In order to recover completely and avoid complications associated with concussion, it's necessary for the patient to rest both physically and cognitively. Physical rest includes the avoidance of activities such as running, jumping, and sports. Cognitive rest includes the avoidance of activities such as schoolwork, video games, using the computer, and texting. In many cases, the adolescent will be asked to return to physical and cognitive activities slowly while monitoring for the return of symptoms. For example, a symptom-free athlete may be allowed to lightly jog with his or her team during practice. If he or she remains symptom free, activity can be increased to running, then progress to non-contact aspects of practice, full practices, and, lastly, sporting events.

The key here is that the athlete remains free of symptoms each step of the way. If symptoms reappear at any step, the athlete will be asked to stop his or her progression and move backward to the previous step. The adolescent needs to avoid both physical and cognitive activities until symptoms subside because it's believed that these activities will further stress the brain and cause worsened symptoms, as well as an increased risk of long-term complications. Due to the fact that adolescents may be reluctant to give up these activities, it's essential for you to provide education to your patient and his or her family or caregivers about the importance of activity avoidance.

Prevention mention

As nurses, we must educate our patients and their families/caregivers about the ways in which they can prevent concussion. Provide education about the importance of the following:

- always wearing seatbelts
- never operating a vehicle while impaired
- wearing helmets while participating in activities such as football, bike riding, and skating
- wearing the appropriate protective gear when participating in athletics
- never diving into shallow water
- following safety rules when participating in athletics
- following all safety precautions after a diagnosed or suspected concussion.

It's also essential to educate your patients on the importance of not returning to athletic play until medically cleared to avoid repeat concussions or complications associated with repeat concussions, such as second impact syndrome. Research has shown that the early recognition of signs and symptoms of concussion and allowing the brain to rest and fully recover before returning to athletic activities are critical to maintaining a healthy brain.

Your educational role

In order to prevent concussion and the complications of concussion, it's important that we educate school-based professionals about concussion, including risks, complications, monitoring, and when to remove an athlete from play. It's essential that education be provided about the significance of immediately removing an athlete from play after concussion is suspected. It's also important to educate athletes and their families about not returning to play until evaluated by a healthcare provider.

You'll want to stress the importance of not returning to play until all concussion symptoms have dissipated. Keep in mind

on the web

- **American Academy of Neurology:** https://www.aan.com/concussion
- **CDC Fact Sheet for Parents:** http://www.cdc.gov/concussion/pdf/TBI_factsheets_PARENTS-508-a.pdf
- **CDC Heads Up:** http://www.cdc.gov/headsup
- **KidsHealth.org:** http://www.kidshealth.org/teen/safety/first_aid/concussions.html
- **Mayo Clinic:** http://www.mayoclinic.org/diseases-conditions/concussion/basics/definition/con-20019272

that adolescents may not grasp the severity of the concussion or the risks associated with playing with a concussion. The education that you provide to school-based professionals and adolescents and their families can save the adolescent's brain. ■

REFERENCES

Ashwell K. *The Brain Book*. New York, NY: Firefly Books; 2012.

Bass PF. Managing a patient after concussion. *Contemporary Pediatrics*. 2014;31(8):32-34. http://www.contemporarypediatrics.com/concussion.

Beth Israel Deaconess Medical Center. Post concussive syndrome. http://www.bidmc.org/CentersandDepartments/Departments/Neurology/ConcussionandTraumaticBrainInjuryClinic/EducationalInformationAboutTraumaticBrainInjury/Postconcussivesyndrome.aspx.

Blakemore SJ. The mysterious workings of the adolescent brain. http://www.brainfacts.org/Brain-Basics/Brain-Development/Articles/2013/SarahJayne-Blakemore-The-mysterious-workings-of-the-adolescent-brain.

Carr J. Hard knocks: the science of concussions. http://www.brainfacts.org/Diseases-Disorders/injury/Articles/2012/Hard-Knocks-The-Science-of-Concussions.

CDC. Heads up: facts for physicians about mild traumatic brain injury (MTBI). http://www.cdc.gov/headsup/pdfs/providers/facts_for_physicians_booklet-a.pdf.

CDC. Traumatic brain injury in the United States: fact sheet. http://www.cdc.gov/traumaticbraininjury/get_the_facts.html.

Edwards JC, Bodle JD. Causes and consequences of sports concussion. *J Law Med Ethics*. 2014;42(2):128-132.

Hainline B. Do female athletes concuss differently than males? http://www.ncaa.org/health-and-safety/medical-conditions/do-female-athletes-concuss-differently-males.

Luo X, Curry E, Matzkin E. A heads-up on concussions: are there sex-related differences? http://www.aaos.org/news/aaosnow/may14/research5.asp.

McGuire CS, McCambridge TM. Concussion in the young athlete: diagnosis, management, and prevention. *Contemporary Pediatrics*. 2011;28(5):30-46.

National Institute of Mental Health. The teen brain: still under construction. http://www.nimh.nih.gov/health/publications/the-teen-brain-still-under-construction/index.shtml.

Society for Neuroscience. Brain facts: a primer on the brain and nervous system. http://www.brainfacts.org/~/media/Brainfacts/Article%20Multimedia/About%20Neuroscience/Brain%20Facts%20book.ashx.

Society for Neuroscience. Teens, neuroscience, and society. http://www.brainfacts.org/In-Society/In-Society/Articles/2011/Teens-Neuroscience-and-Society.

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