

Recognizing and Managing Concussion in School Sport

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ABSTRACT

Every country around the world enjoys some sort of sport. The Olympics sees countries from all over the globe participate in elite sport, in both winter and summer competitions. Australia is widely known for cricket and rugby; America is known for baseball and gridiron football (among others). These sports are played at an elite level as well as beginners from early ages as young as 4 years in the backyard. Yet, it is also these sports that can deliver a ball at the speed of 100 km/h (football), 105 km/h (baseball), 112 km/h (rugby), 150 km/h (cricket), and 211 km/h (soccer). This is the same force that a car collision can produce. That force eventually finds a target, and in some cases, unfortunately, it is a head. Damage to the brain is not only from the impact of the ball hitting its target but rather also the shearing forces of acceleration–deceleration injury that can cause extensive injuries. There has been much discussion of late regarding concussion in sport and the accumulative effects of head blows resulting in varying degrees of memory loss and dementia later in life. The media have been saturated with heightened awareness of chronic traumatic encephalopathy. This, however, is still being researched. It is true that each concussion compounds the one before, but rather than focus on the injury, managers/coaches and sporting codes should be focusing on the identification and proper management of a suspected concussion and the return-to-play protocols. This is especially important in our schools where growing brains need nurturing. Neuroscience nurses are at the forefront of educating school children, teachers, and coaches through partnering with local schools. This article will focus on concussion recognition and management in school sport.

Keywords: chronic traumatic encephalopathy, concussion, head injury, posttraumatic amnesia, second impact syndrome

Mild head injury or mild traumatic brain injury (mTBI) is defined as “a patient with an initial Glasgow Coma Scale (GCS) of 14–15 on arrival at hospital, following acute blunt head trauma with or without a definite history of loss of consciousness or post traumatic amnesia” (NSW Ministry of Health, 2012).

Players, parents, teachers, coaches, managers, and officials must be mindful and cautious of concussion in a culture that continues to honor and enjoy the camaraderie and skill building benefits that sport brings.

“Jack and Jill went up the hill to fetch a pail of water. Jack fell down, and broke his crown and Jill came tumbling after....”

Up Jack got and home did trot as fast as he could caper. He went to bed to mend his head with vinegar and brown paper.”

Unfortunately, recognizing, managing, and treating mild head injury is a little more complicated than in the nursery rhyme Jack and Jill (Figure 1).

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Concussion

Concussion is a temporary diffuse injury to the brain, brought about by acceleration–deceleration force and shearing stress on the reticular formation (Hickey & Joanne, 2009). The concussive injury can be insidious or dramatic. It can progress quickly or over time. Concussion is a TBI—an injury to the head that may cause instant loss of awareness or alertness for a few minutes to a few hours after the traumatic event. It is defined as “an acute brain injury resulting from mechanical energy to the head from external forces” (Institute of Trauma and Injury Management, 2012; McCrory et al., 2013; WHO, 2004). Although concussions usually occur after a direct blow to the head, they can occur as a result of a blow elsewhere that is transmitted to the head (Daneshvar, Nowinski, McKee, & Cantu, 2011).

Concussion is a functional disturbance in cognitive function rather than a structural abnormality. This is why, at present, in the concussed patient, magnetic resonance imaging and computerized tomography are normal. However, Shin et al. (2012) suggest that, in the future, high-definition fiber tracking will allow doctors to clearly see neural connections broken by mTBI.

Symptoms of concussions include headaches, difficulty falling/staying asleep or excessive sleepiness, nausea, dizziness, confusion, difficulty concentrating, short-term

memory dysfunction, and problems with balance and coordination. They can be picked up on the sidelines or some at school when behavior is different. These symptoms are general and could mean many neurological illnesses. This is why the history and mechanism of injury are also important and should always be questioned. This can be done by asking the player, teammates, coaches, or video referee. Any acceleration–deceleration injury can cause the brain fibers to stretch and distort leading to neurological impairment. For example:

It was a routine move, one of 40-odd tackles that “Jake” had made during the game on that Saturday afternoon. Jake, 15, star rugby league player, but in a split second tragedy struck. The “brilliant young player” collapsed after an opponent’s knee hit the side of his head during the tackle—and he never regained consciousness. Life support was turned off the next day (Levy, Sydney Morning Herald, 8th of April 2013).

Sports Concussion Australasia (2013) suggests that three players per team, per season will suffer a concussion. It is the recognition and management of these players that require further attention. The Zurich Consensus (McCrorry et al., 2013) established that early diagnosis and appropriate management of individuals who have sustained an mTBI facilitate good outcomes. Evidence suggests that cumulative effects of repeated concussions increase the likelihood of cognitive impairment later in life (Moser, 2012; Mueller, 2001). Guskiewicz, Weaver, Padua, and Garrett (2000) found that, once a person has had a concussion, he or she is as much as four times more likely to sustain a second one. Moreover, after several concussions, it takes less of a blow to cause the injury and requires more time to recover (Moser, 2012). This is now thought to be of greater significance, particularly for school-age children, and they should not be playing sports until they are completely symptom free (McCrorry et al., 2013).

Concussive injuries often present when in the classroom, where children cannot focus on a task, cannot process information given, or who are just not themselves. This is usually picked up by the teacher, and as such, the teacher should be made aware of any concussive injuries the student may have had after school or over the weekend.

This timely, clinically relevant work examines the ways in which coaches, managers, sports organizations, and healthcare providers can identify and manage suspected concussion in youth sports; also included are return-to-play guidelines.

School Sport

Back in the mid-1990s, the concept of youth-sport concussion was almost unknown to the general public. Many people could discuss the “punch-drunk” concussions that were primarily related to boxers, but that was not translated into childhood sports injuries. Today, it is becoming the “norm” to see concussion-related stories on mainstream television shows such as Law & Order SVU, Criminal Minds, The Simpsons, and 60 Minutes. These shows have brought concussion awareness into the lounge rooms of everyday people.

Today, students have the opportunity to play a range of school sports including gridiron football, Australian rules football, rugby league, rugby union, cricket, equestrian, basketball, soccer, hockey (ice and field), skateboarding, swimming, baseball, wrestling, tennis, golf, skiing, netball, water skiing, squash, 10-pin bowling, and more. Each of these sports has the potential for concussion or mTBI.

Concussion education and management programs are gaining momentum in school sport and are already mandatory in some U.S. sports—National Football League (NFL) and National Hockey League (NHL). For the first time in history, most U.S. states have instigated a law that requires parents to sign a form acknowledging the risks and dangers of concussion in a particular sport, the Zackery Lystedt Law, which can be found at www.cdc.gov/concussion. This law was named after Zack Lystedt, a Seattle teenager who sustained a concussion during a game of football but kept on playing, collapsing afterward and sustaining an extensive brain

FIGURE 1 Nursery Rhyme “Jack and Jill” (Author Unknown, c. 1765)

“Jack and Jill went up the hill to fetch a pail of water.
Jack fell down, and broke his crown and Jill came tumbling after....”

Up Jack got and home did trot as fast as he could caper.
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injury. From this, it is important for the school community to be prepared to create a safe sports environment, an environment where risk of concussion is limited and identification and treatment of concussion are of the best quality. There must be development of reasonable standards of return-to-school first then return-to-sport programs.

Posttraumatic Amnesia (PTA)

Posttraumatic amnesia (PTA) is one of the stages of recovery after a TBI, where there is confusion, disorientation, and/or short-term memory dysfunction. It can last for hours, days, or weeks depending on the severity of the injury. The patient is unable to remember day-to-day events. They can usually remember up to the time of injury but not afterward. When evaluating memory, the time of injury becomes the reference point, because the length of time in PTA is more significant than the length of time unconscious (Hickey, 2009).

Despite the evidence, issues still surround the clearance of athletes/students. The National Collegiate Athletic Association (2011) suggests that concussion is difficult to detect, with athletes often underreporting the injury, minimizing the importance, or not recognizing the injury at all. Assessment and management of concussive injuries remain a difficult task. There are potentially serious complications after a blow to the head including second impact syndrome, postconcussive syndrome, posttraumatic encephalopathy, seizures, cervical spine injuries, skull fractures, intracranial hemorrhage, subdural hematoma, and/or extradural hematoma. Other obstacles include the pressure from teams/parents to allow “star” athletes to play, general practitioners’ not up-to-date concussion management, and “loop holes” in return-to-play guidelines.

A number of sporting codes have introduced rules to avoid dangerous play. In 2012, the NFL banned players from using their helmets to impact players on the head or neck; whereas, in rugby, spear tackles, where a player lifts and dumps a player on his head, is deemed a red card offense (Sports Concussion Australasia, 2013).

Australian Sports Scene

Sports Concussion Australasia (2013) suggests that three players per team, per season will suffer a concussion. The opinion that no player who is suspected of concussion should return to the field on the same day has now been accepted by all Australian football codes—Australian Football League, National Rugby League, Football Federation Australia, and the Australian Institute of Sport. The Australian Institute of Trauma Management published guidelines for general practitioners and hospital emergency departments in 2012 and included this advice. However, despite Regulation 10 of the International Rugby Board code, which says that any player

suspected of concussion must be taken off and not allowed back on to the field, there is an accompanying rule for the 2013 season—still on trial—that states that, if a player with suspected concussion can pass a series of tests lasting 5 minutes, then he can be allowed back into the game: the Pitch Side Concussion Assessment or the “5-minute rule.”

This is a “loophole” allowing for better management of the team result rather than player care. For example, (Australian Rugby Union [ARU]) Wallaby player George Smith returned to the field of play against the British & Irish Lions (July 10, 2013) after sustaining a technical concussion (he had two or more symptoms that showed positive for concussion on the initial sideline assessment). After one collision within the first few minutes of the game, he was dazed and clearly ataxic and had to be helped from the field. It was obvious to everyone watching that he was concussed. Yet, a few minutes later, he was back on the field, supposedly fully recovered. Hopefully, this is not the norm and that player safety is paramount in the minds of all who lead sporting codes and the management of play. Elite sport stars and their management have an obligation to the juniors and fans to abide by the rules, to be a role model, and to show that player safety is first and foremost.

Most sporting codes in Australia as of 2011 have a concussion management plan on file (Concussion in Sport Conference, 2013). Fine tuning of this plan, awareness, and ramifications of the content require extensive education and teaching among all members of the team. It should not be left on the shelf. It needs to be adhered to and worked into play, regardless of the sporting score at the time.

Second Impact Syndrome

During the minutes to a few days after a concussion injury, brain cells that are not irreversibly destroyed remain alive but exist in a vulnerable state. Cantu (1992) and Mueller (2001) suggest that this concept of injury-induced vulnerability has been put forth to describe the fact that patients suffering from head injury are extremely vulnerable to the consequences of even minor changes in cerebral blood flow and/or increases in intracranial pressure and apnea.

Young brains are particularly susceptible to second impact syndrome. This results from acute, usually fatal, cerebral edema, which occurs when a second concussion is sustained before complete recovery from the first concussion. It is almost completely preventable. It is thought to occur because of the loss of cerebral autoregulation. Mechanisms of the cerebral vasculature fail, which leads to a rapid rise in intracranial pressure (ICP) causing fatal herniation (McCrorry, Davis,

& Makdissi, 2012). These authors express concern regarding diffuse cerebral swelling after a head injury, which is more common in children than in adults and usually has a poor outcome.

Although patients with concussion typically have negative head imaging, imaging is warranted in those with severe mechanism, significant loss of consciousness, focal neurologic deficit, or worsening symptoms.

Chronic Traumatic Encephalopathy

Shows such as *Law & Order SVU*, *The Simpsons* and *Criminal Minds* have had story lines around chronic traumatic encephalopathy and dementia. Evidence from McKee et al. (2009) shows that the cumulative effects of repeated concussions may increase the likelihood of cognitive impairment later in life. Once a person has had a concussion, they are four times more likely to sustain a second one, and after several concussions, it takes less of a blow to cause the injury and requires more time to recover (Seichepine et al., 2013). Seichepine et al. describe that former ice hockey and football players who sustained concussions have been found to perform badly with regard to executive and memory tests decades after their last concussion. These studies indicate that executive functioning is impaired in former contact-sport athletes many years after their last exposure to brain trauma. Further evidence is needed to fully understand this phenomenon. Many athletes from different sports are now donating their brains to the study of this illness.

Soccer and “Heading”

Soccer is considered the world’s most popular team sport with over 265 million participants worldwide (FIFA, 2006) in all age groups. Although there are no tackles as such in soccer, the sport does have some risk of concussion. The primary concern in soccer is after the attempt of “heading” the ball and the concern about the risk of damage caused by the repetition of headers. Some early studies are starting to show brain changes in soccer players who have not had concussions but have had a lot of headers (Cantu & Hyman, 2012). There also appears to be greater risk for girl’s high school soccer, where reports of sports-related concussions are higher (Marar, McIlvain, Fields, & Comstock, 2012). This is most likely because of neck strength. Men tend to have stronger necks, and a stronger neck can help reduce the risk of a concussion by slowing down the movement of the head (Moser, 2012).

Proper heading technique is the athlete’s greatest defense against injury from heading a ball. Many coaching books do not address soccer heading until the age of 12 years, and it is recommended waiting until 14 years old before attempting heading (Cantu & Hyman, 2012;

Kirkendall, Jordan, & Garrett, 2001). Children who are not 14 years old are more vulnerable to injury because they are not yet physically mature; they have weak necks, immature musculature, and brains that are still developing (Cantu & Hyman, 2012). Once soccer athletes do begin heading, coaches should instruct them to strike the ball just below the hairline on the frontal bone, the thickest part of the cranium, while simultaneously isometrically contracting the neck musculature (Cantu & Hyman, 2012; Reid, Epstein, Louis, & Reid, 1975).

The potential for risks associated with chronic soccer heading has led some soccer leagues to mandate the use of headgear. Although manufacturers have designed and promoted these headbands to decrease the forces associated with heading a soccer ball, their efficacy has not been tested. In a study by Broglio, Ju, Broglio, and Sell (2003), they found a significant reduction in peak force of impact with all headgears on the market at that time.

Helmets and Mouthguards

Although many companies are looking at creating better technology and equipment to reduce head impact, these improvements have not decreased concussions. A concussion results from the brain moving about inside the skull. A safety device such as a helmet or mouthguard, although important for protecting the player from injury, will not protect them from a concussion. The Zurich Consensus (McCrary et al., 2013) suggests that stronger rules against hitting would be more beneficial to prevent concussions than a “concussion-proof” helmet. However, headgear and mouthguards are recommended to prevent other mTBI that can occur in contact sports. The better management for concussion is to recognize the symptoms, remove from play, and refer for medical review. A gradual return to school and then return to sport is advised (McCrary et al., 2012).

Mouthguards do prevent injury by providing a “cushion” that absorbs impact. Mouthguards were originally developed in the late 1800s as “gum shields,” a means of protection from lip lacerations for boxers. Today, there are many different types of mouthguards on the market—simple mouthguards, boil and bite mouthguards, and dentist-prepared mouthguards. In general terms, a custom fitting design is necessary to ensure retention in collision or contact sports (McCrary, 2001). However, mouthguards often fit poorly, therefore providing less protection, and can interfere with breathing and speech on the field. Currently, there are no international standards for mouthguards. Although hard evidence is limited in studies pertaining to prevention of brain and spinal injuries when wearing a mouthguard, evidence does show that there is a cushioning effect and lip/mouth/teeth injuries are less often reported in individuals wearing mouthguards.

Critical Role of Coaches in Concussion Care

Players, parents, teachers, coaches, managers, and officials must be mindful and cautious of concussion in a culture that continues to honor and enjoy the camaraderie and skill building benefits sport can bring.

Coaches have a vital role to play in recognizing concussion, being alert to the warning signs, referring players to medical care, being involved in rehabilitation, and insisting on final medical clearance from a medical doctor before the player is involved in contact training (International Rugby Board, 2012). At the community-sport level, return-to-play after concussion should be conservative, that is, preferentially taking longer than sooner. In school sport, the ARU insists that a player should only start team training a minimum of 2 weeks after symptoms have disappeared (Cantu & Hyman, 2012; Moser, 2012).

The 2013 Concussion in Sport Conference was held in Melbourne, Australia, and was supported by all Australian football codes—Australian Football League, ARU, National Rugby League, and soccer (Football Federation Australia/FIFA). Players, coaches, referees, first-aiders, and medical personnel were represented. Australian and international experts from a range of sports (including American grid-iron football and ice hockey) spoke on topics including the following:

- Current best practice management of concussion in elite and community level sport
- Latest research about the short-term and possible longer-term effects of concussion
- Putting concussion research into practice
- Priorities for concussion-related research now and into the future
- Implementation of outcomes from the 2012 Zurich International Conference on Concussion in Sport

A number of sporting codes have introduced rules to avoid dangerous play. In 2012, the American NFL banned players from using their helmets to impact players on the head or neck; whereas, in rugby (league and union), spear tackles, where a player lifts and dumps a player on his head, is deemed a red card offense.

The 2013 outcomes included the following:

- Rule changes regarding substitutes and eliminating the shoulder charge
- Education for players, coaches, family, general practitioners, and schools
- Strict enforcement of rule changes: fines to clubs and individuals
- Encouragement of sportsman-like behavior
- Encouragement of helmets and mouthguards where appropriate

- The use of the SCAT 3 and Pocket Concussion Recognition Tool (PCRT) in elite, club, and school sports
- Recognize—remove—refer

Discussion needs to include the definition of “rest” nowadays after a concussion. This means no reading, no TV, no computer, and no handheld electronic devices (iPods, iPhones, iPads, Gameboys, etc.). There must be complete mental and physical rest until all symptoms have gone. It is important to return the player to school first and then to sport.

Preseason testing can give an accurate evaluation of an athlete’s capabilities before an injury occurs. It is advisable that season preparation include shoulder and neck strengthening exercises, baseline Sports Concussion Assessment Tool (SCAT3 test; see Figure 2), education for the coaches and officials regarding the use and interpretation of the PCRT (see Figure 3), and education regarding the use of the SCAT3 by medically trained personnel.

The SCAT3 covers the following:

- Memory function
 - “What venue are we at today?”
 - “Which half is it now?”
 - “What team did you play?”
 - “Did your team win last week?”
- Neuropsychological testing: cognitive ability and reaction times
- Balance testing: tandem stance (heel-toe, 20 seconds; hands on hips, eyes closed)

The general practitioner/medical doctor will screen for and look at the following:

- Anxiety; depression; stress; teacher concern at school—“zoning out,” bad behavior, disruptive, and/or grades dropping; time since discharged from hospital; mechanism of injury; protective equipment at the time of injury; loss of consciousness, concussion, or symptoms; PTA and/or period of amnesia; previous incidence(s) of concussion

Return to School

No child should return to play without a thorough examination by a healthcare provider trained in sports concussion. Preseason baseline neuropsychological testing, coupled with postconcussion testing, greatly enhances the decision to return to play. Despite this knowledge, most schools do not have such testing programs in place. Children may not exhibit the first signs of concussion until days after a particularly hard knock or rough tackle, which makes diagnosing concussion difficult (Moser, 2012).

FIGURE 2 SCAT3

SCAT3™
Sport Concussion Assessment Tool – 3rd Edition

For use by medical professionals only

Name: _____

Date of Injury: _____

Date of Assessment: _____

From: _____

What is the SCAT3?

The SCAT3 is a standard tool for evaluating injured athletes for concussion and for the sideline assessment (1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12) (13) (14) (15) (16) (17) (18) (19) (20) (21) (22) (23) (24) (25) (26) (27) (28) (29) (30) (31) (32) (33) (34) (35) (36) (37) (38) (39) (40) (41) (42) (43) (44) (45) (46) (47) (48) (49) (50) (51) (52) (53) (54) (55) (56) (57) (58) (59) (60) (61) (62) (63) (64) (65) (66) (67) (68) (69) (70) (71) (72) (73) (74) (75) (76) (77) (78) (79) (80) (81) (82) (83) (84) (85) (86) (87) (88) (89) (90) (91) (92) (93) (94) (95) (96) (97) (98) (99) (100) (101) (102) (103) (104) (105) (106) (107) (108) (109) (110) (111) (112) (113) (114) (115) (116) (117) (118) (119) (120) (121) (122) (123) (124) (125) (126) (127) (128) (129) (130) (131) (132) (133) (134) (135) (136) (137) (138) (139) (140) (141) (142) (143) (144) (145) (146) (147) (148) (149) (150) (151) (152) (153) (154) (155) (156) (157) (158) (159) (160) (161) (162) (163) (164) (165) (166) 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It is paramount that the student be returned to school as a priority before returning to sport. Concussion symptoms may affect an athlete not only on the sports field but also in the classroom. “When I got a concussion (while playing soccer), I expected to sit out some games, but I never realized that it would actually hurt to think.” This is a common observation. After a concussion, rest is critical to help the brain heal. Davis, Makdissi, and McCrory (2013) suggest that during this time, not only physical activities but also activities that involve learning and concentration, which are common in the classroom, can aggravate concussion symptoms (such as an inability to pay attention or learn new information, fatigue, headaches). Concussion symptoms can hamper memory and information processing, which interferes with the child’s ability to learn in the classroom. Medical clearance is required before children return to school. Teachers should be made aware that a concussion has taken place, because they are at the forefront to pick up any subtleties that the child may display. It is normal for a child to miss a day or two after a concussion. In some children, a graduated return to school may be necessary, and a pediatric neuro-psychologist may be required for the more difficult cases.

School management of concussion and mTBI rehabilitation involves the following:

- Teacher/nurse: return to learn
- Physiotherapist: return to vision and balance
- Coach: return to exercise/sport
- Hospital/medical doctor: final medical clearance

Return to Sport

Aubry et al. (2013) suggest that concussion must be recognized and treated appropriately. However, the most important decision is the timing of the return to play. The player should not return to play until completely symptom free. The mantra of “If in doubt, sit it out” should be followed.

Nurses and Concussion

Nurses play a pivotal role in the treatment and education of patients and their families after a concussion. This is not only seen during their hospital stay, with the nurse attending to neurological observations and PTA testing, but also as part of the student’s sport training and coach/manager education within the school community itself. A number of neuroscience nurses visit

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FIGURE 3 Pocket Concussion Recognition Tool

Pocket CONCUSSION RECOGNITION TOOL™

To help identify concussion in children, youth and adults

RECOGNIZE & REMOVE

Concussion should be suspected **if one or more** of the following visible clues, signs, symptoms or errors in memory questions are present.

1. Visible clues of suspected concussion

Any one or more of the following visual clues can indicate a possible concussion:

- Loss of consciousness or responsiveness
- Lying motionless on ground/Slow to get up
- Unsteady on feet / Balance problems or falling over/Incoordination
- Grabbing/Clutching of head
- Dazed, blank or vacant look
- Confused/Not aware of plays or events

2. Signs and symptoms of suspected concussion

Presence of any one or more of the following signs & symptoms may suggest a concussion:

<ul style="list-style-type: none"> - Loss of consciousness - Seizure or convulsion - Balance problems - Nausea or vomiting - Drowsiness - More emotional - Irritability - Sadness - Fatigue or low energy - Nervous or anxious - "Don't feel right" - Difficulty remembering 	<ul style="list-style-type: none"> - Headache - Dizziness - Confusion - Feeling slowed down - "Pressure in head" - Blurred vision - Sensitivity to light - Amnesia - Feeling like "in a fog" - Neck Pain - Sensitivity to noise - Difficulty concentrating
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3. Memory function

Failure to answer any of these questions correctly may suggest a concussion.

"What venue are we at today?"

"Which half is it now?"

"Who scored last in this game?"

"What team did you play last week /game?"

"Did your team win the last game?"

Any athlete with a suspected concussion should be IMMEDIATELY REMOVED FROM PLAY, and should not be returned to activity until they are assessed medically. Athletes with a suspected concussion should not be left alone and should not drive a motor vehicle.

It is recommended that, in all cases of suspected concussion, the player is referred to a medical professional for diagnosis and guidance as well as return to play decisions, even if the symptoms resolve.

RED FLAGS

If ANY of the following are reported then the player should be safely and immediately removed from the field. If no qualified medical professional is available, consider transporting by ambulance for urgent medical assessment:

- Athlete complains of neck pain
- Increasing confusion or irritability
- Repeated vomiting
- Seizure or convulsion
- Weakness or tingling/burning in arms or legs
- Deteriorating conscious state
- Severe or increasing headache
- Unusual behaviour change
- Double vision

Remember:

- In all cases, the basic principles of first aid (danger, response, airway, breathing, circulation) should be followed.
- Do not attempt to move the player (other than required for airway support) unless trained to do so
- Do not remove helmet (if present) unless trained to do so.

from McCrory et. al, Consensus Statement on Concussion in Sport. Br J Sports Med 47 (5), 2013

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local schools to teach a program highlighting the need to be vigilant when it comes to head knocks. The program, graded for each year group, emphasizes the importance of children's sport, brain function, how to best protect the head, how to recognize a concussion, how to manage a concussion, implementing a graded return to school, and a graded return to sport. The schooling system is open to having nurses educate their teachers, coaching staff, and students. The teaching program emphasizes that it is not OK to continue to play sport with neurological symptoms. It is imperative that children, parents, teachers, and coaches understand the importance of recognizing a potential concussion, removing the student from play, and referring children with suspected concussion to a medical practitioner or hospital. Nursing goals in teaching center around best practice in regards to concussion recognition and response protocols, safer tackling techniques, safe play, equipment fitting instruction, teaching strong leadership, and team spirit.

Conclusion

Sport provides children with an avenue for setting and achieving goals, learning discipline, and building team skills. They are encouraged to take pride in success and be gracious in defeat. It is widely agreed that children

who play sport have stronger self-esteem, perform better in school, and are healthier and fitter than those who do not play an active sport. The general concepts of sport include the following:

- Physical activity keeps us healthy.
- Play safely by being in good physical shape.
- Practicing the skills of the game through drills and structured workouts improves game play, mobility, hand-eye coordination, balance,
- Teach sportsmanship: it is not personal; do not respond in an aggressive way on the field.
- Teach in the "spirit of the game" where "doing my best doesn't mean winning at any cost."
- Discourage unsafe play.
- Be aware of the signs and symptoms of a concussion.
- "When in doubt, sit it out."
- Encourage and enforce safety standards—helmets and mouthguards.

Head injuries will never be totally eliminated from contact sports, but with proper education, awareness, and preventative measures in place, the frequency and severity can be dramatically reduced. Athletes, parents, teachers, and coaches should be educated about the

signs and symptoms associated with concussion as well as the dangers of recurrent injury. A comprehensive understanding of concussion and its related risks is important in making return-to-play decisions as well as healthcare and league policy.

Sporting rules and equipment need to be modified to prevent concussions from occurring. Two of the main reforms that relate specifically toward children are that tackling during football and heading the ball during soccer should be limited until the age of 14 years.

Great advances in technology could make diagnosing concussion possible in the future. High-definition fiber tracking is a promising technology to directly measure breaks in brain fibers that control function. This technology will allow for biological diagnosis of concussion—"proof" that a brain injury has occurred.

As the hunt for better tests continues, the bigger message is to take steps to protect young brains by new rules, strengthening exercises, and protective equipment. However, what makes the biggest difference for everybody, from children riding bikes, school children at sport, athletes playing elite sport, to soldiers at war, is the awareness, recognition, and management of TBI. Neuroscience nurses are well positioned to bring head injury awareness into the school setting to facilitate the message that it is not OK to return to play unless all symptoms have cleared. As the saying suggests, "there is no I in TEAM"—everyone has a role to play in the recognition and management of concussion, for the good of the player, the team, and the sport.

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