American Association of Neurological Surgeons

Sports-related Head Injury

Patient Information

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Although sports injuries rarely contribute to fatalities, the leading cause of death from sports-related injuries is traumatic brain injury. Sports and recreational activities contribute to about 21 percent of all traumatic brain injuries among American children and adolescents.

Traumatic Brain Injury

A traumatic brain injury (TBI) is defined as a blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain. TBI can result when the head suddenly and violently hits an object, or when an object pierces the skull and enters brain tissue. Symptoms of a TBI can be mild, moderate or severe, depending on the extent of damage to the brain. Mild cases (mild traumatic brain injury, or mTBI) may result in a brief change in mental state or consciousness, while severe cases may result in extended periods of unconsciousness, coma or even death.

The 4th International Conference on Concussion in Sport held in Zurich, Switzerland in 2012 defined concussion, a subset of mTBI, as the following:

Concussion is the historical term representing low velocity injuries that cause brain 'shaking' resulting in clinical symptoms and that are not necessarily related to a pathological injury. Concussion is a subset of TBI and will be the term used in this document. It was also noted that the term commotio cerebri is often used in European and other countries. Minor revisions were made to the definition of concussion, which is defined as follows:

Concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces. Several common features that incorporate clinical, pathologic and biomechanical injury constructs that may be utilized in defining the nature of a concussive head injury include the following:

1. Concussion may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an "impulsive" force transmitted to the head.
2. Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously. However, in some cases, symptoms and signs may evolve over a number of minutes to hours.
3. Concussion may result in neuropathological changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies.
4. Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course. However, it is important to note that in some cases symptoms may be prolonged.

To view peer-reviewed literature related to sports concussions, the Sports Concussion Library can be found **here.**

Incidence

The U.S. Consumer Product Safety Commission (CPSC) tracks product-related injuries through its National Electronic Injury Surveillance System (NEISS).

According to CPSC data, there were an estimated 446,788 sports-related head injuries treated at U.S. hospital emergency rooms in 2009. This number represents an increase of nearly 95,000 sports-related injuries from the prior year. All of the 20 sports noted below posted increases in the number of injuries treated in 2009, except for trampolines, which posted 52 fewer injuries in 2009. Sports that exhibited substantial increases from 2008 to 2009 included water sports (11,239 to 28,716*), cycling (70,802 to 85,389), baseball and softball (26,964 to 38,394) and basketball (27,583 to 34,692).

**Four categories were tabulated by the AANS in the current analysis that were not reflected in the 2008 injury data analysis but, together, these account for only 1,397 injuries.*

The actual incidence of head injuries may potentially be much higher for two primary reasons. In the 2009 report, the CPSC excluded estimates for product categories that yielded 1,200 injuries or less, those that had very small sample counts and those that were limited to a small geographic area of the country. Additionally, many less severe head injuries are treated at physicians' offices, immediate care centers or are self-treated.

Included in these statistics are not only sports/recreational activities, but the equipment and apparel used in these activities. For example, swimming-related injuries include the activity as well as diving boards, equipment, flotation devices, pools and water slides.

The following 20 sports/recreational activities represent the categories contributing to the highest number of estimated head injuries treated in U.S. hospital emergency rooms in 2009.

- **Cycling:** 85,389
- **Football:** 46,948
- **Baseball and Softball:** 38,394
- **Basketball:** 34,692
- **Water Sports** (Diving, Scuba Diving, Surfing, Swimming, Water Polo, Water Skiing, Water Tubing): 28,716
- **Powered Recreational Vehicles** (ATVs, Dune Buggies, Go-Carts, Mini bikes, Off-road): 26,606
- **Soccer:** 24,184
- **Skateboards/Scooters:** 23,114
- **Fitness/Exercise/Health Club:** 18,012
- **Winter Sports** (Skiing, Sledding, Snowboarding, Snowmobiling): 16,948

- **Horseback Riding:** 14,466
- **Gymnastics/Dance/Cheerleading:** 10,223
- **Golf:** 10,035
- **Hockey:** 8,145
- **Other Ball Sports and Balls, Unspecified:** 6,883
- **Trampolines:** 5,919
- **Rugby/Lacrosse:** 5,794
- **Roller and Inline Skating:** 3,320
- **Ice Skating:** 4,608

The top 10 sports-related head injury categories among children ages 14 and younger:

- **Cycling:** 40,272
- **Football:** 21,878
- **Baseball and Softball:** 18,246
- **Basketball:** 14,952
- **Skateboards/Scooters:** 14,783
- **Water Sports:** 12,843
- **Soccer:** 8,392
- **Powered Recreational Vehicles:** 6,818
- **Winter Sports:** 6,750
- **Trampolines:** 5,025

**Note: Reported incidence is known to be significantly under-reported (up to 50%, McCrea Clin J Sports med 13:13-17, 2004) and do not reflect those that are treated by family doctors or other para-medical professionals.*

Additional Sports Facts

Boxing

Over time, professional and amateur boxers can suffer permanent brain damage. The force of a professional boxer's fist is equivalent to being hit with a 13-pound bowling ball traveling 20 miles per hour, or about 52 times the force of gravity.

According to the *Journal of Combative Sport*, from January of 1960 to August of 2011, there were 488 boxing-related deaths. The journal attributes 66 percent of these deaths to head, brain or neck injuries; one was attributed to a skull fracture.

There are boxers with minimal involvement and those that are so severely affected that they require institutional care. There are some boxers with varying degrees of speech difficulty, stiffness, unsteadiness, memory loss and inappropriate behavior. In several studies, 15-40 percent of ex-boxers have been found to have symptoms of chronic brain injury. Most of these boxers have mild symptoms. Recent studies have shown that most professional boxers (even those without symptoms) have some degree of brain damage.

Cheerleading

Cheerleading has changed drastically in the last 20 years, with increasingly difficult acrobatic stunts being performed. A number of schools at the high school and college level have limited the types of stunts that can be attempted by their cheerleaders. Rules and safety guidelines now apply to both practice and competition.

According to 2010 cheerleading data from the CPSC, head and neck injuries accounted for 19.3 percent of total cheerleading injuries. Additionally, in the 2010-2011 school year head injuries were associated with 1579 concussions, 361 contusions and 2,292 internal injuries; neck injuries accounted for 118 contusions, 16 fractures and 1,301 sprains/strains.

In its Catastrophic Sports Injury Report for fall 1982 through spring 2011, the National Center for Catastrophic Sport Injury Research at the University of North Carolina (UNC) noted that there was one direct high school cheerleading catastrophic injury during the 2010-2011 school year. A high school cheerleader collided with another cheerleader during practice and was elbowed in the temple. The result was two skull fractures, seizures and a medically induced coma. Recovery at the time was incomplete.

UNC also reports that college cheerleading was not associated with any direct injuries during the 2010-2011 school year.

A 2009 study by the Center for Injury Research and Policy of The Research Institute at Nationwide Children's Hospital yielded the following head-injury statistics:

- The majority (96 percent) of the reported concussions and closed-head injuries were preceded by the cheerleader performing a stunt.
- Nearly 90 percent of the most serious fall-related injuries were sustained while the cheerleaders were performing on artificial turf, grass, traditional foam floors or wood floors.

A 2012-2013 RIO study by the Nationwide Children's Hospital yielded the following statistics about high school cheerleading:

- Cheerleading yielded 0.73 injuries per 1,000 athletic exposures in the 2012-2013 school year.
- Injuries to the head/face accounted for 36.5 percent of all cheerleading injuries in the 2012-2013 school year.

The National Cheer Safety Foundation also offers comprehensive resources and safety information specific to cheerleading, including news articles such as this.

Cycling

Every year, more than 500,000 people visit emergency rooms in the U.S. with bicycle-related injuries. In 2009, nearly 85,000 of those were head injuries. There are about 600 deaths a year, with two-thirds being attributed to TBI. It is estimated that up to 85 percent of head injuries can be prevented through proper usage of helmets, such as those approved by The Snell Memorial Foundation, American National Standards Institute (ANSI) or American Society for Testing and Materials (ASTM). It is essential that the helmet fit properly so that it doesn't fall off while the user is riding or if he or she takes a fall. According to Safe Kids Worldwide, more children from ages five to 14 are seen in emergency rooms for biking-related injuries than from any other sport. Helmets can reduce the risk of severe brain injuries by 88 percent. However, approximately 55 percent of children are reported as not always wearing a helmet while bike riding.

The following facts/statistics are from Safe Kids USA:

- Head injury is the leading cause of wheeled sports-related death and the most important determinant of permanent disability after a crash.
- Without proper protection, a fall of as little as two feet can result in a skull fracture or other TBI.
- Approximately 50 percent of U.S. children between 5- and 14-years-old own a helmet, and only 25 percent report always wearing it while bicycling.
- Universal use of bicycle helmets by children ages 4 to 15 could prevent 45,000 head injuries.
- Helmets reduce the risk of head injury by at least 45 percent, brain injury by 33 percent, facial injury by 27 percent and fatal injury by 29 percent. Eight states and the District of Columbia require children to wear a helmet while participating in wheeled sports such as riding on scooters, in-line skates or skateboards.
- One study found that the rate of bicycle-helmet use by children ages 14 and under was more than twice as high in a county with a fully comprehensive bike-helmet law than in a similar county with a less comprehensive law.

Safe Kids Worldwide further reported that in 2010, 112 children under the age of 19 died while riding a bike. This is the smallest number of deaths since 1999, and is a 56-percent reduction in the number of deaths since the year with a 59-percent decrease in the death rate.

Football

The National Center for Catastrophic Sport Injury Research (NCCSIR) also tracks a number of statistics for "catastrophic" football injuries, which it defines as those that resulted in brain or spinal cord injury; or skull or spine fracture. Recent findings in the Annual Survey of Catastrophic Football Injuries, 1977-2012, include the following:

- During the 2012 football season there were a total of three cervical cord injuries with incomplete neurological recovery. One of the injuries occurred at the high school level and two at the college level. The 2012 total is 11 fewer than the 14 in 2008, six fewer than the nine in 2009, and five fewer than the eight in 2011.
- The incidence of catastrophic injuries is very low on a 100,000-player exposure basis. For the approximately 4,200,000 participants in 2012, the rate of cervical cord injuries with incomplete neurological recovery was 0.07 per 100,000 participants.
- The rate of injuries with incomplete neurological recovery in high school and junior high school football was 0.07 per 100,000 players (1,500,000 high school and junior high school players). The rate at college level was 2.66.
- A majority of catastrophic spinal cord injuries usually occur in games. During the 2012 season two injuries took place in games and one in a weight-lifting session.
- Tackling and blocking have been associated with the majority of catastrophic cervical cord injuries. In 2012, two injuries were caused by tackling and one in a weight-lifting session. Tackling has been associated with 67 percent of the catastrophic injuries since 1977.
- The majority of catastrophic injuries occur while playing defensive football. In 2012, two players were on defense and one was in a weight-lifting session. Since 1977, 228 players with permanent cervical cord injuries were on the defensive side of the ball and 55 were on the offensive side, with 44 unknown. Defensive backs were involved with 34.6 percent of the permanent cervical cord injuries followed by member of the kick-off team at 9.2 percent and linebackers at 9.5 percent.
- During the 2012 football season, there were also five brain injuries that resulted in incomplete recovery. Four were at the high school level and one at the college level. This is a decrease of nine, compared to the 2011 data.
- In 2012, there were also five injuries that involved either a head or neck injury, but the athlete had full neurological recovery. High school athletes were associated with four and college football was associated with one.

In addition, the National Center for Catastrophic Sport Injury Research reported the following incidences: (For a full listing of incidences, read the Annual Survey of Catastrophic Football Injuries, 1977-2012.)

- On Oct. 26, 2012, a 17-year-old high school football player collapsed on the sideline during a game. He suffered a subdural hematoma and was in the hospital for three weeks. He was a defensive end and an offensive tackle. The athletic trainer noticed his odd behavior on the sideline and did not allow him to return to the game. Recovery was incomplete.
- A high school senior was injured in a game on Sept. 7, 2012. He was hit by two tacklers as he attempted to make a block – one from the front and one from behind. He was unconscious and had two fractured cervical vertebrae. He had initial paralysis and is recovering from the injury, but will not be able to play football again.
- A high school football player was injured in a play-off game while making a tackle on Nov. 6, 2012. He was a senior linebacker. The injury involved surgery to a fractured cervical vertebra number 6. Recovery was incomplete.
- A high school senior linebacker was injured in a game on Nov. 1, 2012. The injury was diagnosed as a brain bleed. He collapsed on the field and later had emergency surgery. He had a concussion earlier in the season and had to sit out one game before being cleared to play by a physician. Recovery is incomplete.

- A high school football player was injured in a game on Sept. 21, 2012, while playing quarterback/linebacker. The exact play involved in the injury was unknown. The injury was a subdural hematoma. Emergency surgery was performed and recovery was incomplete.

A few football injuries also have resulted in fatalities, according to the National Center for Catastrophic Sport Injury Research's Annual Survey of Football Injury Research, 1931-2012:

- There were two fatalities directly related to football during the 2012 football season. Both of the fatalities were in semi-professional football. There is only one other year where there were no direct fatalities in high school and college football and that was in 1990.
- The rate of direct fatal injuries is very low on a 100,000 player exposure basis. For the approximately 4,200,000 participants in 2012, the rate of fatalities was 0.04 per 100,000 participants.
- The rate of direct fatalities in high school (grades 9-12) was 0.00 per 100,000 participants. The rate of direct fatalities in college was 0.00 per 100,000 participants. The rate for all other areas of football was 0.06 per 100,000 participants.
- Most direct fatalities usually occur during regularly scheduled games, and in 2012 this was true with both direct semi-professional fatalities occurring in games.

According to the same report by NCCSIR, a number of the players associated with brain trauma complained of headaches or had a previous concussion prior to their deaths.

The National Federation of State High Schools released the following statement on February 23, 2010: "Effective with the 2010 high school football season, any player who shows signs, symptoms or behaviors associated with a concussion must be removed from the game and shall not return to play until cleared by an appropriate health-care professional." The new concussion language has been placed in all NFHS rules books as well as the "NFHS Suggested Guidelines for Management of Concussion."

More recently, the long-term implications of concussion have been discussed at length in the media, sparked by the controversy between the NFL and its former players. An ESPN news story from early November 2013 covered the chronic traumatic encephalopathy (CTE) diagnosis of three ex-NFL players. Additionally, ESPN also reported that last year UCLA tested five other former players and were able to diagnose all five as has having signs of CTE, marking the first time the disease has been recognized in living patients.

Horseback Riding

While head injuries comprise about 18 percent of all horseback riding injuries, they are the number one reason for hospital admission. A 2007 study by the Centers for Disease Control and Prevention found that horseback riding resulted in 11.7 percent of all traumatic brain injuries in recreational sports from 2001 to 2005, the highest of any athletic activity. Of the estimated 14,446 horseback-related head injuries treated in 2009, 3,798 were serious enough to require hospitalization. Subdural hematomas and brain hemorrhages comprised many of the serious injuries. According to the Equestrian Medical Safety Association, head injuries account for an estimated 60 percent of deaths resulting from equestrian accidents.

There are factors that may increase the risk of falling, such as a green horse, slippery footing or bareback riding, but it is the height from which the rider falls that most significantly impacts the severity of the injury. According to the Ontario Equestrian Federation, a rider sitting on a horse is elevated eight feet or more above the ground: a fall from just two feet can cause permanent brain damage. Riders ages 10-14 are most likely to be involved in an accident with a horse.

While serious head injury can occur while wearing a helmet, the data very clearly shows that the severity of the head injury can be decreased through helmet wear. According to the *New England Journal of Medicine*, helmets can reduce head and brain injuries by 85 percent. While helmets are required in equestrian sports that involve jumping, including eventing and show jumping, in high-level dressage competitions, the riders generally wear top hats, which provide no protection. Accidents are less common in competitive dressage, but accidents can occur. While most dressage riders do not wear helmets even when practicing, they are allowed both during practice and competition.

The U.S. Equestrian Federation strongly encourages all riders while riding anywhere on the competition grounds to wear protective headgear with harness secured which passes or surpasses ASTM (American Society for Testing and Materials)/SEI (Safety Equipment Institute) standards for equestrian use and carries the SEI tag.

Snow Skiing/Snowboarding

According to a John Hopkins Medicine-led study, approximately 10 million Americans ski or snowboard in the United States each year, with about 600,000 injuries reported annually. Severe head trauma accounts for about 20 percent of all skiing- and snowboarding-related injuries, and of those head injuries, 22 percent are severe enough to cause loss of consciousness or concussion. Head injuries are the most frequent cause of death and severe disability among skiers and snowboarders.

According to the National Ski Areas Association's (NSAA's) 2012-2013 National Demographic Study, 70 percent of skiers and snowboarders wore helmets during the most recent ski season. This shows a 5-percent increase from the 2011-2012 season. Among those interviewed, helmet usage has increased by 180 percent since the 2002-2003 season, when only 25 percent of skiers and snowboarders reported wearing helmets.

More importantly, 80 percent of skiers and snowboarders age 17 and under reported wearing helmets on the slopes during the 2012-2013 ski season. The NSAA National Demographic Study was compiled from more than 130,000 interviews of skiers and snowboarders nationwide.

The 2012-2013 NSAA study also revealed that:

- 89 percent of children 9 years old or younger reported helmet usage in the 2012-2013 ski season
- 83 percent of children between the ages of 10 and 14 reported wearing helmets
- 81 percent of adults over the age of 65 reported helmet usage
- Skiers and snowboarders ages 18-24 have traditionally represented the lowest percentage of helmet use among all age groups. In the 2012-2013 season, 60 percent of all 18 to 24 years olds interviewed wore helmets, a 13-percent increase from the 2011-2012 season, when only 53 percent wore helmets.

NSAA recently launched a revamped Lids on Kids website designed to provide parents with pertinent helmet-safety information; it includes simple helmet-sizing instructions to help ensure a proper fit.

Helmet Usage

In 2011, New Jersey became the first state to require those under the age of 18 to wear a helmet while skiing or snowboarding. Currently, there are no other state laws mandating helmets for skiing or any winter sports. Ski resorts in Aspen, Colo., mandate that skiers under age 12 wear helmets. Following the high-profile skiing-related deaths of Michael Kennedy in December of 1997, Sonny Bono in January of 1998 and Natasha Richardson in March of 2009, an increase in the number of skiers wearing helmets has been noted in several studies.

Meanwhile, helmet use has been mandatory for snowpark users in Quebec, Canada, since the winter of 2006-2007, according to the Quebec Ski Areas Association (ASSQ). And in January of 2010, the Canadian Ski Council (CSC) issued the following national policy:

"The Canadian Ski Council recommends wearing helmets for skiing and riding. Skiers and snowboarders are encouraged to educate themselves on the benefits and limitations of helmet usage. The primary safety consideration, and obligation under the Alpine Responsibility Code, is to ski and ride in a controlled and responsible manner."

The policy was developed after research undertaken by the CSC showed that helmet usage in Canada is increasing steadily, with more than 50 percent of Canadian skiers and boarders wearing helmets; usage is much greater among youth, reaching 90 percent in many areas. In order to further ensure compliance with this initiative, the CSC notes that Canadian ski areas have invested heavily in making the sport safer, with improved signage, better grooming and safer equipment; areas have purchased more than 50,000 rental helmets to include in their rental packages, which are available at nearly all Canadian ski areas.

In a February 2010 release from Quebec's Trauma Centres and the ASSQ, Dr. Tarek Razek, director of the Montreal General Hospital Trauma Program, said, "Wearing a helmet reduces the risk of head injuries in skiers and snowboarders by approximately 35 percent." Dr. Razek also advocates helmet use in other sports, including cycling and rollerblading.

As part of a survey of 80 Canadian ski areas:

- Area operators estimated that 55 percent of all skiers and boarders wore helmets. Quebec had the highest rate of usage at 65 percent, with the lowest rate in Western Canada at 50 percent.
- The Grade 4/5 Snowpass program, which had 41,000 youth participants in 2008-2009, provides reduced-cost lift tickets and other specials for participants. Fifty-four percent of the parents of Snowpass holders reported wearing helmets regularly, and 93 percent of youth participants reported wearing helmets on a regular basis.
- A survey of 1,500 attendees conducted at the Toronto Ski Show in October of 2008 found that 55.3 percent of men and 57.6 percent of women wore helmets all or most of the time. Older skiers and boarders had a higher usage of helmets than younger adults.

Meanwhile, according to the 2012-2013 National Demographic Study of skiers and boarders, the National Ski Area Association in the U.S. found the following;

- Seventy-one percent of survey respondents were wearing a helmet when interviewed, up six percent in the previous season.

- Helmet usage increases with ability level, rising from 26 percent usage by beginners, to 38 percent by intermediates, to 55 percent by advanced/expert participants.
- Helmet usage is higher for children ages 9 and under (89%) and 10-14 (83%), and adults ages 55-64 (76%) and 65+ (81%) than for other age groups. Helmet usage is lowest among 18-24-year-olds (62%).

Soccer

Protection against head injuries in soccer is complicated by the fact that heading is an established part of the game, and any attempt to protect against head injuries must allow the game to be played without modification. Several head guards have been developed to reduce the risk of head injuries in soccer. One independent research study found that none of the products on the market provided substantial benefits against minor impacts, such as heading with a soccer ball.

A McGill University study found that more than 60 percent of college-level soccer players reported symptoms of concussion during a single season. Although the percentage at other levels of play may be different, these data indicate that head injuries in soccer are more frequent than most presume.

According to CPSC statistics, 40 percent of soccer concussions are attributed to head to player contact; 10.3 percent are head to ground, goal post, wall, etc.; 12.6 percent are head to soccer ball, including accidents; and 37 percent are not specified.

Types of Head Injuries

Concussions

Cerebral concussions frequently affect athletes in both contact and non-contact sports. Cerebral concussions are considered diffuse brain injuries and can be defined as traumatically induced alterations of mental status. A concussion results from shaking the brain within the skull and, if severe, can cause shearing injuries to nerve fibers and neurons.

Grading the concussion is a helpful tool in the management of the injury (see Cantu below) and depends on:

1. Presence or absence of loss of consciousness;
2. Duration of loss of consciousness;
3. Duration of posttraumatic memory loss; and
4. Persistence of symptoms, including headache, dizziness, lack of concentration, etc.

Some team physicians and trainers evaluate an athlete's mental status by using a five-minute series of questions and physical exercises known as the Standardized Assessment of Concussion (SAC). This method may not be comprehensive enough to pick up subtle changes. More recently, teams have employed ImPACT, a 25-minute computer-based testing program specifically designed for the management of sports-related concussion. A player who has sustained a concussion is three to six times more likely to sustain another one.While the decision on when an athlete is ready to return to play isn't straightforward — such as in this news story, when in November of 2013 a professional soccer player helped bring his team to victory despite having lost consciousness and dislocating five vertebrae — every player could benefit from baseline neurological testing before the season so that the results can be used for comparison in the event the athlete receives a blow to the head.

Note: There is no evidence to demonstrate all participants in contact collision sports should have baseline computerized neuropsychological (NP) tests. NP tools such as ImPACT/Cogsport, as well as SCAT3 have yet to be proven reliable or validated. These screening tests can be used only as a tool in the expert medical diagnosis and return to play decision-making process.Second Impact Syndrome (SIS) results from acute, sometimes fatal, brain swelling that occurs when a second concussion is sustained before complete recovery from a previous concussion. This causes vascular congestion and increased intracranial pressure, which may be difficult or impossible to control. The risk for SIS is higher for sports such as boxing, football, ice or roller hockey, soccer, baseball, basketball and snow skiing.

In September 2011, the AANS issued a Powerpoint presentation, titled "Concussion and Sports: Useful prevention and treatment information for your community from America's neurosurgeons" to help prepare and educate the public on this critical issue.

The issue of concussion is covered further within the AANS Patient Information section as well. To view that page, click here.

Coma

The word coma refers to a state of unconsciousness. The unconscious state has variability and may be very deep, where no amount of stimulation will cause the person to respond or, in other cases, a person who is in a coma may move, make noise or respond to pain, but is unable to obey simple, one-step commands such as "hold up two fingers" or "stick out your tongue." The process of recovery from coma is a continuum along which a person gradually regains consciousness.

For people who sustain severe injury to the brain and are comatose, recovery is variable. The more severe the injury, the more likely the result will include permanent impairment.

The Glasgow Coma Scale usually is administered upon admission to the hospital or by paramedic first responders to establish a baseline level of consciousness, motor function and eye findings. Frequent evaluations of the patient are imperative to help assess neurologic improvement or deterioration.

Brain-imaging technologies, particularly computerized axial tomography (CT or CAT scan), can offer important immediate information about a person's status. The purpose of performing an emergency CT scan is to rule out a large mass lesion (hematoma) compressing the brain that requires immediate surgical removal. Magnetic Resonance Imaging (MRI) is used in a more elective setting to image subtle changes that are not picked up by CT.

Brain Injury Symptoms

- Pain: Constant or recurring headache
- Motor Dysfunction: Inability to control or coordinate motor functions, or disturbance with balance
- Sensory: Changes in ability to hear, taste or see; dizziness; hypersensitivity to light or sound
- Cognitive: Shortened attention span; easily distracted; overstimulated by environment; difficulty staying focused on a task, following directions or understanding information; feeling of disorientation and confusion and other neuropsychological deficiencies
- Speech: Difficulty finding the "right" word; difficulty expressing words or thoughts; dysarthric speech

Head Injury Prevention Tips

Buy and use helmets or protective head gear approved by the ASTM for specific sports 100 percent of the time. The ASTM has vigorous standards for testing helmets for many sports; helmets approved by the ASTM bear a sticker stating this. Helmets and head gear come in many sizes and styles for many sports and must properly fit to provide maximum protection against head injuries. In addition to other safety apparel or gear, helmets or head gear should be worn at all times for:

- Baseball and softball (when batting)
- Cycling
- Football
- Hockey
- Horseback riding
- Powered recreational vehicles
- Skateboards/scooters
- Skiing
- Snowboarding
- Wrestling

Head gear is recommended by many sports safety experts for:

- Bull riding
- Martial arts
- Pole vaulting
- Soccer
- Vintage motor sports

General Tips

- Supervise younger children at all times and do not let them use sporting equipment or play sports unsuitable for their age.
- Do not dive in water less than 12 feet deep or in above-ground pools.
- Follow all rules at water parks and swimming pools.
- Wear appropriate clothing for the sport.
- Do not wear any clothing that can interfere with vision.
- Do not participate in sports when ill or very tired.
- Obey all traffic signals and be aware of drivers when cycling, skateboarding or rollerblading.
- Avoid uneven or unpaved surfaces when cycling, skateboarding or rollerblading.
- Perform regular safety checks of sports fields, playgrounds and equipment.
- Discard and replace sporting equipment or protective gear that is damaged.

Rule Changes in College Football to Prevent Head and Neck Injuries

The National Athletic Trainers' Association (NATA) and the American Football Coaches Association (AFCA) Task Force, headed by Ron Courson, director of sports medicine for the University of Georgia, has focused on two primary problems associated with head contact.

- Head-down contact still occurs frequently in intercollegiate football

- Helmet-contact penalties are not adequately enforced.

Rule changes implemented by the National Collegiate Athletic Association (NCAA) related to head-down contact and spearing in collegiate football have been distributed to all coaches and officials throughout the country. The objective is to eliminate injuries resulting from a player using his helmet in an attempt to punish an opponent.

With the rule changes and more diligent enforcement of the rules, there is hope that a significant reduction in head and neck injuries will result.

The NCAA revised its 16-year-old guidelines on treatment of concussion in the NCAA Sports Medicine Handbook to better provide member institutions with appropriate responses to concussion injuries and procedures for returning athletes to competition or practice. According to page 59 of the 2013-2014 edition, "...Any athlete who is diagnosed with a concussion must not return to play or practice that day and must be cleared by a healthcare professional before returning to play or practice."

The "Concussion Diagnosis and Management" section details circumstances in which an athlete should be withheld from competition pending clearance by a physician.

Football-related Head and Neck Injury Prevention Tips

- All players should receive pre-season physical exams, and those with a history of prior brain or spinal injuries, including concussions, should be identified.
- Football players should receive adequate preconditioning and strengthening of the head and neck muscles.
- Coaches and officials should discourage players from using the top of their football helmets as battering rams when blocking, hitting, tackling and ball carrying.
- Coaches, physicians and trainers should ensure that the players' equipment is properly fitted, especially the helmet, and that straps are always locked.
- Coaches must be prepared for a possible catastrophic spinal cord injury. The entire staff must know what to do in such a case; being prepared and well informed might make all the difference in preventing permanent disability.
- The rules prohibiting spearing (hitting another player with the crown of the helmet) should be enforced in practice and games.
- Ball carriers should be taught to not lower their heads when making contact with the tackler to avoid helmet-to-helmet collisions.

The AANS does not endorse any treatments, procedures, products or physicians referenced in these patient fact sheets. This information is provided as an educational service and is not intended to serve as medical advice. Anyone seeking specific neurosurgical advice or assistance should consult his or her neurosurgeon, or locate one in your area through the AANS' Find a Board-certified Neurosurgeon online tool.